FUTURE WORKSPACES

Proceedings of the Transdisciplinary Workplace Research (TWR) Conference 2020

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EDITORIAL

Understanding and shaping future workspaces in a transdisciplinary way!

Employers, consultants and researchers are constantly looking for ways to better understand how work can lead to optimal results in terms of performance, satisfaction, health and well-being. Within this search, there is a growing awareness that the space where work is done plays an important role. Social, physical, technological, and operational aspects of the working environment interact with the behaviour of workers and with each other. A transdisciplinary (= interdisciplinary + practical) approach is therefore needed to advance our knowledge and practices in this area.

Until now, the various aspects of the workplace have mostly been studied in isolated academic and professional fields. For this reason, the 'Transdisciplinary Workplace Research Network' (TWR Network) was launched in 2017. It aims to bring together the various workplace researchers and professionals from all relevant disciplines to exchange findings and ideas (www.twrnetwork.org) and is led by an international board. The idea of the network is that design and operations of healthy and productive working environments not only takes individual economic, personnel, design, or technical-communicative aspects into account; integrative approaches beyond disciplinary paths are also necessary. In addition, practical experience must be combined with applied research in order to generate sound evidence and overcome the theory-practice dichotomy.

To achieve this transdisciplinarity, the network organises a biannual conference, the TWR Transdisciplinary Workplace Research Conference. After the first TWR Conference 2018 in Tampere Finland, this year's conference took place online and in Frankfurt from 16th to 19th September 2020. The intended mix was achieved: The proportion of academics and practitioners was about 50% each. Participating practitioners were project developers, asset managers, space and technology providers, investors, users, planners, consultants and other service providers. They met with a broad range of academic disciplines: occupational science, psychology, sociology, medicine, (interior) architecture, building, information and communication technology, real estate and facilities management, human resources, project and change management.

All research contributions to the conference were first submitted as abstracts and after acceptation as short papers to a review process. The reviewers, a great number of internationally reputed researchers, checked the quality of the contributions and gave helpful recommendations to further optimize the papers and presentations. The result is a really remarkable and unique collection of most up-to-date research insights and a previously not seen broadness of topics.

But not only contents of the TWR2020 are remarkable. The whole conference was a challenge and an experiment, given the global disruptions and resulting uncertainties for any kinds of meetings from the beginning of 2020 on. Yet, thanks to the trust of TWR board members, authors, and reviewers worldwide into the organization committee and its ability to somehow provide a valuable experience, the experiment could take place. And now, according to the cheering feedback after three intensive and innovative days, it can be stated: The experiment was a success!

70 virtual and 30 physical participants from 17 countries were able to engage in an exchange that crossed borders and disciplines in every respect. All events - from the architecture tour and the round tables on Covid19, key notes and more than 70 presentations, up to joint cooking, the running dinner and the excursion to the intelligent building of smart engine | wtec - were held in a hybrid form: virtually live and on site. The site, the flexible office COWORKSTATT in Frankfurt-Griesheim, proved to be the ideal place for the discussion about modern and contemporary workplaces.

The round tables on the topic 'Future of work after COVID19' focused on the question, what consequences the pandemic has for the design of workplaces. The round table discussion was splitted into two thematic groups that each included physical and virtual participants, interactively working. One group was moderated by Malte Kopmann (RBS Group) and Wilco Poppelier (Drees & Sommer), discussing the question how the office of the future might look like in concrete terms. The second was chaired by Cheuk F. Ng (Athabasca University/ Canada), and examined the question of what challenges, opportunities and risks the increased home office work could mean for the users themselves and the future use of buildings.

The first keynote was held by Workplace Trendscout Raphael Gielgen (Vitra GmbH). He invited the participants to join him on his journey into the future and presented his roadmap that may well point the way forward. The second key note was a splitted one by Nigel Oseland (Workplace Unlimited), Pia A Döll, President of the Association of German Interior Designers (bdia e.V.), Tobias Just, President of the German Society of Property Researchers (gif e.V.) and Marcel Özer, Team Leader EPEA | Part of Drees & Sommer. Together, the speakers contributed to presenting the question of the future design of workplaces from different perspectives: the users', the planners', the investors', and the societies), thus complementing each other and inspiring the audience.

The heart of the event were the 20 sessions with nearly 70 presentations of an exciting variety of topics that were each discussed by virtual and physical participants alike. The short written contributions to the presentations are compiled in these proceedings. They provide a unique snapshot of state-of-the-art transdisciplinary workplace research and cover the following topics:

- healthy and collaborative workplaces
- health and well-being@workplace
- new ways of working / collaboration / collaboration spaces
- digitalization & technology
- workplace productivity
- workspace culture and management
- learning & virtual work environments.

Alongside the TWR board and network - most notably Rianne Appel-Meulenbroek, Remi Ayoko, Sally Augustin, and about 80 reviewers from all over the world - we would like to thank the various partners who made the realization of the event possible and supported it. Without the experienced team of Omega Veranstaltungstechnik Weimar, we would not have been able to implement the novel hybrid conference concept. Many thanks also go to our sponsors Drees & Sommer, COWORKSTATT Frankfurt, Society of Property Researchers (gif) e.V. and Association of German Interior Deisgners (bdia). The whole project was so successful, however, because the researchers involved were unwavering in their efforts to realize outstanding results. Through their contributions and participation, the conference achieved its goals: linkage between workplace research and practice as well as across disciplines and geographical borders, and research enhancement of workplace topics. A thousand thanks to you all!

Mascha Will-Zocholl & Annette Kämpf-Dern

CONFERENCE PROGRAM

Wednesday, 16.09.2020 (Pre-Conference Day)

10.00-12.00	Guided Tour "The Frankfurt High-Rise Center" (Spots still available)
12.30-13.30	TWR Board Meeting
14.00-17.30	Virtual Round Tables topical frame **"The Future of Workplaces in the light of COVID-19"** Chairs • Malte Kopmann, RBSGROUP – Part of Drees & Sommer • Cheuk F. Ng, Athabasca University Canada • Kerstin Sailer, University College London/GB Planned break-out sessions (for example) with the following chairs: • What are alternate uses for under used commercial buildings? • With the experience of the last months, how do we want to reimagine the role of the office in the future? • Assessing health and wellbeing in the workplace • Impact on the home/residential real estate
18.30-20.00	Reception/Virtual Apéro

Thursday, 17.09.2020 (Conference Day 1)

		ROOM 1		
09.00-10.00		Welcome and Presentation of Round Table Results		
10.00-11.00		Keynote: Raphael Gielgen, Vitra Gmbh		
11.00-11.30		Break		
	ROOM 1	ROOM 2	ROOM 3	ROOM 4
11.30-13.00	Session 1 Determinants of CoWorking Spaces	Section 5 Activity-based Workplaces	Session 11 Architecture and New Working Concepts	Session 17 Optimizing Workplaces
13.00-14.00		Lunch Break		
14.00-15.30	Workshop	Session 6 Experiences of Collaborative Spaces	Session 12 Challenges of New Ways of Work	Session 18 Digital Work Issues I
15.30-16.00		Break		
16.00-17.30	Session 2 Healthy Workplaces I	Session 7 Creating Collaborative Spaces	Session 13 Physical Workplace Issues	Session 19 Digital Work Issues II
		ROOM 1		
18.30-20.00		Cooking for the virtual participants		
19.30-20.00		Aperitivo at the COWORKSTATT for the physical participants		
20.00-22.00		Running Dinner		

Friday, 18.09.2020 (Conference Day 2)

		ROOM 1		
9.00-10.15		Splittet Keynote: Holistic Perspective on Workplace Design		
	Pia A. Döll, bdia e.V.	Tobias Just, gif e.V.	Nikolas Müller, HSBA	Marcel Özer, EPEA
10.15-11.00		Postersession		
Methods of measuring the added value of Facility Management for generating competitive advantage Christian Schlicht, University of Seattle	The Effects of Biophilic Design: Measuring the Well-being value in workplaces through Post-Occupancy Evaluation (POE) Joyce Chan, Loughborough University Derek Clements-Croome, Reading University	Rosatom New Workplace Design: Pilot Spaces Assessment Daria Rud, National University Higher School of Economics, Moscow Mikael Ukhov, Huazhong University of Science and Technology	Environmental Factors Affecting Employees' Choice of Workstation for Creative Activities in Activity-Based Offices Sepideh Yekanialibeiglou Halime Demirkan, Bilkent University Leif Denti, University of Gothenburg	What role will the office in the future play? Rowena Johnston, RBSGROUP - Part of Drees & Sommer
11.00-11.30		Break		
	ROOM 1	ROOM 2	ROOM 3	ROOM 4
11.30-13.00	Session 3 Healthy Workplaces II	Session 8 Personality and Workplaces	Session 14 Quality of Office Places	Session 20 Virtual Spaces of Work
13.00-14.00		Lunch Break	Speed-Dating	
14.00-15.30	Session 4 Health and Well-being@work	Session 9 Workplace Performance Management	Session 15 Sustainability and Working Conditions	
15.30-16.00		Break		
16.00-17.30	Workshop	Session 10 Workplace Culture & Management	Session 16 Learning and Community@Work	
		ROOM 1		
17.30-18.00		Final Plenary Note		
19.30		Dinner in a typical Frankfurt Restaurant "Apfelweinwirtschaft"		

Satursday, 19.09.2020 (After-Conference Excursion)

10.30-13.00	Visit of a modern workplace: a former engine shed transformed by architecture and smart building technology (wtec GmbH)

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SESSION 1: DETERMINANTS OF COWORKING SPACES

Differences in user preferences across European coworking spaces

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ABSTRACT

Purpose: Due to the sharing economy and new forms of collaborations, work practices have changed and led to continuing popularity of coworking spaces. The aim of this study was to find out whether user preferences and motivations are consistent among coworking space users across three different countries, namely the Netherlands, Germany and Czech Republic.

Theory: Research has shown that coworking space users are heterogeneous by occupation and/or sector. Many are attracted by the potential for knowledge sharing and belonging to a working community, but other motivations have been identified for their use as well. Physically, these spaces are diverse in outside and inside appearance, from modern offices to redeveloped industrial warehouses. Their numbers are increasing, and worldwide chains are expanding rapidly.

Design/methodology/approach: To analyze potential differences between countries, a mixed multinomial logit model (MMNL) for each country was estimated. Data for this model was collected in the Netherlands (219 respondents), Germany (98 respondents) and Czech Republic (79 respondents), within three years (2016-2019). The online survey consisted out of two parts, namely a general questionnaire about personal- and work-related characteristics and a stated-choice experiment to collect data on preferences for important coworking space characteristics.

Findings: The results showed that the vibrant and creative atmosphere of a coworking space is one of the main three motivations of coworking space users, followed by work-life balance. Professional appearance is more important in Germany compared to other countries. On the other hand, the opportunity for social interaction with other coworkers is more important for coworkers in the Netherlands, while flexibility is highly essential for coworkers in the Czech Republic. Concerning design preferences, coworkers in the Netherlands and the Czech Republic prefer a homier atmosphere and interior, while coworkers in Germany prefer a more modern interior. The

findings showed that the accessibility of the location is the most crucial coworking space attribute for coworkers in the Czech Republic and Germany. For coworkers in the Netherlands, the type of lease contract is the most important aspect, when choosing a coworking space.

Originality/value: Existing studies about coworking with respondents from multiple countries are scarce or do not offer a clear insight in the user preferences for the physical workspace design and especially whether this differs between countries. Still little is known about the specific preferences of users of coworking spaces. The findings give more understanding of how coworking space providers of different countries can design their business models.

KEYWORDS

Coworking spaces, user preferences, stated choice method, mixed logit model, country differences

1 INTRODUCTION

For the last two decades, work practices have changed due to the collaborative economy and new forms of collaboration (Mitev et al, 2018). One of the consequences is the continuing rise of coworking spaces and the flexible office space industry. Up until 2022, the number of coworking spaces is expected to grow at an annual rate of 6% in the U.S. and 13% elsewhere. Europe is forecast to see 23.7 million square meters of flexible space in 2019, which represents an increase of 12% (Instant Offices, 2019). Attracting new members has been and remains the number one challenge for coworking spaces (Deskmag, 2018). However, as Bouncken, Clauss & Reuschl (2016) mentioned, there is limited understanding of how coworking space providers can design their business models for differing user demands. User preferences must be clear before specific user-focused business models can be determined. With the extensive market growth, operators with a more user-centered business model are more likely to survive.

Coworking spaces have been studied extensively in different European countries such as the Netherlands (Weijs-Perrée et al, 2019), Germany (Thierstein, Marx & Stadt, 2016; Bouncken et al, 2018), Austria (Gerdenitsch et al, 2016), Switzerland (Burret, 2014), Italy (Mariotti, Pacchi & Di Vita, 2017), Norway (Frick, 2015), Slovakia (Holienka & Racek, 20015) and Slovenia (Rus & Orel, 2015). Such papers have many different focus areas for analyzing the coworking phenomenon and relate it to many different theories. However, they generally lack a clear insight in the user preferences for the physical workspace design and mainly whether this differs between countries, because of their single country focus. Coworking space users seem to prefer different services and spaces (Yang et al., 2019), but several coworking operators have started providing nearly identical looking coworking spaces worldwide (e.g. WeWork, ImpactHub, Spaces) to cater multi-nationals. On the contrary, some local, small and independently run coworking operators are instead specializing in specific local user groups and show a high diversity in terms of strategy, location and set-up (Bouncken et al. 2020). Studies about coworking with respondents from multiple countries are still scarce and do not analyze whether the country of residence might relate to different user preferences. Therefore, the following paper aims to analyze the consistency of user preferences among coworking space users from three different countries, namely the Netherlands (Western Europe), Germany (Western Europe) and Czech Republic (Central Europe).

2 COWORKING SPACE PREFERENCES

2.1 Coworking space benefits

Parrino (2015) described coworking spaces as the co-localization of various coworkers within the same work environment, who are heterogeneous by occupation and/or sector in which they operate and/or organizational status and affiliation, and where activities and tools designed to stimulate the emergence of relationships and collaboration among coworkers are present (or not). This relatively new model of *working alone-together* (Spinuzzi, 2012) is not only elusive to participants but also increasingly an intrigue of academics (Waters-Lynch et al, 2016).

Previous research mentioned that the main added value of a coworking space is not a favorable rent or a more pleasant working environment than home, but the possibility of collaborating with other coworkers when ideas, resources and necessary information are lacking (Waters-Lynch & Potts, 2017). Gerdenitsch (2016) investigated social interaction in coworking spaces and found that the social support in coworking spaces indeed led to higher quality and satisfaction of work. Besides attracting people with different profiles and social interactions being central to the concept, coworking spaces are also said to be different from other shared office concepts in the aesthetic design of the spaces (Waters-Lynch et al., 2016). What is more, they generally develop and utilize mediation mechanisms that expand the capacity of networking activities (Cabral & van Winden, 2016) and co-create a sense of supportive community within the space (Garrett et al., 2017).

2.2 Coworking space attributes

To study preferences of users, it is vital to identify the most important attributes of coworking spaces that can satisfy or frustrate particular preferences. First, like all offices, coworking spaces need to be positioned in accessible locations to be able to attract tenants (Green, 2014). Generally, accessibility by car and/or by public transport can be distinguished as relevant attribute levels. Regardless of their location as a second distinguishing attribute, coworking spaces can be located in new, modern offices, but also in the former industrial era warehouses (Deskmag, 2016). Early coworking spaces made the use of practical furniture when setting-up typical home-like environments i.e. atmosphere and aesthetics with couches, kitchen desks and other home-based furniture (Neuberg, 2005; Brown, 2017). A third attribute is the layout of the space, as openness has been shown to influence face-to-face interactions in offices (e.g. Rashid et al, 2006). Generally, coworking spaces have an open layout (Gertner & Mack, 2017), as this is likely to stimulate interaction between coworkers as intended, but a half-open layout can also be present and even individual, closed spaces are offered in some coworking spaces (Deskmag, 2016) to cater all possible preferences (Wright, 2018).

Besides the regular workspace, a majority of coworking spaces are combined with private meeting rooms and a kitchenette. However, the trend is progressively shifting in a way that many contemporary buildings offer additional types of areas, such as informal break out zones and spaces for specific events (Kojo & Nenonen, 2014; Deskmag, 2016), and provide their users additional leisure and well-being services such as recreational facilities (e.g., gym, spa, etc.) and guided sport activities (e.g., yoga, meditation classes, etc.) (Spinuzzi, 2012; Cabral & Van Winden, 2016). However, it is not clear whether these additional facilities attract more tenants.

Additionally, many coworking spaces have a coworking host or manager who curates the interactions and interconnects regular users in supportive networks (Merkel, 2015; Rus & Orel, 2015; Spinuzzi et al, 2019). Community managers regularly play an essential role in coworking space development and positioning on the market (Gregg & Lodato, 2018).

The last two attributes concern the diversity of tenants and the lease contract. The description of coworking spaces by Parrino (2015) emphasized a diversity of users regarding their sector, although some coworking spaces focus on a specific industry. According to multiple studies (Spinuzzi, 2012; Fuzi et al., 2015; Sykes, 2014), a short contract is also a typical coworking space characteristic. Some even have no contract at all, but extended contracts can also be an option.

3 METHODOLOGY

3.1 Data collection

Data were collected with an online questionnaire consisting of two parts. First, respondents were asked more personal questions, such as gender, age and education level, and their motivations to work at a coworking space, followed by work-related characteristics (i.e. user group, position within the organization, sector of the organization, and several hours working at the coworking space). For the second part, a stated-choice experiment (see Hensher, Rose & Greene, 2015) was used to collect data on preferences concerning the coworking space attributes. In this experiment, respondents were asked to choose between three descriptions of hypothetical alternative coworking spaces, plus the option to instead work from home or at another coworking space than those presented. These alternatives varied based on the possible levels of the identified coworking space attributes from literature. As discussed before, the eight attributes shown in Table 1 were included, with three distinguished levels of 'quality'.

Table 1. The attribute levels

Attribute	**Attribute level**
Accessibility	Level 0: By car and public transport
	Level 1: By car
	Level 2: By public transport
Atmosphere and interior aesthetics	Level 0: Industrial
	Level 1: Modern
	Level 2: Homey
Layout of the space	Level 0: Open layout
	Level 1: Half open layout
	Level 2: Closed layout
Diversity in supply spaces	Level 0: Basic coworking space
	Level 1: Standard coworking space
	Level 2: Premium coworking space
Reception and hospitality	Level 0: No reception and no host
	Level 1: Reception but no host
	Level 2: Reception and active host
Events	Level 0: None
	Level 1: Sometimes
	Level 2: Often
Diversity of tenants	Level 0: No diversity of tenants
	Level 1: Moderate diversity of tenants
	Level 2: Strong diversity of tenants
Lease contract	Level 0: No contract
	Level 1: Short-term contract
	Level 2: Long-term contract

As each attribute has three levels, this would result in (3^8 =) 6,561 possible alternatives. As it is not possible to show all these alternatives, an orthogonal fraction of this design was constructed (Hensher et al., 2015), consisting of 27 alternatives. These alternative spaces were randomly divided over 9 choice sets, with each 3 alternatives. This way each respondent evaluated all hypothetical workspaces (meaning a complete design).

The survey was spread in the Netherlands, Germany and the Czech Republic, within a period of three years (2016-2019). The samples were collected in many different regions/cities and coworking spaces in order to provide a spatial heterogeneity of the participants. In Berlin, for example, there is a very mature coworking space market, which attracts many workers from the IT sector, while in Frankfurt many workers come from the financial sector. Furthermore, the survey was conducted in small and medium-sized cities, so that a cross-section of coworking spaces was achieved. In Czech Republic, data was collected only in the main capital Prague, ranging from student-style coworking cafes to corporate coworking spaces. Centrally positioned and with a midsized urban area, Prague has seen a swift growth of coworking spaces and users in recent years (Mayerhoffer, 2020). The coworking spaces in all countries were visited personally to achieve a high response rate. In the Netherlands, a total of 219 respondents successfully completed the questionnaire, in Germany 98 respondents, and in Czech Republic 79 respondents.

3.2 Analytic strategy

A mixed multinomial logit model (MMNL) for each country was estimated to analyze the differences between countries regarding user preferences for the characteristics. A MMNL is a very efficient and flexible discrete choice model (McFadden & Train, 2000) for analyzing data with a panel structure (i.e. multiple choices by the same respondent). Furthermore, using this approach, it is possible to capture unobserved heterogeneity (McFadden & Train, 2000). It estimates a constant utility parameter that reflects the alternative ‘none of these options’ in which a respondent rather would work at home or somewhere else than in one of the three hypothetical coworking spaces.

4 RESULTS AND DISCUSSION

4.1 Sample description

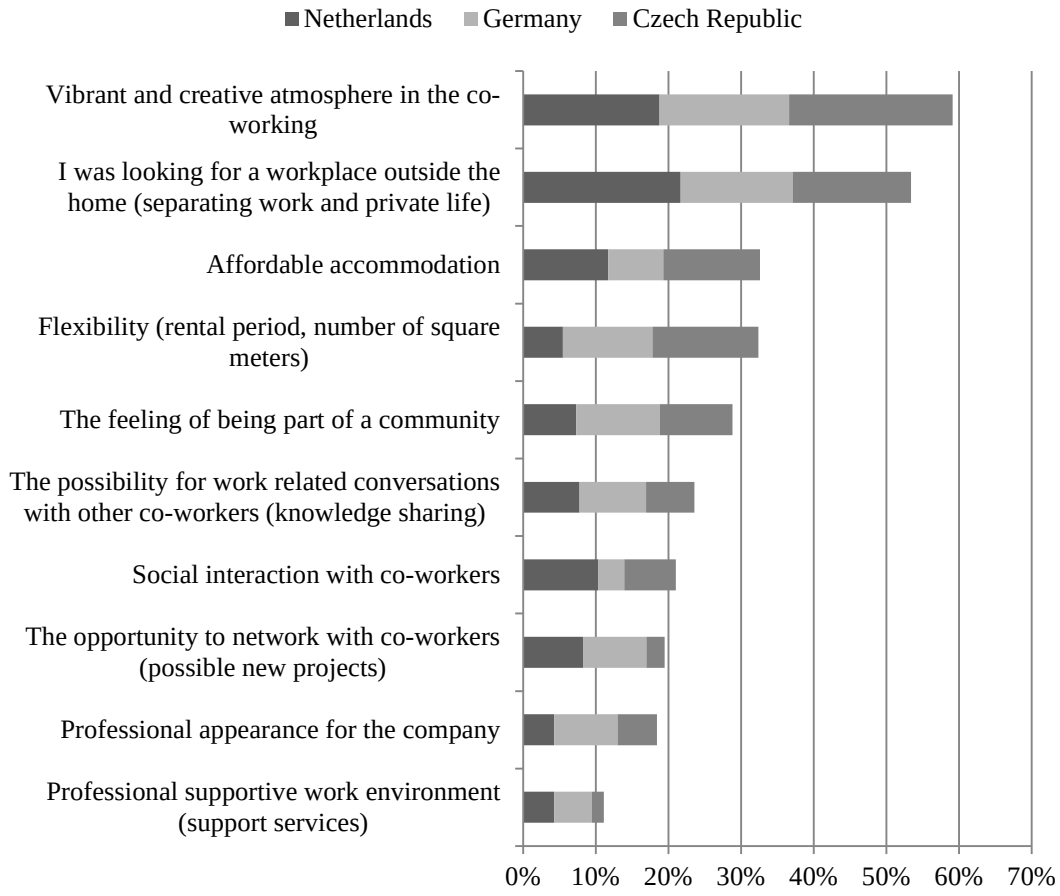
In all three countries, coworking spaces seem to attract young, highly educated employees, with an increased balance between males and females. It is not a place for full-time work, as the average hours spend there during the week in each country was about 20 hours. Furthermore, many coworkers are self-employed workers (ranging from 31-54%). Somewhat unexpected, in Germany, many respondents (33%) work for a company with more than 11 employees and over half is a regular employee. In comparison, in the Netherlands 42% is owner/board member of their organization. This could also be related to the fact that the hours spent in a coworking space is the highest in Germany (approximately 24 hours, versus 21 in the Netherlands and 19 in the Czech Republic). Regarding sector, in the sample of the Netherlands, coworkers are more frequently working in the consultancy sector compared to coworkers from Germany or the Czech Republic.

4.2 Main motivations

Figure 1 shows the main motivations per country to work at a coworking space. As can be seen, there are some differences between countries. For example, respondents from the Netherlands, choose “I was looking for a workplace outside the home” as the most crucial motivation to work at a coworking space, while in Germany and Czech Republic this was the vibrant and creative

atmosphere. The opportunity for social interaction with other coworkers is also relatively more important for respondents of the Netherlands compared to the other two countries. On the other hand, flexibility seems less important for the Netherlands than for the other two countries. Professional appearance is more important in Germany compared to the other countries, and affordability less so.

Figure 1. Main motivations per country to work at a coworking space

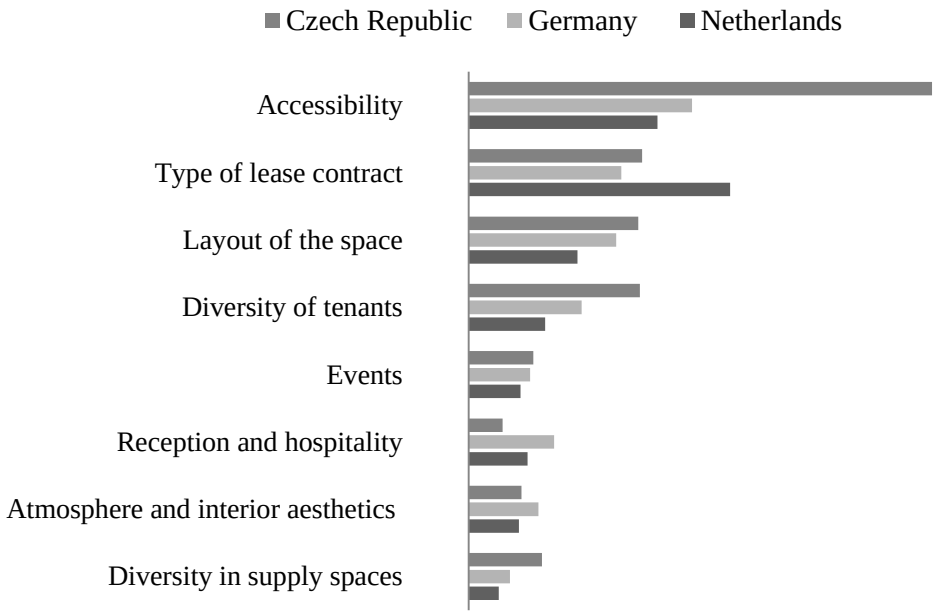


4.3 User preferences

Table 3 shows the results concerning the three MMNL models of different countries. As can be seen, based on the samples of the three countries, one or more levels of all attributes were found to be significant. This finding suggests that all attributes are important for choosing a coworking space. Figure 2 shows the utility impacts of all attributes per country, which are computed using the difference between the lowest and highest part-worth utility of the attribute levels. These utilities refer to the importance of each attribute when choosing a coworking space to work at. Overall, as with all real estate transactions, accessibility, contract options, and type of layout came forward to be the most important attributes in choosing which coworking space to work at in all three countries. This appears to imply that coworking spaces are not that different from other offices and that their users go through similar decision-making processes. As can be seen in Figure 2, the accessibility of the location is the most crucial coworking space attribute for coworkers in Czech Republic and Germany. For coworkers in the Netherlands, the type of lease contract is more

important. Reception and hospitality, atmosphere and interior aesthetics and diversity of supply spaces were found to be the least important when choosing a coworking space.

Figure 2. Total utility of attributes per country



Not only the importance of different attributes but also the preferred 'quality' level of the attributes differs between the countries. Concerning accessibility, the MMNL models showed that the part-worth utility of the level of accessibility by car and public transport is the highest for the Netherlands and Germany. This suggests coworkers in these countries prefer coworking spaces that are accessible by both car and public transport. In the Czech Republic, the probability that coworkers choose a coworking space that is accessible only by public transport is higher. This might be related to the high share of students within the sample, who are more likely to travel by public transport.

Next, coworkers in the Netherlands and the Czech Republic prefer a homey atmosphere and interior, while coworkers in Germany prefer a more modern interior. This could be related to the higher share of coworkers who work at a more extensive (corporate) company in Germany, compared to the other countries. An industrial interior is the least preferred by coworkers from the Netherlands and Germany, while a modern interior is the least preferred by coworkers from the Czech Republic. Concerning preferences for the lease contract, coworkers from the Netherlands and the Czech Republic prefer no lease contract, while coworkers from Germany prefer a short-term lease contract.

No differences were found concerning preferences related to the layout of the space. Coworkers from all the three countries prefer a coworking space with a half-open layout design, which consists of open workspaces in combination with areas for concentration and formal meetings. Also, no differences were found regarding the diversity in supply spaces. Coworkers from all countries prefer a standard coworking space that offers office space with informal meeting areas and event spaces. Moreover, coworkers from the three countries all mostly prefer a reception but no host, only sometimes an event (not too often) and a moderate diversity of tenants.

Table 3. Results MMNL country models

		Netherlands (N=219)	*Germany (N=98)*	*Czech Republic (N=79)*
Attributes	Attribute level	Coefficient	Coefficient	Coefficient
Random parameters				
Constant	Constant	1.3388***	1.1891***	-0.3915
Accessibility	By car and public transport	0.5949***	0.5770***	0.9137***
Atmosphere and interior aesthetics	Industrial	-0.1587***	-0.2869**	0.0190
Layout of the space	Open layout	0.0551	0.0424	0.3010**
Diversity in supply spaces	Basic coworking space	-0.0595	-0.1692**	-0.0180
Reception and hospitality	No reception and no host	-0.2109***	-0.3542***	-0.1008
Events	None	-0.1727***	-0.1334*	-0.2315**
Diversity of tenants	No diversity of tenants	-0.3239***	-0.4287***	-0.6606***
Type of lease contract	No contract	0.6638***	0.1683	0.4671***
Non-random parameters				
Accessibility	By car	-0.6118***	-0.8506***	-1.9389***
Reference level	By public transport	0.0169	0.2736	1.0252
Atmosphere and interior aesthetics	Modern	-0.004	0.1590*	-0.1785*
Reference level	Homey	0.1627	0.1279	0.1595
Layout of the space	Half open layout	0.3200***	0.4508***	0.3918***
Reference level	Closed layout	-0.3751	-0.4932	-0.6928
Diversity in supply spaces	Standard coworking space	0.1261**	0.0945	0.2433**
Reference level	Premium coworking space	-0.0666	0.0747	-0.2253
Reception and hospitality	Reception but no host	0.1665***	0.1930**	0.1150
Reference level	Reception and active host	0.0444	0.1612	-0.0142
Events	Sometimes	0.1586***	0.2604***	0.181
Reference level	Often	0.0141	-0.127	0.0505
Diversity of tenants	Moderate diversity of tenants	0.1660***	0.3511***	0.2265
Reference level	Strong diversity of tenants	0.1579	0.1356	0.4341
Type of lease contract	Short-term contract	0.3440***	0.4199***	0.1749
Reference level	Long-term contract	-1.0078	-0.5721	-0.642
Parameters		26	26	26
Log Likelihood function (LL(β))		-2122.08098	-993.16821	-733.51220
Restricted Log Likelihood function (LL(0))		-2732.38619	-1222.71163	-985.65529
ρ2		0.223	0.188	0.256

ρ2 adjusted	0.220	0.180	0.247
AIC	4296.2	2038.3	1519.0

Note: The grey coloured cells refer to the highest utility per attribute
*Significant at 0.1 level, **Significant at 0.05 level, *** Significant at 0.01 level

5 CONCLUSION

This study has shed light on preferences for coworking spaces in different countries. For many office aspects these seem to be consistent and even not very different from preferences for more traditional office types (e.g. a combination of openness and places to concentrate and meet; high importance of accessibility and variety of rental contract). Nonetheless, the coworking population is very different from the regular office population because it is much more diverse. Besides, this study showed differences in the three countries analyzed here, both regarding coworking users and their preferences.

Coworking spaces are one of the unique work arrangements that can be used by users all over the world. Large serviced office providers are increasingly offering coworking spaces with a universal standard in their offices worldwide, which however might not serve users from all countries to a similar extent. They provide conformity in standards worldwide for large corporates using these coworking spaces but might not attract local users in all countries this way. Coworking operators can use the identified preferences as guidance on their path from a product-centered to a user-centric environment and help them to find their competitive advantage. It is vital to meet the user demands of workers from different cultures and different types/size of organizations. The first, smaller coworking space providers are perhaps still serving a more locally and culturally determined need, which caused the rise of these work environments. The future will tell which users they will continue to attract versus the large global serviced office providers and corporates opening up coworking spaces inside their company offices. All will have to meet user preferences to compete in this fast-growing market.

Future studies should include new types of coworking initiatives (e.g. corporate coworking) to see whether they attract a certain kind of coworkers in comparison to ‘older’ models. Future research could also include rental prices to analyze the willingness to pay for each attribute. Finally, due to the drastic changes that flexible office space markets have experienced due to the recent COVID-19 pandemic, coworking spaces might see transformative changes and changed expectations from occupiers’ perspective. The latter would hybridize the model and open a research gap in a contemporary understanding of coworking environments.

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Sustainability in the field of new work – an empirical study & potential analysis of “green coworking spaces”

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ABSTRACT

This paper examines the influence of sustainability in the field of new work with a focus on coworking and coworking spaces. A sound analysis based on secondary literature will highlight the link between sustainability and coworking. Furthermore, possibilities for designing sustainable office space (i.e., a “green office”) are presented. In the second part of the paper, empirical research will examine the extent to which measures to increase sustainability in coworking-spaces are already being implemented and whether such a concept can offer a competitive advantage in the market. The empirical research model consists of guideline-structured qualitative expert interviews with operators of various coworking spaces, as well as experts in the fields of coworking and sustainability. The empiricism is supplemented by a quantitative survey conducted with coworkers. In summary, it can be said that a sustainably designed coworking space arouses great interest among coworkers and can offer an opportunity for differentiation in the increasingly competitive environment of the coworking-space industry. According to the survey, most coworkers are likely to accept an increased service charge for a green coworking space, which simplifies the implementation of such a concept from the operator’s point of view. This paper confirms the promising assimilation of a green coworking concept into the competence profile of coworking space operators.

Keywords

Sustainability, coworking, CSR, sharing economy, new work

1 INTRODUCTION

The following empirical study on “Sustainability in the field of new work – an empirical study & potential analysis of ‘green coworking spaces’” deals with the development of working environments that are becoming increasingly flexible due to ongoing digitalization, and accordingly present new challenges to property owners and providers of office space. Companies must react to this development to be able to guarantee competitiveness on the market in the future. This development has given rise to the concept of coworking, which has gained in importance for several years. At the same time, concerns about sustainability and climate change are becoming increasingly central in the consciousness of many people. The following paper analyzes the trend toward these concerns and examines the influence of sustainability on coworking and coworking spaces. The analysis focuses on the concept of a sustainable coworking space (i.e., green coworking space), which is based on its relevance and acceptance on the market.

2 PROBLEM

Competition in the coworking business is growing fiercer, as the number of coworking spaces is dramatically increasing. As a result of this competition, many coworking spaces cannot operate profitably and must close at short notice. The problem statement of this paper relates to the role of sustainability aspects in coworking and whether a sustainably designed coworking space can better perform on the market. A few coworking concepts around the world are already sustainably designed and remain profitable. However, on the German market sustainability has not yet to play a major role.

3 AIM

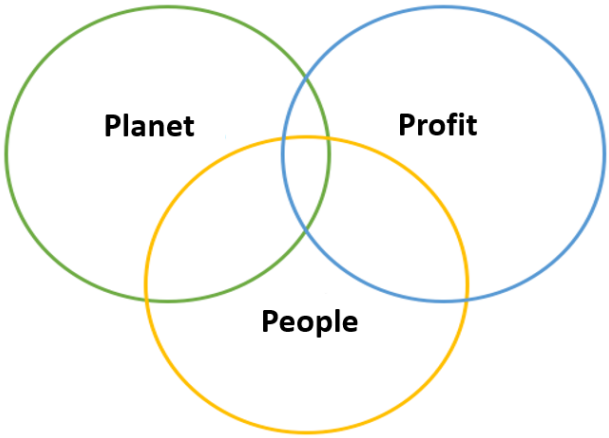
The aim of the study is to gain knowledge about the influence of sustainability aspects on coworking and coworking spaces and the relevance of a green coworking concept. In addition, it examines the areas where sustainability can be applied in a coworking space and the importance it has for its coworkers. The basic hypothesis of the study is that a green coworking concept is accepted by the market and represents a fundamental differentiation from other coworking spaces. Sustainability is an added value for coworkers, which also means that they are willing to pay higher rent. Another hypothesis is that a coworking space designed in a sustainable way has an impact on the structure of the community. Accordingly, the community of a green coworking space is mainly composed of coworkers whose business models are linked to sustainability. These hypotheses will be verified by secondary and primary research.

4 THE CONCEPT OF SUSTAINABILITY

Sustainability has become much more important in recent years and is also becoming increasingly present in public awareness. People are starting to be aware and to fear that the basis of human life is threatened or at least limited (Osranek, 2016, p. 23). To present the aspect of corporate sustainability in a visual and intelligible manner, the three pillar model or the triple bottom line (TBL) are often used. TBL was first defined in 1997 by John Elkington in his book "Chapter 1 - Enter the Triple Bottom Line". (Ampofo, 2017, p. 2). The TBL model was developed because companies usually measure their profits on a financial basis, but social and environmental performance indicators should be included as well. Today, the model is often represented by a Venn diagram (Figure 1).

Sustainability can be defined by the intersection of the three circles in Figure 1. The TBL concept has established the idea of sustainability as an inclusion of people, planet, and profit (Osranek, 2016, p. 47). However, the model also conveys that the idea of financial success does not have to be abandoned for sustainable behavior. The three circles of the model are the same size, as they are equally important (Ampofo, 2017, p. 2). The TBL is often criticized because the necessary weighting of the aspects is not clearly apparent. Furthermore, no practical consequences or recommendations for action can be derived from the model, which makes it difficult to operationalize.

Figure 1: Triple Bottom Line of Sustainability

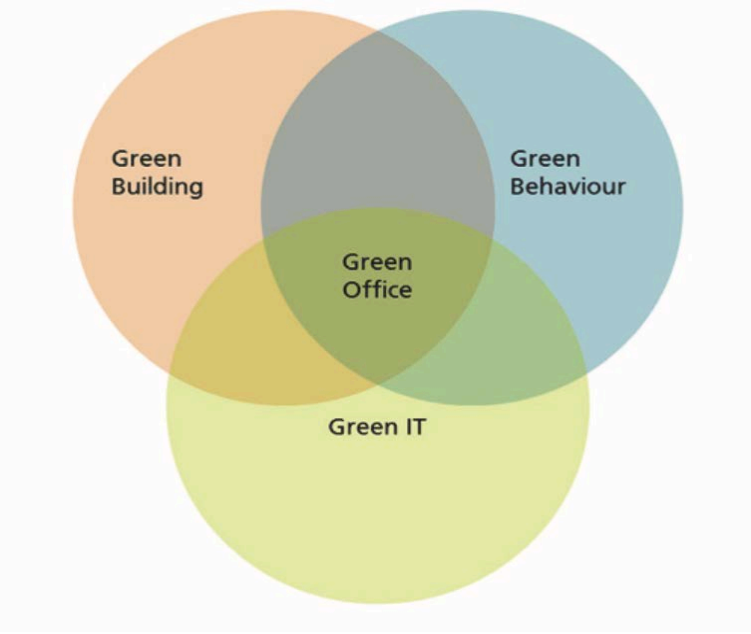


Source: Adapted from (Corsten & Roth, 2012, p. 135) (Osranek, 2016, p. 48) (von Hauff, 2014, p. 120) (Ampofo, 2017, p. 2)

5 GREEN OFFICE

The term “green office” is used to describe an office space that is operated using various measures to increase sustainability. The workplaces will be designed in accordance with ecological, economic, and social objectives. It is therefore not just a matter of looking at energy and resource efficiency of a workplace, but of taking a holistic view. However, “green office” is also often used for departments that manage the sustainability activities in organizations. This interpretation is not used in this paper. In addition to sustainable information and communication technology (green IT), green offices are based on environmentally friendly building and interior design (green building) and sustainable user behavior (green behavior) (Reif, et al., 2014, p. 5).

Figure 2: Design areas “green office”



Source: (Reif, et al., 2014, p. 5)

All three core aspects of the green office are always in conflict between the cost of implementation and the value toward sustainability. Due to the shorter innovation cycles, measures in green IT can be implemented much faster and more cost effectively than many other measures. However, the short innovation cycle of the IT sector also forces production and operation of these systems to be environmentally friendly and to pay attention to the efficient use of the technologies.

6 COWORKING

Coworking is the flexible working of largely independent knowledge workers in a common, institutionalized place. The nonhierarchical social network allows a variety of cooperation advantages for the participants. (Reif, et al., 2014, p. 43) Coworking is based on five core values: collaboration, community, sustainability, openness, and accessibility. Coworking spaces focus on building a network for knowledge sharing, innovation, and training that helps coworkers build up their businesses (Schürmann, 2013, p. 34).

Companies such as Google, TUI, and Daimler have created coworking spaces to improve collaboration and creativity within their organizations (Schürmann, 2013, p. 34). At the same time, independent coworking spaces act as service providers and offer an organizational structure for independent knowledge workers who pursue projects together or alone (Reuschl & Bouncken, 2017, p. 186) (Schürmann, 2013, p. 33).

Looking at the current growth of the coworking market, it can be assumed that such a concept can break up the rigid structures of established companies. In addition, the concept could compensate for the lack of structure and the desire for community, because many people miss these values in the digitalization of the economy (Reuschl & Bouncken, 2017, p. 193).

Due to its defined basic values and the included aspects of the sharing economy, coworking spaces already have an enormous potential for promoting sustainability. Coworking supports the shared use of space, supplies, and other resources and thus reduces waste. However, the potential of coworking to achieve sustainability goes far beyond this idea. We see far-reaching measures to make an office space sustainable. To a large extent, these measures can also be applied to a coworking space to make it more sustainable. Some coworking spaces already make use of such measures and try to establish them in their spaces in the best possible way.

7 EMPIRICAL STUDY

The current study is a cross-sectional analysis, which is divided into qualitative and quantitative research. Qualitative research is usually carried out when the research subject is new, and hypotheses are to be established. Quantitative research is carried out to make conclusions based on numerical data or to test previously established hypotheses (Raithel, 2008, p. 8). The empirical research model consists of guideline-structured qualitative expert interviews with operators of various coworking-spaces, as well as experts in the fields of coworking and sustainability. The empiricism is supplemented by a quantitative survey conducted with 61 coworkers.

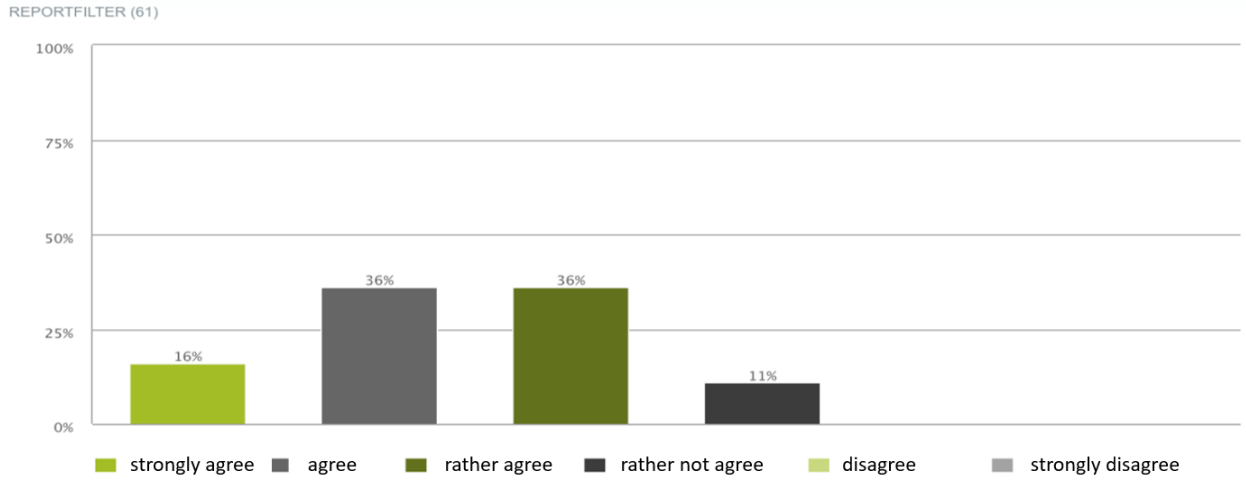
8 DISCUSSION OF RESULTS

The five core values of coworking have often been discussed in the literature, and several studies have concluded that these values are lived in each coworking space, but many coworkers are not aware of them. For instance, the empirical research shows that the aspect of sustainability occupies

last place in the ranking of associations with the term "coworking." Other aspects seem to be more important for many coworkers (see Figure 8 in appendix). This assessment could be explained by the fact that many coworkers are not aware of the different aspects of sustainability, which is often reduced to the ecological perspective.

Furthermore, the expert interviews and the trend analysis show that there will be further growth in this industry, which will also intensify the competition between spaces (Emergent Research, 2016). Many coworking spaces are already operating at low profitability and often do not have large financial reserves (Foertsch, 2018). Therefore, it is important for operators of coworking spaces to position themselves strategically and cover niches in demand that currently promise little competition. A green coworking space can describe one of these niches that is almost unoccupied yet, at least in Germany. Several coworking concepts worldwide already have a special focus on sustainability (see Table 1 in appendix). The analysis of secondary literature has shown that a green concept is accepted by different markets on an international basis. However, a sustainable coworking space cannot escape competition completely. In recent years, some of these spaces have closed because of economic inefficiency (Impact Hub DC, n.d) (Impact Hub Berkeley, n.d). Nonetheless, the research results in Figure 3 underline that German coworkers are interested in the concept and that 89 percent of the coworkers surveyed would rather work in a sustainably designed coworking space than in a conventional space.

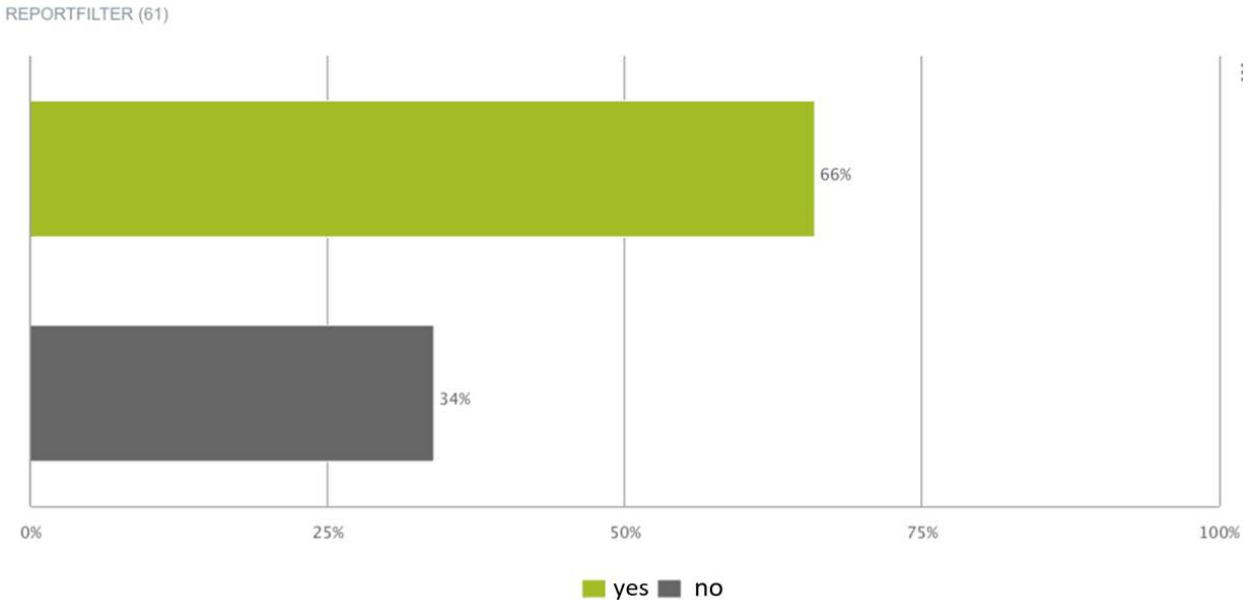
Figure 3: Question 19 – "I would rather work in a green coworking space than in a conventional space"



Source: Authors' data

Related to the statement in Figure 3 ("I would rather work in a green coworking space than in a conventional space"), the respondents were also asked whether they were willing to pay higher rent to work in a green coworking space. Sixty-six percent were willing to accept a higher service charge in return for more sustainability.

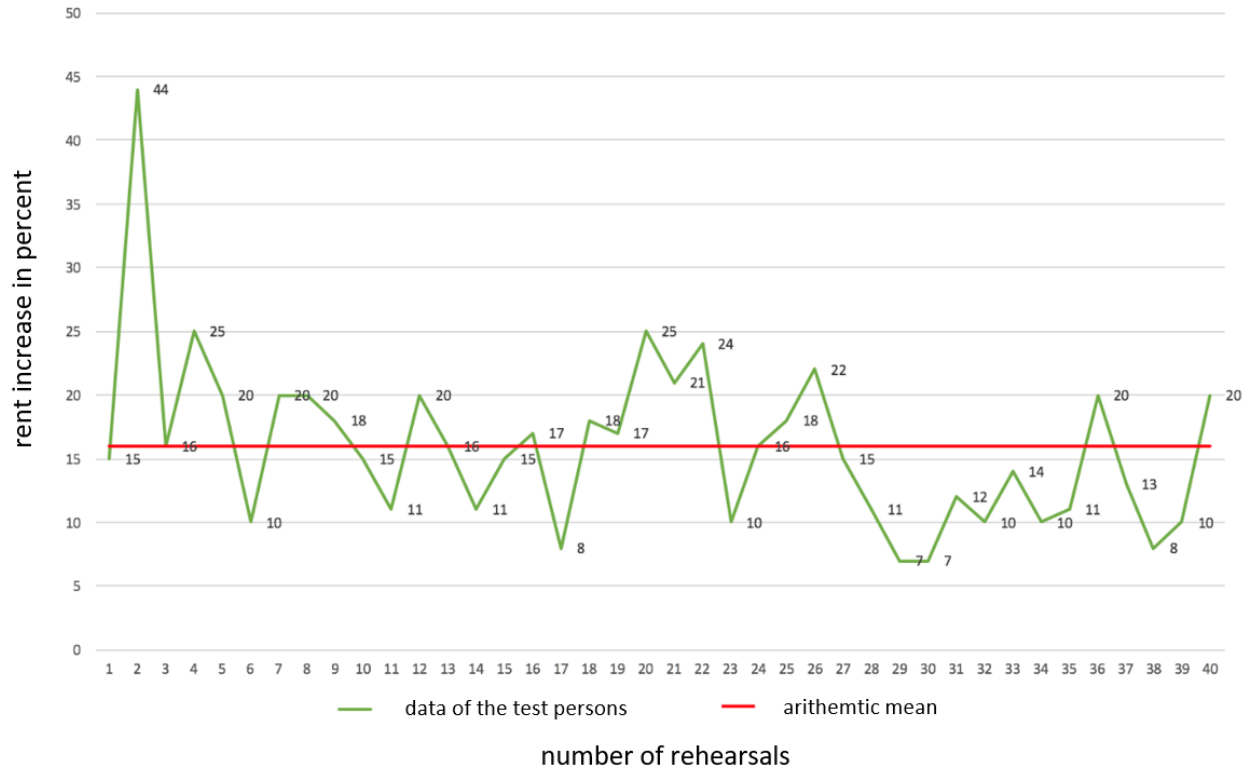
Figure 4: Question 20 - Acceptance of a rent increase



Source: Authors' data

In addition, the coworkers were also asked about the charge increase they would accept. The answers were given in percentage points (Figure 5).

Figure 5: Question 21 - Level of a reasonable increase in rental costs



Source: Authors' data

The evaluation shows 16 percent is an acceptable increase. The range of acceptable rent increases extends from seven percent to 44 percent. However, 44 percent is the only significant upward outlier. If the 44 percent increase is not considered, the average acceptable price increase is approximately 15.3 percent. This result far exceeds the estimations of the interviewed experts. They had stated that an increase of five to 10 percent might be acceptable. The study shows quite clearly that it is important to underline the sustainable performance (e.g., all the measures taken to make the space more sustainable and energy efficient) with transparent communication to all coworkers. This is key to achieving a common understanding of what the additional investment (16 percent rental increase) is used for.

Furthermore, the experts and 89 percent of the surveyed coworkers agree on the statement that green coworking spaces should be distinguished by sustainable interior and design elements (see Figure 8 in the appendix). This can help to enhance the association between sustainability and coworking. One way to do this is by simply using the color green in the space. Additionally, plants and art have a positive influence on how coworkers perceive their environment. To combine design and sustainability, it can also make sense to cooperate with start-ups that already produce sustainable consumer products and furniture. More ideas out of the study are presented in Figure 9 in the appendix.

Because of the rapid innovation cycles, modern technology is an important criterion when it comes to choosing the “right” space. A sustainable design of the IT structure should accordingly be based on these short innovation cycles (Spath & Bauer, 2010, p. 24). Modern and sustainable IT structures support the desire for flexibility (see Figure 7 in the appendix). Cutting-edge technology reduces the relevance of a physical meeting and enables coworkers to exchange information virtually with their clients and business partners. The need for business trips is minimized, which reduces the environmental impact. At the same time, a positive influence on the work-life balance of coworkers should be noticeable (Spath & Bauer, 2010, p. 26). To ensure that the full range of functions of the IT systems will be used by many coworkers, it may be useful to offer small training sessions as required to demonstrate and convey the full functionality of the systems.

Sustainable design principles, including the related measures, have already been implemented by some operators. Measures include the installation of LED lighting as well as the monitoring and optimization of heating costs through intelligent technologies. However, it often becomes problematic when measures to increase sustainability are related to constructional measures that affect the entire building. In most cases, coworking space operators are only tenants and not owners of the property (Kitel, 2018) (Losos, 2018). Therefore, it is difficult for operators to convince the landlord to invest in more far-reaching modernizations. This is also called the user/investor dilemma. Moreover, the lack of capital for far-reaching modernization measures is often a problem. Therefore, when designing office space in a sustainable manner, coworking space operators should focus primarily on measures that reduce the ancillary costs of the coworking space and that are associated with manageable investments, promise a rapid return on investment (ROI), can mostly run automatically, and increase the comfort in the space. This includes the previously mentioned use of LED lighting connected with motion detectors or light-sensitive blinds, the automation of the heating systems using intelligent thermostats, and the reduction of water consumption by using greywater solutions (Kitel, 2018). The selection of a central location when planning a coworking space also plays a role. Good public transport connections and a location close to the city center also favor selection criteria that are important for coworkers when choosing a space. More information about the queried criteria is presented in Figure 10 and Figure 11 in the appendix.

Moreover, cooperation with other companies regarding the accessibility of a coworking space can also offer added value. For example, joint venture models with providers of electric mobility could be considered (Cordes, 2018). Collaboration can enable coworkers to use electric vehicles at a lower rental price than the market average. This measure increases the flexibility of coworkers and improves the accessibility of the space. In combination with the production of renewable energy, electric vehicles can even be charged in an environmentally friendly way, which greatly reduces the CO_2 emissions of electric mobility.

Beyond that, similar cooperation models can also be implemented with city bike concepts. The mobility of a bicycle does not emit CO_2 and is therefore even more environmentally friendly than an electric vehicle. In addition, a cheap or free bicycle rental service also increases the flexibility in the city center and can be implemented with less effort.

Measures regarding the insulation of the building envelope or the installation of energy-efficient windows can be carried out as further steps and in tandem with the landlord.

Certifications of office space should be avoided for the time being because these certificates are usually very expensive, and it is not yet possible to make a clear statement about the marketing effect. The financial resources can better be used to make the space more sustainable by implementing further measures (Kitel, 2018) (Wienberg, 2018) (Losos, 2018).

To have an influence on the behavior of coworkers, incentive programs can be used. These programs motivate coworkers to behave in a more sustainable way through monetary incentives. Ninety-two percent of the coworkers surveyed have assessed this as useful, but it is also important to comply with the General Data Protection Regulation, which makes the monitoring of personal data very complex or even prohibits it completely (Kitel, 2018) (Zinke, 2018).

Finally, green coworking spaces can improve their environmental balance by investing in carbon offsets. However, this should only be considered as an additional action to the implementation of the measures described above. In the case of carbon offsetting, the subsidized projects should be communicated transparently. The COO at betahaus Hamburg, Mr. Zinke, suggested in an interview that planting trees could be a good idea to reduce the coworking spaces' CO_2 emissions. This would involve planting a tree for each coworker in the space. As new coworkers join the community, the number of trees planted will increase (Zinke, 2018).

The assumption that green coworking spaces have an impact on the sustainable behavior of coworkers can also be confirmed after the evaluation of the survey. The results show that coworkers who tend to prefer a green coworking space indicated a link between sustainability and the business models of their companies in almost all cases. Furthermore, coworkers who already deal with sustainability issues in other life situations would tend to choose a green coworking space as well. Accordingly, it can be assumed that the target group already has the necessary understanding of sustainability and that the exchange on sustainability-related topics will be greater. To the question of whether coworkers, in general, live more sustainably, the experts gave positive feedback, because many coworkers live the idea of the sharing economy and often have innovative business models that support digitalization. The results of the quantitative research support this statement as well because 57 percent of the respondents stated that they tried to orientate their lifestyles toward sustainability. On the other hand, 36 percent were not sure whether their lifestyles can be classified as sustainable (see figure 6).

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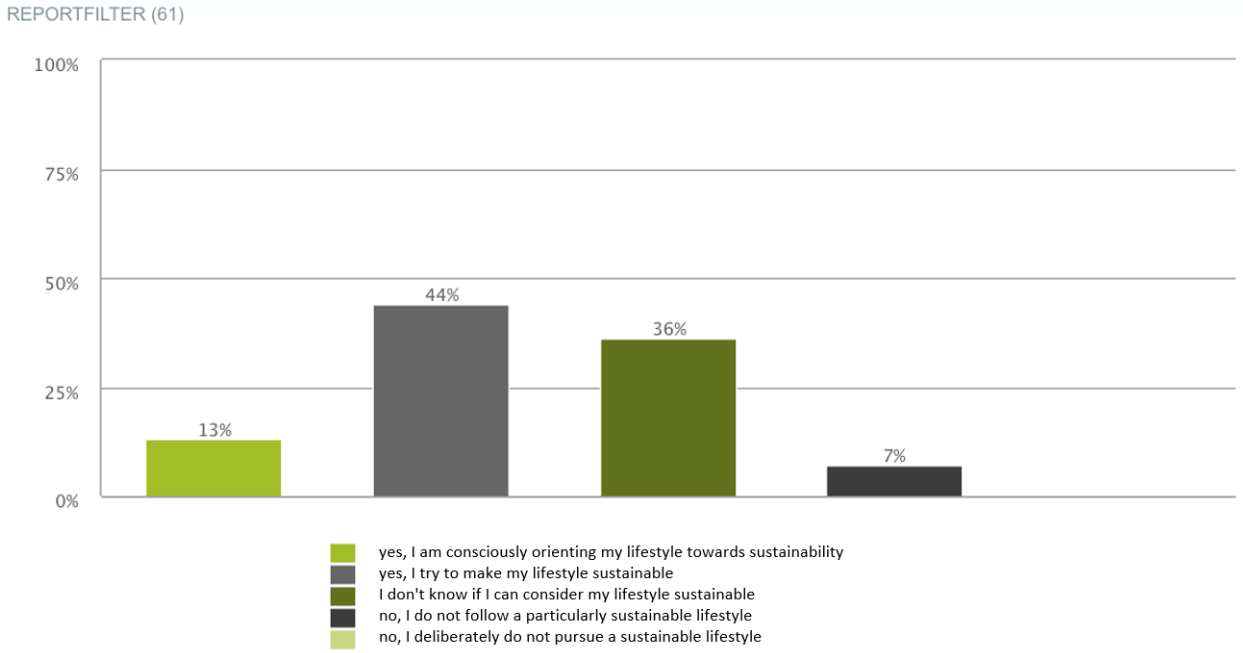
Figure 6: Question 14 - Assessment of sustainable lifestyles



Source: Authors' data

In summary, it can be said that most coworkers surveyed attach importance to a sustainable way of living. The relevance of sustainability can also be explained by the average high level of education. Ninety-eight percent of the respondents stated that they had at least an A-level or university degree. On the other hand, it is surprising that sustainability as a criterion has a comparably low priority when it comes to choosing a coworking space or in the associations with the term "coworking" (see Figure 7 and Figure 10 in the appendix). This insight requires further analysis, which cannot be provided based on the data collected in the underlying empiricism.

Visualization of sustainability in the design of a green coworking space is welcomed by most of the respondents (see Figure 8 in the appendix). It can be assumed that sustainability in relation to coworking only becomes a more relevant topic when coworkers are directly confronted with it or actively made aware of it. The growth of the sustainability trend, as well as the results of the quantitative research in this paper, underline that the sustainable design of office space will continue to be a serious topic in the real estate industry in the future. A focus on this topic is also necessary to meet the future expectations of tenants. Regarding the understanding of sustainability, the secondary and primary research show a lack of consistency. Many people associate sustainability with ecological perspectives, but the fact that sustainability is also based on other pillars is often forgotten.

9 CONCLUSIONS

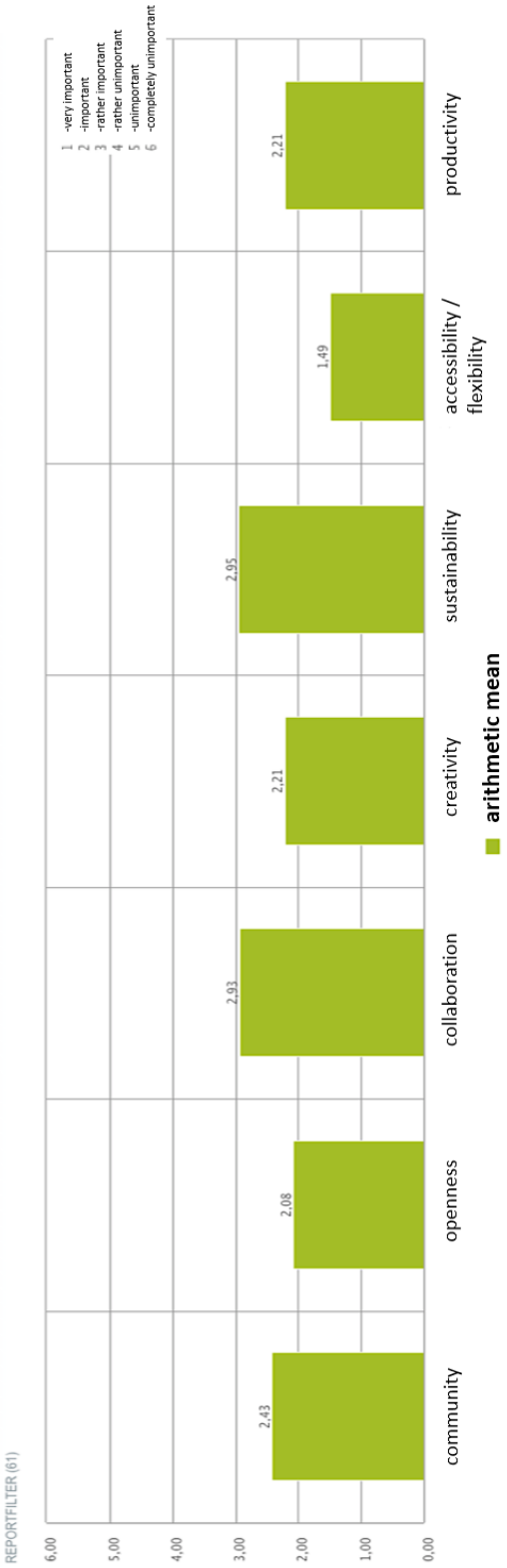
Working environments are becoming increasingly flexible due to ongoing digitalization. This development poses new challenges for real estate owners and suppliers of office space, which increases the competitive pressure in the industry. Therefore, previously well-performing business models can be at stake if companies do not react. This development has given rise to the subject of coworking, which has been gaining importance for several years. Due to the digital business models of many entrepreneurs and the increasing number of start-ups in society, the demand for a

flexible office space concept is still growing. Coworking has a strong connection to the sharing economy and thus also to the issue of sustainability. For this reason, sustainability is part of the five core values of coworking. The analysis of various studies has shown that neither the operators nor coworkers of many coworking spaces are aware of the values represented by coworking.

Conclusively, the results of this paper show that the hypotheses can be confirmed. Coworking spaces will continue to face increasing competition in the future. The effects of the growing competition are already evident today in the fact that many spaces cannot be operated profitably and will be forced to close after a short time. The competition in the market is growing, and one way to avoid competition at an early stage is to differentiate the business model. The study shows that creating a green coworking space can create such a differentiation, which may lead to a competitive advantage and allow the business to operate profitably in the future. An individual design is already an aspect that many spaces rely on to distinguish themselves from the competitors. However, this individuality is apparently not enough to achieve a real competitive advantage. Differentiation regarding a green coworking space has the potential to create such an advantage.

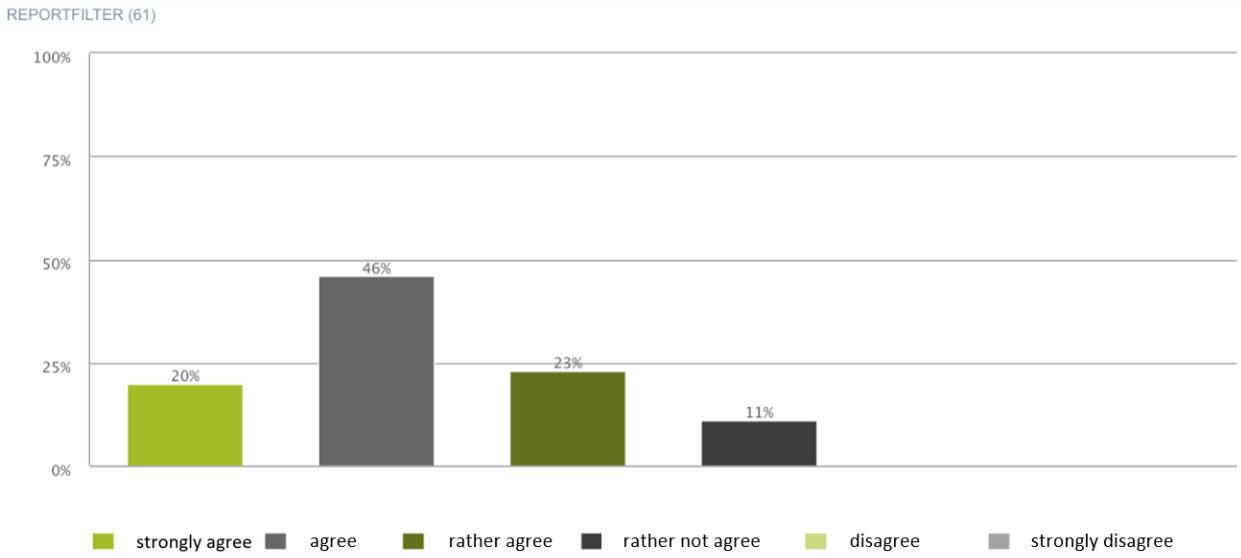
APPENDIX

Figure 7: Question 12 - Associations with the term “coworking” (arithmetic mean)



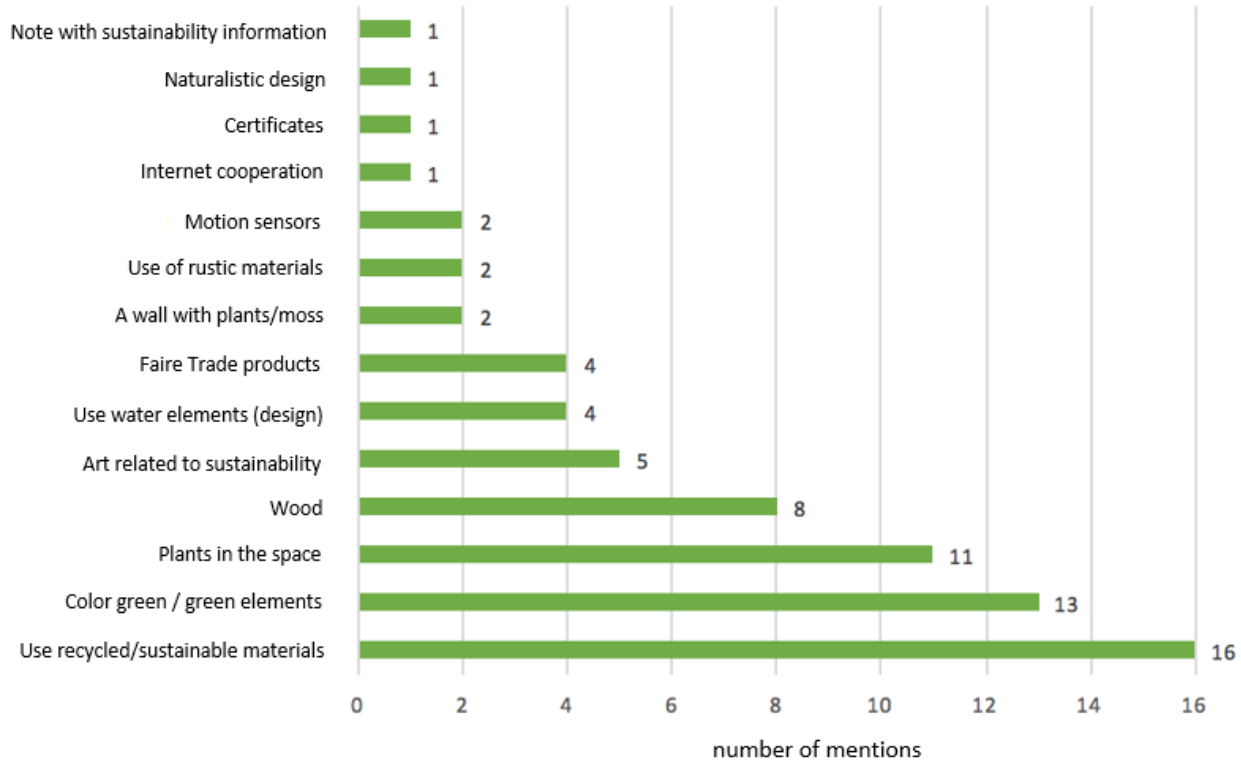
Source: Authors’ data

Figure 8: Question 17 - Sustainability should be visualized in the design of the coworking space



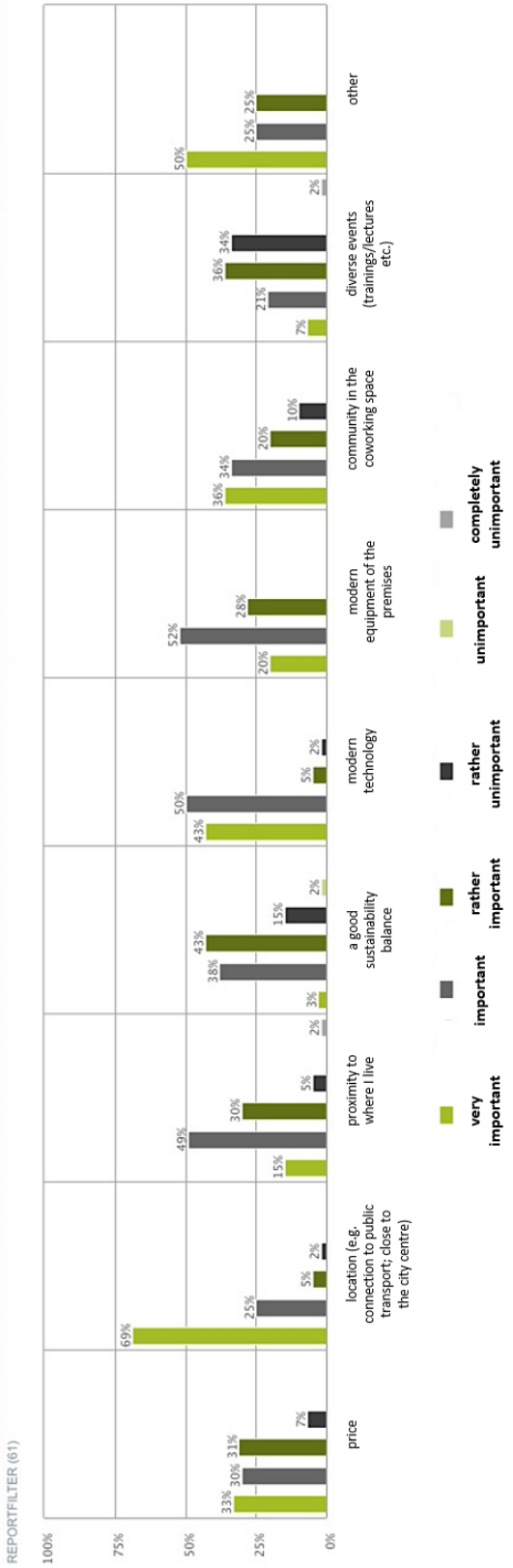
Source: Authors' data

Figure 9: Question 18 - Measures to visualize sustainability in a coworking space



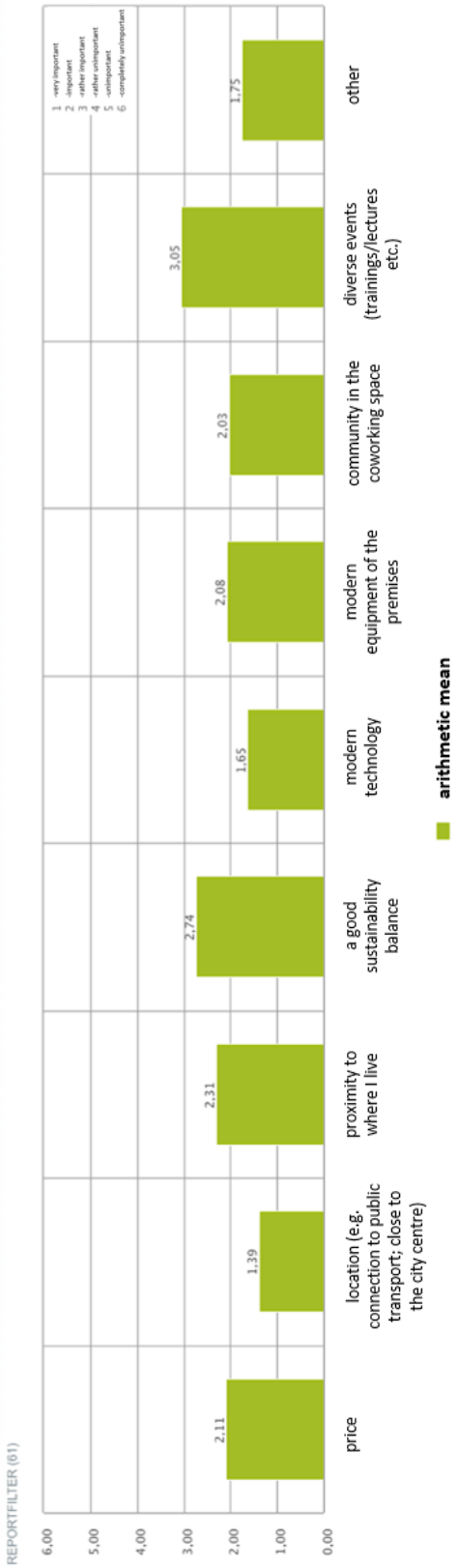
Source: Authors' data

Figure 10: Question 11 - Relevance of different aspects in the process of selecting a coworking space



Source: Authors' data

Figure 11: Question 11 - Relevance of different aspects when choosing a coworking space (arithmetic mean)



Source: Authors' data

Table 1: Overview of green coworking spaces

Coworking-Space	**Location**
Green Spaces	Denver, USA
Eco-System	San Francisco, USA
Grind	New York, USA
CityCoHo in Cooperation with Philly Nexus	Philadelphia, USA
CoCoon – Community for Entrepreneurs	Hong Kong, Hong Kong
Impact Hub	Worldwide
Huckletree	London, England/Dublin, Ireland

Source: Authors' data

Table 2: List of Interviews

Interview Partner	**Job Title**	**Coworking-Space/Company**	**Date of Interview**	**Length of Interview**
Christian Cordes	Leader of the Board	German Coworking Federation e.V. - Bundesverband Coworking Deutschland	May 10, 2018	40 minutes
Timm Wienberg	CEO	projektquartier - Bürogemeinschaft am Fischmarkt	May 14, 2018	41 minutes
Robert Kitel	Head of Sustainability & Future Research	alstria office REIT-AG	May 16, 2018	51 minutes
Klaus-Peter Stiefel	Department Cognitive Environments	Fraunhofer-Institut für Arbeitswirtschaft and Organisation IAO	May 18, 2018	29 minutes
Mathias Zinke	COO	betahaus Hamburg	May 8, 2018	47 minutes
Christian von Berg / Tim Burda	Event-Management	Otto GmbH & Co. KG (Collabor8)	May 17, 2018	24 minutes
Christian Moll	General Manager	Design Offices GmbH	May 16, 2018	22 minutes
Anna-Maria Losos	Head of Coworking Business	beehive GmbH & Co. KG	June 5, 2018	47 minutes

Source: Authors' data

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SESSIONS 2 & 3: HEALTHY WORKPLACES

The added value of healthy workplaces - In search for evidence

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ABSTRACT

Purpose: This paper aims to explore the added value of healthy workplaces for organizations, employees, other stakeholders, and the society as a whole, and what evidence is available about the impact of healthy workplaces on end user satisfaction, productivity, and cost. The paper ends with reflections and suggestions for follow-up research.

Design/methodology/approach: A literature research of journal papers, conference papers and other sources covering the disciplines and fields of Building Research, Corporate Real Estate Management (CREM), Facilities Management (FM), Environmental Psychology, Ergonomics, and Health Management.

Findings: The paper presents a conceptual model of influencing factors on health and wellbeing, possible interrelationships with other values, and possible benefits on individual, organizational and societal level. The literature review shows that limited research is available on the impact of healthy workplaces on other value dimensions. Most research regards the positive relationship between healthy workplaces and employees' wellbeing, satisfaction and productivity. Data on economic benefits are available as well, with a focus on health promoting programs.

Practical implications: The conceptual model and findings from the literature can be used to assess a work environment on its impact on end users' health and wellbeing, and to define objectives, interventions and priorities in value adding management.

Originality/value: This conceptual model of influencing factors on healthy work places and possible impacts of healthy workplaces on other value dimensions is new and can be used to define the agenda of future transdisciplinary research.

Keywords

health, wellbeing, satisfaction, productivity, cost, workplace

1 INTRODUCTION

The World Health Organization WHO defines health as a state of complete physical, mental and social wellbeing, which presents a wider scope than just the absence of disease or infirmity. As such, a healthy workplace can be defined as a workplace that contributes to the physical, mental and social wellbeing of its users and avoids negative impacts on people's health and wellbeing.

Various concepts are used to identify a positive contribution of the physical environment to health and wellbeing, for instance:

- *Healthy office* (Nelson and Holzer, 2017): a concept that covers both environmental adjustments - e.g. healthy lighting (daylight, higher brightness of artificial light, installing a circadian-friendly schedule) and incorporating nature (e.g. by potted plants and flowers and view on nature) - and stimulating healthy choices, e.g. by offering healthy nutrition, facilitating mental balance by providing rooms for meditation, yoga, naps and chair massages, and "active workspaces" that stimulate physical exercise e (e.g. treadmills at desks, sit-stand desks and walking meetings);
- *Healing office:* a design method that has been developed by design studio D/DOCK in the Netherlands (Bauer, forthcoming), which defines ten design qualities with positive effects on happiness and health: diversity (both functional and a good balance of complexity, mystery, coherence and legibility), connectedness, (day)light, contact with nature, sense of ownership of the workplace (including personal control), sustainability, physical activity, opportunities to re-energize and recover from fatigue and stress), and healthy food;
- *Healing architecture* (Nickl-Weller and Nickl, 2013) and *healing environment* (Ulrich et al., 2008): a concept that is used in the health care sector to emphasize the healing effects of daylight, plants, appropriate indoor climate and outsight view (preferably on nature)
- *Biophilic design*: according to Wilson (1984) biophilia refers to love for nature and can be described as the innately emotional affiliation of human beings to other living organisms; biophilic design focuses on strengthening the connection with nature i.e. by natural light, views on nature, pictures of nature, plants, water, natural materials, textures and patterns (Browning et al., 2014; Designcurial, 2019);
- *Salutogenic design:* a concept that focuses on factors that support human health and wellbeing, in contrast to the *pathogenic* approach, which is primarily concerned with prevention of factors that cause disease (Antonovsky, 1987, Roskams and Haynes, 2020). An interesting concept in salutogenic design is sense of coherence (Antonovsky,1987), i.e. individual perceptions regarding the extent to which events occurring around them are structured, predictable, and explicable (comprehensibility), the extent to which the individual perceives sufficient resources to meet the challenges posed by the environment (manageability), and the extent to which events are perceived as challenges worthy of investment and engagement (meaningfulness).

Concepts that refer to a negative contribution of the physical environment to health and wellbeing are for instance:

- *Sick Building Syndrome*: a concept that refers to poor indoor environment quality and other factors that contribute to symptoms related to the mucous membranes (i.e. the eyes, nose and throat), dry skin, headache and lethargy (e.g. Gau and Lau, 2012):
- *Toxic workplaces*: physical workplaces that are harmful to employees on a day-in and day-out basis (Too and Harvey, 2012).

What these concepts have in common is a growing awareness of the impact of the physical environment on peoples' health and wellbeing. This is also reflected in a growing attention to healthy work places, both in research (e.g. Van der Voordt, 2020) and in practice (e.g. by large insurance companies like Medibank in Australia and VGZ in The Netherlands), and the risk on health complaints, illness or burnout (see for instance Aussems et al., forthcoming).

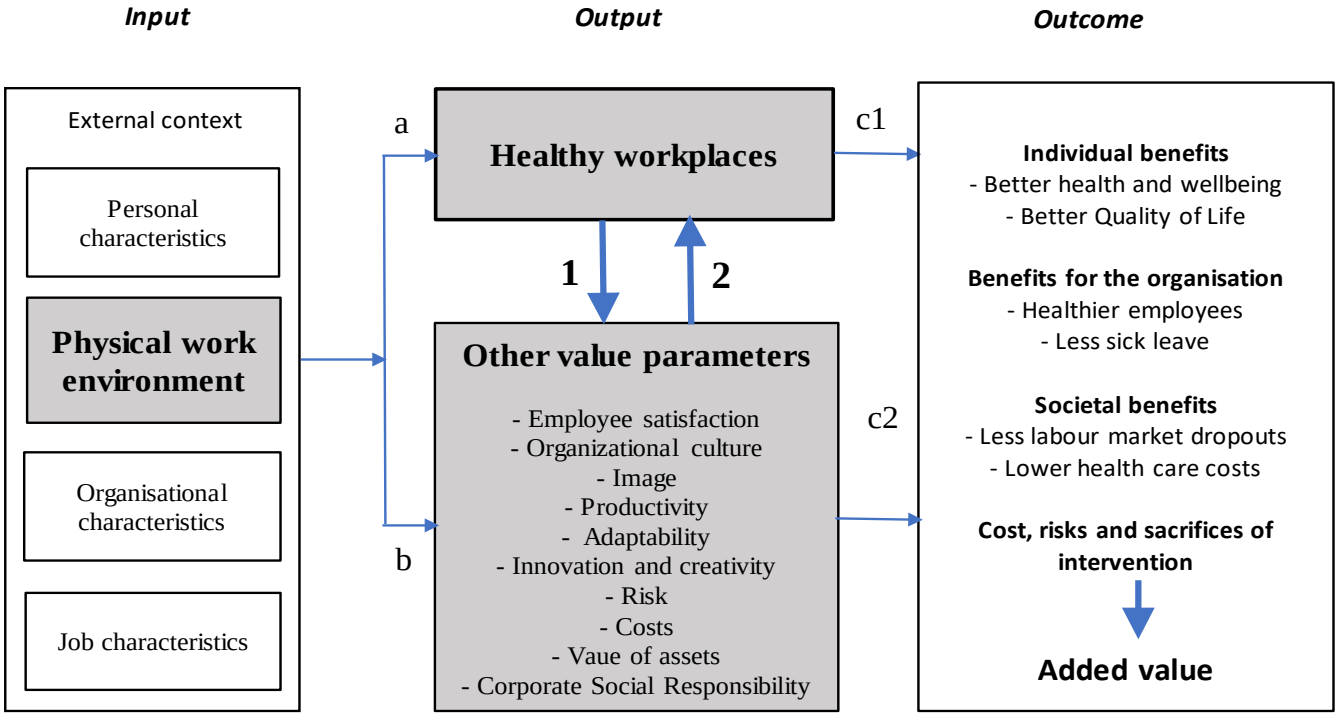
Healthy workplaces that support employees' health and wellbeing can be a goal in itself, but may also have intended or unintended effects on other values such as employee satisfaction, labour productivity, creativity and so on. The current paper aims to start an exploration of these additional impacts and searches for answers to two questions:

1) What is (or could be) the added value of healthy workplaces for clients, customers, end users and the society as a whole?
2) Which evidence (if any) is available for possible relationships between healthy workplaces and other values?

The term value refers to what extent buildings, facilities and services – in this context: healthier workplaces – contribute to the goals and objectives of the organization and other stakeholders. Added value refers to the trade-off between the benefits of different design choices or an intervention in a current environment and the sacrifices in terms of costs, efforts and risks, from the perspective of different stakeholders (Jensen, Van der Voordt and Coenen, 2012).

Figure 1 presents a conceptual model that visualizes possible relationships between workplace characteristics, health and wellbeing, and other value dimensions.

Figure 1: Conceptual model of possible relationships between physical characteristics of the work environment, healthy workplaces and other values (adapted and extended from Jensen and Van der Voordt, 2020)



The arrows a, b, c1 and c2 represents:

a. Physical characteristics of the work environment may contribute to healthy workplaces. This assumption has been explored in various reviews of the literature (Meijer et al., 2009; Jensen and Van der Voordt, 2020); Roskams and Haynes, 2020; Forooraghi, 2020), by using

questionnaires (e.g. Aussems et al., forthcoming) and in case studies (e.g. Cordero, 2020; Bauer, forthcoming). It appears that in particular a poor indoor climate, noise and distraction have a negative impact on employees' health and wellbeing, whereas plants and appropriate opportunities to communicate and to concentrate contribute to a healthy workplace. A recent literature review of the relationship between interior office space (layout, furniture, light, greenery, controls and noise) and employee physical, psychological and social well-being showed that evidence on the relationship between interior space and health has accumulated only within a few topics (Colenberg, Jylhä and Arkesteijn, 2020). On the one hand, open-plan offices, shared rooms and higher background noise are negatively related to health. On the other hand, positive relationships are found between physical well-being and aspects that encourage physical activity; between physical/psychological well-being and (day)light, individual control and real/artificial greenery; and between social well-being and small shared rooms.

b. Physical characteristics of the work environment may contribute to many other value parameters as well. Van der Voordt and Jensen (2017) identified 12 value parameter divided in four people oriented value parameters (satisfaction, image, culture, and health and safety), four product or process oriented variables (productivity, adaptability, innovation and creativity, and risk), two economic value parameters (cost, and value of assets), and two value parameters that are relevant for the society as a whole (sustainability and corporate social responsibility). Various experts explored which environmental characteristics affect the twelve value parameters, how, and to what extent (Van der Voordt and Jensen, 2017).

c1. Healthy workplaces aim to contribute to healthier people, less sick leave, a better quality of life, less labour market dropouts and lower health care costs. For instance, Bodin Danielson (2014) found a significant higher short sick leave spells among women in small, medium sized and large open-plan offices and among men in flex-offices. For long sick leave spells, a significantly higher risk was found among women in large open-plan offices and for the total number of sick days among men in flex-offices.

c2. Satisfied, productive and creative employees, a positive image, a supportive organizational culture and so on contribute to attaining organizational goals and objectives, and increased organizational performance and as such add value to the organization. This assumption has also been explored in Van der Voordt and Jensen (2017).

Arrow 1 suggests that healthy workplace may have an effect on other added values as well i.e. make people more healthy, happy, productive, satisfied, creative and innovative, may have an impact on real estate and facility costs and the value of assets, and may be related to corporate social responsibility and sustainability. Vice versa, arrow 2 suggests that other values may contribute to healthy workplaces as well. For instance, green buildings are supposed to be healthier than non-green buildings. Arrow 1 and 2 are meant to represent correlations, whereas it might be that some relationships are *causal* relationships.

The rest of this paper will further explore the interrelationships between healthy workplaces and other values. Due to lack of space and because some relationships are more plausible than other ones, we will focus on user satisfaction, productivity and facility cost. These three values turned out to be most frequently prioritized in interviews with corporate real estate and facility managers Van der Voordt and Jensen, 2014).

2 METHODS

The literature review applied a structured approach according to Webster and Watson (2002), where the review is based on leading journals in the field. In a former paper about impact factors on healthy workplaces (Jensen and Van der Voordt, 2020), we checked four FM and CREM oriented journals for relevant papers in a ten-year period, covering 2008-2017: *Journal of Corporate Real Estate* (JCRE), *Corporate Real Estate Journal* (CREJ), *Facilities*, and the *Journal of Facilities Management* (JFM). We also screened the *Workplace Health & Safety Journal and the International Journal of Workplace Health Management*. However, most papers in both latter journals focus on organizational interventions such as fitness programs, healthy food, weight management, hygiene, pet-friendly workplaces, burnout prevention, health code of conduct, and prevention of bullying and violence.

For the current paper we extended our search to the period 2018-2019 (and 2020 when available) and to other journals selected based on paper citations and journal titles. In particular, we have screened the last five volumes of *Applied Ergonomics, Building and Environment, Building Research & Information, Environment and Behavior, Ergonomics, Intelligent Buildings International, and Journal of Environmental Psychology.* We also screened the journal with the promising title *Performance Enhancement & Health*, but it mostly included papers on sport, performing arts, drugs and doping. We searched in particular on (combinations of) the keywords health, wellbeing and workplace.

3 FINDINGS ON THE ADDED VALUE OF HEALTHY WORKPLACES

General findings

Environmental characteristics that effect healthy workplaces and related values include office type (cellular offices; combi offices with assigned workplaces; flex offices with non-assigned workplaces; open plan offices), teleworking, office layout, desk location, architecture, comfort (air quality, lighting, temperature, humidity, noise, acoustics, size of windows, access/distance to windows, carbon dioxide, carbon monoxide), plants, workspace segregation (versus openness), workspace territoriality, individual environmental control, aesthetic quality, distraction, cleanliness, sustainability (green buildings), and flexibility criteria. So there is a huge range of independent variables.

Papers that link healthy workplaces to other value dimensions regard a variety of topics, in particular employee satisfaction, productivity, or a combination of both values, individual and organizational performance, effectiveness, privacy, concentration, distraction/disturbances, communication, social contact/interaction, territoriality, depression-enthusiasm, anxiety, absenteeism, creativity, and user experience. So apparently healthy workplaces may have many intended or unintended side effects as well.

Ways to measure employees' health and wellbeing include inter alia surveys, semi-structured interviews in which respondents are asked to freely reflect on their feelings of wellbeing (with open questions such as "what in the office makes you feel well" or particular questions about comfort, ergonomics, privacy and stress levels), workshops and group interviews, prototype testing and pilot projects, self-measurement of health and health supportive behaviour (e.g. by using wearables and apps to measure the number of steps per day, heart rate, calories, sleep etc.), and data on sickness absence. Ways to measure health supporting or hindering characteristics of the physical environment include observations, identifying healthy office design qualities, scores on the WELL standard, and data about toxic substances in the air such as carbon monoxide, carbon dioxide and

volatile organic compounds. See for instance Cordero et al. (2020), Forooraghi et al. (2020), Jensen and Van der Voordt (2020) and Bauer (forthcoming). For an overview of ways to measure all twelve values see Van der Voordt and Jensen (2018).

Health, satisfaction and productivity

Two literature reviews concern the relationship between wellbeing/comfort and productivity in a broad sense. Isham et al. (2019) present a review on wellbeing and productivity in a report for the Economic and Social Research Council in the UK together with recommendation for further research. The executive summary presents three key findings; (1) Wellbeing is linked to higher levels of labour productivity; (2) Certain factors may be able to explain the positive relationship between levels of wellbeing and labour productivity; (3) Productivity growth may have detrimental effects on wellbeing. Recommended topics for further research are divided in eight research areas, which include Workplace factors and ICT as two of the areas. Al Horr et al. (2016) discuss the importance of comfort in a review on office indoor environmental quality (IEQ) and occupant productivity. The review is divided in 8 IEQ factors: indoor air quality and ventilation, thermal comfort, lighting and daylighting, noise and acoustics, biophilia and views, look and feel (including color), and location and amenities. The conclusions include that thermal comfort, indoor air quality, office layout, and noise and acoustics were found to be highly significant in affecting occupant productivity. Occupant comfort directly relates to the physical factors of the indoor environment, but comfort is highly subjective and depends on various independent personal variables such as individual metabolism, clothing preference, activity patterns and the localized conditions of different zones inside an office.

Three reviews focus on specific aspects of workplaces. Engelen et al. (2019) made a review on the impact of activity-based working (ABW) on health, work performance and perceptions. The review found that ABW has positive merits in the areas of interaction, communication, control of time and space, and satisfaction with the workspace; however, it is unfavourable for concentration and privacy. For physical and mental health, the evidence is equivocal. Vos et al. (2018) presents a review on cleanliness with a service management perspective. The review is not related to a particular type of setting or facility, but some studies concern offices. The paper covers health-related behaviour and satisfaction and includes findings on the relation between cleanliness and satisfaction, which rejects that cleanliness is only a hygiene factor with reference to Herzberg two factor theory. Chambers et al. (2019) presents a review on the effect of sit-stand desks (SSDs) on office worker behavioural and health outcomes. It examines the effects of SSDs on six domains: behaviour (e.g. time sitting and standing), physiological, work performance, psychological, discomfort, and posture. The paper concludes that SSDs effectively change behaviours, but these changes only mildly effect health outcomes. SSDs seem most effective for discomfort and least for productivity.

Monetary costs and benefits of healthy workplaces

The ratio between cost of energy, buildings and people is estimated to be about 1:10:100 (Marson, 2018). Thus, it makes sense to reduce staff costs and to search for the cost-effectiveness of healthy workplaces. According to Marson (2018), in the US, the total annual costs of lost productivity due to employee absenteeism counts $84bn with a reference to Investopedia and that creating and implementing wellbeing programs can reduce employee ‘sick days’ by 26 per cent according to The International Well Building Institute.

According to Lee (2018), to manage real estate and facility costs, it is necessary to identify and measure three key aspects: a) demand drivers, for instance real estate costs will be partly driven by

the amount of space needed; catering costs will be partly driven by the number of people using the services; b) service level i.e. required quality; c) agility i.e. how quickly an organization can react to changes. The author pleas for the use of sensor technology to measure workplace performance continuously, consistently, systematically and in real time. Due to lowering prices of building and body sensors and cloud computing becoming more affordable, it is possible to capture data on many cost factors. Yet, no cost figures are presented to support this conceptual paper.

The Canadian Industrial Accident Prevention Association (IAPA) discusses the business case for a healthy workplace (Burton, 2008). They argue that a worker's health is produced by two factors: 1) what workers bring with them to the workplace in terms of heredity, personal resources, health practices, beliefs, attitudes, and values; and 2) what the workplace does to employees once they are there, in terms of organization of work in both the physical and psychosocial sense. Based on a literature review on costs and benefits of healthy workplaces they found that stress in a business contributes to 19% of absenteeism costs, 30% of disability costs, at least 60% of workplace accidents, and 40% of staff turnover costs. On the contrary, a number of organizations are presented that saved much money due to the positive impact of healthy workplaces on staff turnover and sick leave. An example is a company that emphasized 2-way communications and employee involvement and designed the entire workplace around health and cleanliness. Their average sick time is incredibly low (0.1 day per employee per year). With only three employees leaving voluntarily in the past 5 years, their turnover is also extremely low. According to the IAPA report, in spite of the difficulties to quantifying some of the results, there are many examples showing that the cost-benefit ratio may range from $1.50 to $6.15 for every dollar invested. The higher numbers result, when a comprehensive approach to a healthy workplace is used, rather than a single focus, and when cost-benefit is measured several years after inception of the interventions, rather than at the beginning. In particular, great cost savings can be gained, when health promotion programs are implemented in a supportive work environment.

A report by the International Green Building Council (Laski, 2018) presents 11 cases that analyze the impact of green features with environmental, health and wellbeing benefits, in particular the influence of the location and amenities, Indoor Air Quality, acoustics, and look and feel on occupant satisfaction and economic benefits. Due to the variety in projects regarding its size, type of organization and type of interventions, the cases that have calculated economic benefits show a wide range with drops in employee sick days of 25% to 58%, reductions in staff turnover of 27% and annual savings that go up to 85,000 per year. These data have not been tested scientifically on reliability and validity.

4 CONCLUDING REMARKS

Due to the impact of many interrelated variables, it is difficult to trace cause-effect relationships between characteristics of healthy work environments and health related value dimensions. Usually, various interventions are conducted simultaneously. Furthermore, employees' health not only depends on what the workplace does to employees, but also on what workers bring with them to the workplace. Cause-effect relationships are even more difficult to trace from aggregated data on national or international level. In order to be able to interpret the impact of separate measures, reflections on data by an interdisciplinary team and experimenting with particular interventions may be helpful.

Taking care for healthy work environments is a matter of moral responsibility. On the other hand, organizations must be financially healthy. For this reason, business cases often focus on financial

costs and benefits. The relationships between design choices and interventions in the work environment and different values and between values themselves plea for a more integrated, holistic business case. An obstacle may be that the cost of interventions and its resulting output and outcomes are not always easy to measure in a quantitative way. One solution is to base business cases not only on financial data but to take into account well-argued qualitative considerations as well. Additional research may help to provide input to both the input and outcome side of interventions that aim to provide more healthy environments.

In spite of methodological limitations and measurement difficulties and the limited scope of this review, it may be concluded that providing healthy workplaces is relevant, both from a point of view of corporate social responsibility and due to the many positive impacts of healthy work places on employees' health and wellbeing, employee satisfaction, productivity and economic benefits.

The conceptual framework that is presented in this paper can serve as input to follow-up transdisciplinary research by academics from different fields, including corporate real estate management, facilities management, human resource management, environmental psychology and work and organizational psychology, in order to get a more deeper, holistic and evidence based understanding of the added value of healthy workplaces.

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The association between office use and the burnout-engagement continuum in activity-based offices

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ABSTRACT

Purpose: Activity Based offices (ABOs) provide a variety of flexible workspaces designed to support different types of activities. The success of such a work environment is based on certain rules (e.g. no desk claiming) and thus requires a certain type of workplace use. This paper studies how workspace use and obeying rules in ABOs is related to employee well-being, both positively (engagement) and negatively (burnout).

Theory: Research has shown that people do not use ABOs as intended (e.g. limited desk-switching) and need to cope with stressful conditions (e.g. disturbance by noise). This implies a poor (perceived) fit between those employees and their work environment, which according to person-environment fit theory would cause stress. Continuous stress is known to lead to burnout symptoms and decreased employee engagement.

Design/methodology/approach: After literature review, data has been collected by means of an online questionnaire with 184 respondents from 14 Dutch office organisations working in an ABO. Burnout/engagement was measured with the validated UBOS-GS scale, distinguishing 3 dimensions: exhaustion-energy, cynicism-involvement and inefficacy-efficacy. To measure office use, a scale with 10 items was developed. The data is analysed with descriptive statistics, bivariate correlation and factor analysis.

Findings: Respondents agree to clearing out the workspace after they have fully completed a task, but refuse to act similarly when they are out on a small break. They value desk-sharing and have a lot of interactions at/around the workspace. Notably, the respondents have also indicated to be able to concentrate quite well. Generally, they claim to follow the activity-based office rules fairly well. Factor analysis created four distinct office use factors, labelled ‘interaction’, ‘distraction’, ‘desk-switching’, and ‘claiming’. Distraction is related to decreased feelings of energy and involvement. Also, an increase in either interaction or desk-switching is related to increased feelings of professional efficacy. Desk claiming did not show significant associations.

Originality/value: Nowadays, job burnout has become the single most important occupational disease in Dutch work-life, and there is thus increased interest for a healthy office environment. There is very little research on health related to ABO environments, especially their use by the employees.

Keywords

Office use, stress, burnout-engagement continuum, activity-based offices

1 INTRODUCTION

Organisational health used to be managed by many organisations towards preventing disease rather than optimizing health (Robin, 2003). Stress at work therefore was able to become a major public health risk, also associated with heart problems, and people are experiencing burnout symptoms at a younger age than ever before (Maslach et al., 2001). Burnout can be defined as a state of mental and physical exhaustion caused by one's professional life (Freudenberger, 1974). Maslach and Leiter (2008), among others, argue that burnout has been associated with reduced productivity, but also job dissatisfaction, lower levels of commitment, and more absenteeism underline the importance of gaining a better insight into the early predictors of burnout. Maslach and Leiter (2008) propose that people's psychological relationship to their job is a continuum between the negative experience of burnout and the positive experience of engagement. With work engagement being "a positive, work-related state of well-being" which has been associated with high levels of energy, pleasure, activation and commitment (Bakker et al., 2011; Parker & Griffin, 2011). Over time, consensus was found regarding the three dimensions of the burnout-engagement continuum (BEC), being the individual strain (exhaustion – energy), interpersonal strain (cynicism – involvement) and self-evaluation strain (inefficacy – efficacy).

In literature on organisational risk factors correlated with burnout, a problematic relationship between the person and the environment is consistently found, often referred to as misalignment, person-environment misfit or job-person incongruity (Leiter & Maslach, 2004; Maslach & Leiter, 2008; Maslach et al., 2001; Bakker & Leiter, 2010). Also in practice, organisations are increasing efforts to support their employees better by aligning the physical workplace and services to their activities better (Chandrasekar, 2011; Appel-Meulenbroek et al., 2011, 2015). As a result, employee health is rapidly becoming a key business factor for organisations which are only beginning to understand and interpret the implications of healthy work environments (Kirsten, 2010; Burton, 2008).

Over the years, various office concepts have been developed in an attempt to make optimal use of the available space and empower knowledge workers to work more efficiently and effectively (Blok et al., 2012). One of these developments is called 'new ways of working', which implies offering employees more autonomy and freedom by introducing flexible work arrangements (Blok et al., 2012). For efficiency reasons, new ways of working is often implemented by using 'activity-based office' designs. Activity based working is supported by work environments that combine hot-desking with a variety of workplaces, designed to support different types of activities (Hoendervanger et al., 2015). It is supposed to grant the organisation cost reduction through workplace sharing (Gorgievski et al., 2010). Not surprisingly, the activity-based office is rapidly being introduced worldwide (Dixon & Ross, 2011). However, unexpected negative effects have been shown as well (Engelen et al., 2019). Thus, when not implemented correctly, the activity-

based office concept can cause negative correlations with organisational productivity and employee satisfaction where positive correlations were expected (Hoendervanger et al., 2015).

Especially effects of how ABO workplaces are used on employee outcomes are hardly studied (Appel-Meulenbroek et al., 2018). The few existing workplace use studies show that most people do not switch spaces (Hoendervanger et al., 2016) and many claim the same workspace every day and come in more early to guarantee its availability (Brown, 2009). Territoriality is even so much present, that people do not choose an empty workspace that is known to 'belong' to someone else (Babapour & Rolfö, 2019). So, gaining better insight in how workplace use relates to employee well-being both positively (engagement) and negatively (burnout) provides workplace managers a guideline to make well-founded accommodation decisions for incorporating activity-based office concepts. The main research question of this paper is therefore: *How does workplace use in activity-based offices relate to the position of workers on the burnout – engagement continuum?*

2 LITERATURE REVIEW

Previous research on office use primarily focussed on the physical aspects (e.g. fixed vs. shared workspaces) of the office environment (e.g. De Croon et al., 2005), but few have investigated the behavioural aspects of office use. Where the physical ABO environment offers certain job resources, in general characteristics of the behavioural environment have primarily been associated with greater burnout or job demands (e.g. Maslach et al., 2001; Bakker et al., 2013). The way workers interact with the physical environment is said to have a greater influence on their productivity then the physical environment itself (Haynes 2007a; Olson, 2002). As the activity based working concept is based on a set of rules (e.g. employees choose the workplace that best fits the activity), this behaviour includes aspects like claiming- and switching behaviour, interaction and distraction, noise and privacy.

Desk-sharing in open office environments is argued to improve communication between office workers (De Croon et al., 2005), but other studies show that a decrease can also happen (e.g. Kim & DeDear, 2013). Haynes (2007a) argued that the 'interaction' component of the behavioural environment can be defined by attributes such as social- and work interaction, atmosphere, position relative to the office equipment, and overall office layout. On the other hand, the 'distraction' component was defined by attributes such as interruptions, perceived feelings of crowding and noise. Both the interaction and distraction components may be closely related to the individual strain of exhaustion and the interpersonal strain of involvement. Noise from conversations of surrounding occupants is the biggest source of disturbance in and around regular workspaces (Olson, 2002). Exposure to uncontrollable noise leads to aftereffect deficits in task performances (e.g. Cohen, 1980), which may be associated with greater exhaustion (e.g. Maslach et al., 2001). There is also a trade-off to make between support of communication and of privacy (Kim & DeDear, 2013). The psychological need for privacy has been shown to be the strongest predictor of general environmental satisfaction (Hoendervanger et al., 2018), and lack thereof has been associated with greater feelings of exhaustion, which in turn can cause employees to become cynical (e.g. Bakker et al., 2013). Claiming behaviour might be the consequence. It may be associated with feelings of unfairness and conflicting values and thus relate to the exhaustion and involvement components of burnout. In addition, claiming behaviour might correlate with the inefficacy component of burnout, especially if the conflict in values is perceived to be of a structural nature (e.g. Maslach et al., 2001). That the majority of employees never actually switch workplaces during the day (Hoendervanger et al., 2016), may indicate low levels of perceived task

variety, which is associated with respectively the individual strain of exhaustion (task variety) and the self-evaluation strain of inefficacy (task significance) (e.g. Maslach et al., 2001).

3 APPROACH

The data on office use and the position on the BEC were gathered as part of a larger online questionnaire, which was send to workplace managers of fourteen organisations with an activity-based office in the Netherlands by the second author on the TU Eindhoven survey platform. They were asked to distribute the link to this questionnaire to knowledge workers within their organisation, between July 10 and September 4, 2018, resulting in 184 Dutch respondents from all fourteen organisations.

The section of the questionnaire that addresses rules associated with office use, included 10 statements for 5 aspects, for example '*I clear out the workspace if I am away for more than 15 minutes*'. The respondents were asked to indicate to which extent they follow these rules, on a 5-point Likert scale (see Table 1).

Table 1 Workplace use statements

Use characteristics	**Variable**
Desk-switching	I choose the workspace that fits the activity best I clear out the workspace if I am away for more than 15 minutes
Desk-sharing	After finishing my task, I leave the workspace back to its original and clean set-up I claim workspaces by personalising them
Interaction	During work, I interact with colleagues on a social level During work, I have work-related conversations with colleagues at and around the workspace
Distraction	During work, I am easily distracted by colleagues If needed, I can isolate myself from colleagues At work, I experience excessive noise
Privacy	During work, I'd prefer working alone

The employee's position on the BEC, was measured by asking how often 15 statements adopted from the 'Utrechtse Burnout Schaal' (UBOS) (Brenninkmeijer and Van Yperen, 2003; Vanheule et al., 2012) apply to a respondent (see Table 2). Items were scored on a 7-point scale ranging from 1 = never to 7 = always.

The use aspects with more than 1 item in the survey were checked on internal consistency by Cronbach's Alpha. Bivariate correlation analyses were performed to identify possible associations between the office use aspects and the three BEC dimensions.

Table 2 Burnout-engagement statements

Use characteristics	Variable
Exhaustion - Energy	I feel emotionally drained from my work
	I feel used up at the end of the workday
	I feel fatigued when I get up in the morning and have to face another day on the job
	Working all day is really a strain for me
	I feel burned out from my work
Cynicism - Involvement	I am not as enthusiastic as a I used to be about my work
	I have become cynical towards the effects of my work
	I have developed a distant attitude towards my work
	I am questioning the meaning and purpose of the work that I do
Inefficacy - Efficacy	I deal very effectively with the problems at my work
	I feel I am positively influencing the functioning of the organisation through my work
	I feel exhilarated after finishing a task at my work
	I have accomplished many worthwhile things in this job
	I am very confident about my work
	I think I am very good at the work I do

4 RESULTS, DISCUSSION AND RECOMMENDATIONS

The sample contains 56% females and is aged between 20 and 66 (M = 43.7; SD= 11.76). The majority (77.7%) is highly educated, 20% is single, 76.6% is living together/married without children (32.1%) or with children (44.6%). Work experience averages 13.1 years (SD = 11.4) and most respondents are regular employees (71.2%). In general, the mean scores on the BEC traits were on the positive side of the 7-point scale (so pointing towards an engaged sample with relatively low burnout symptoms). The individual dimension scored a 6.13 average (SD = .74), the interpersonal dimension 6.36 (SD = .82) and the self-evaluation dimension 5.70 (SD = .713).

The Cronbach's alpha coefficients of the single aspects were insufficient to add items into clear scales (Desk switching $\alpha = .345$; Desk sharing $\alpha = .388$; Interaction $\alpha = .697$; Distraction $\alpha = .479$) . Therefore, factor analysis was used (Principal Axis Factoring, Direct Oblimin with Kaiser normalisation as rotation method). Factors were extracted when eigenvalues were higher than one (the screeplot showed four changes in direction that did make the cut-off of Eigenvalue even higher). In addition, the Bartlett's test of sphericity is significant (Sig = .000) and the Kaiser-Meyer-Olkin measure is larger than the threshold of .6 (.616). This provided four factors, labelled interaction, distraction, desk-switching and claiming, explaining 62.8% of the total variance (see Table 3). The interaction and the distraction items combined into their own separate factors as expected. The desk-switching items combined with privacy (preference to work alone) and clearing out the desk after finishing a task. Claiming behavior turned out to be a sole, separate factor.

Table 3 Workplace use factors

	Factor			
Variable	Interaction	Distraction	Desk-switching	Claiming
Interaction_social	**.816**	.000	-.014	.093
Interaction_work_related	**.661**	.004	.022	-.002
Distraction_noise	.094	**.806**	-.214	-.187
Distraction_interruptions	.076	**.681**	.014	.026
Distraction_isolation	-.166	**.485**	.140	.110
Desk_switching_choose_best_workspace	.286	.018	**.665**	.032
Privacy	.286	-.065	**.425**	-.138
Desk_switching_clear_out_workspace	-.120	-.013	**.396**	.036
Desk_sharing_leave_to_original_set_up	-.086	-.007	**.378**	-.226
Desk_sharing_claiming_workspace	.058	-.009	-.025	**.741**
Eigenvalue	2.177	1.665	1.581	1.052
Explained variance (%)	21.77	16.65	15.81	10.52

Table 4 shows how these four factors correlate with the three BEC dimensions. The negative correlations between distraction and both the individual strain (r = -.282) and interpersonal strain (r = -.176) indicate that an increase in distraction is associated with decreased feelings of energy and of involvement. On the other hand, the positive correlations of interaction and desk-switching with the self-evaluation strain show that both are associated with increased feelings of professional efficacy. Although significant, the strength of the correlations is considered small (according to Cohen in Pallant, 2016).

Table 4 Pearson correlations office use versus BEC

Office use N = 184	Individual strain	Interpersonal strain	Self-evaluation strain
Interaction	,078	,085	**,168***
Distraction	**-,282****	**-,176***	-,110
Desk-Switching	,008	,074	**,210****
Claiming	-,086	-,103	-,037

**. Correlation is significant at the 0.05 level (2-tailed).*
***. Correlation is significant at the 0.01 level (2-tailed*

As stated in the Job-Demands-Resources (JDR) model of burnout, work environments should not be an additional demand and add stress, but instead function as a resource (Demerouti et al., 2001). The data show that people who interact more often, perceive higher personal efficacy (r = .168). ABO's are supposed to increase interactions through their openness, which would thus be considered as a resource (if this effect indeed is realised, which is not always the case as seen in Kim & DeDear, 2013). At the same time, the data show that the distraction by noise and the inability to isolate yourself from colleagues in these ABOs, are associated more strongly to

decreased energy (r = -.382) and involvement (r = -. 176). Disturbance by noise, privacy and concentration issues are proven negative effects of ABOs in several studies (Engelen et al., 2019) and have been mentioned as the main reasons to even avoid the open workspaces when possible (Appel-Meulenbroek, Groenen & Jansen, 2011). The findings show that it can also increase the likelihood of burnout symptoms, and thus might have to be considered as an additional demand by the ABO environment.

ABOs provide individual choice where to work in the office, so they are supposed to create a fit for more employees and deal with differences in individual workplace needs and abilities (Kristof-Brown, Zimmerman & Johnson, 2005). Choice should thus show lower workplace related stress. Surprisingly, although 62% of the sample often or always chooses the workspace that fits the activity best, such behaviour does not seem to be associated with the exhaustion-energy dimension and thus appears not to decrease exhaustion. On the other hand, it has been shown to increase satisfaction with the ABO (Hoendervanger et al., 2018), and the findings add that it also can be associated with increased perceived personal efficacy (r = .210).

Additionally, not everybody switches and some studies show even 50% of employees coping with the move to an ABO by trying to claim workspaces by a form of personalisation (Hirst, 2011). In this sample only 29% said to do so (ranging from sometimes 13,5% to often/always 12%). Claiming does not show any association with perceived levels of energy, involvement or efficacy. It thus does not seem to be able to decrease perceived stress by moving into a flexible work environment and employees need to be taught more effective ways of coping with the openness of the ABO concept. Individuals are known to keep with customary choices even when superior alternatives are available and they are informed about them, known as the status quo or default bias (Loewenstein, Brennan, & Volpp, 2007). Also, when the number of available choices increases (which an ABO does), at first autonomy, control, and liberation seem positive, but as the number of possible choices grows too much, it no longer liberates but debilitates (Schwartz & Ward, 2004). It remains unknown whether this is the case in an ABO, but it appears to take more than introducing and explaining a new ABO concept to employees to trigger their correct use and deserves more research and more attention in practice.

Research on how to deal with office noise focuses on acoustical design (e.g. Aliabadi et al., 2016) and lately noise-cancelling technologies (e.g. Yadav et al., 2017), but ignores how office use influences both the noise that a person is exposed to and the noise generated by people through their specific use of the office. Concentration and privacy versus communication conditions at work require a delicate balance and need to be studied together more often in future research. Roper and Juneja (2008) performed a literature review on both communication and concentration at the office and identified over ten studies showing that employees prefer privacy over accessibility of colleagues. Introducing an open-plan layout can make employee satisfaction drop more due to increased noise levels and decreased privacy than that it is raised by the increased ease of interaction (Kim & De Dear, 2013).

5 CONCLUSIONS

When striving towards engaged and healthy employees, workplace managers should aim at maximising interaction and desk switching, whilst at same time minimising distraction for other colleagues by noise. It is unlikely to create workspaces that are completely distraction-free, but if needed, workers should be given the opportunity to isolate themselves from colleagues by providing various types of workplaces (e.g. cell-offices, shared-room offices, quiet areas, private

areas). ABOs have the opportunity to provide both with thoughtful office design and correct change management to ensure beneficial use of the new work environment. Limitations of this exploratory study is its small sample, the cross-sectional nature of the data (with no insight in number of respondents per organisation) and that no causal relationships can be concluded from the correlation analyses. This is thus an urgent call for more scientific research in this area and for more attention of workplace managers in practice to workplace perception and use, when they implement the ABO concept.

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Designing to Beat Burnout and Encourage Engagement

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ABSTRACT

Employee burnout is a serious workplace issue; it degrades employee quality-of-life and professional performance (Appel-Meulenbroek, Le Blanc, and de Kort, 2020).

Employee engagement, conversely, supports worker wellbeing and performance to full potential (Bakker, 2011). Maslach (2017) reports that "work engagement . . . is not the opposite of burnout (although it is negatively related to it)."

Maslach (2017) recommends that organizations battle burnout by focusing on employee "workload, control, reward, community, fairness, and values." Focusing on the six burnout predictors/risk factors identified by Maslach, design can generate conditions of positive affect inconsistent with burnout and supportive of engagement (e.g., Al Horr, et al., 2016; Appel-Meulenbroek, Le Blanc, and de Kort, 2020; Newsham, et al., 2009; Veitch, 2012). Similarly, design strategies can directly make employee engagement more likely (e.g., Veitch, Stokkermans, and Newsham, 2013).

Negative workload-related experiences are less likely when the design of the workplace supports tasks-at-hand (Appel-Meulenbroek, Le Blanc, and de Kort, 2020), for instance, and when employees have at-work opportunities for cognitive refreshment (Veitch, 2012). Investigators have directly linked providing a workplace that supports professional activities with lower levels of burnout/greater employee engagement (Barnes, Wineman, and Adler, 2020); similarly, adequate cognitive restoration has been tied to less employee burnout (Thompson and Bruk-Lee, 2019).

Researchers have comprehensively assessed how workplace design can support particular work activities and design consistent with these findings makes workload overload less likely. For example, looking at the color green can enhance creative performance (Lichtenfeld, et al., 2012; Studente, Seppala, and Sadowska, 2016) as can being in warm light (Weitbrecht, Barwolff, Lischke, and Junger, 2015).

Similarly, researchers have determined that when workers have a comfortable (Iyengar and Lepper, 2000) amount of environmental control their workplace wellbeing as well as their performance is optimized (O'Neill, 2010; Veitch, 2012). Investigators have directly linked having appropriate amounts of environmental control to lower levels of professional burnout (e.g., Laurence, Fried, and Slowik, 2013). Researchers have also identified effective methods for providing environmental control, for instance, via activity-based work environments (e.g., Spivack and Milosevic, 2018).

Workplaces can send nonverbal messages that support positive moods inconsistent with burnout (e.g., Commission for Architecture and the Built Environment and the British Council for Offices, 2006; Visher, 2007) and can signal that employment-related decisions and rewards are fair (e.g., Visher, 2005) as well as convey organizational values (e.g., Becker and Steele, 1995).

Workplace design can support the positive development of employee communities, via, for example spatial layout (Allen and Henn, 2007) and tactile experiences (Ackerman, Nocera, and Bargh, 2010).

Hoendervanger, Ernst, Albers, Mobab, and van Yperen (2018) generally link environmental satisfaction, and the resulting more positive moods, to employee engagement and Nieuwenhuis, Knight, Postmes, and Haslam (2014), for instance, tie the presence of green plants to greater levels of employee engagement.

Workplace design recommendations, informed by scientific studies and empirical research, that support minimization of burnout and optimal levels of employee engagement, are synthesized in this paper into a model that is practical for workplace designers/managers and human resource professionals to apply.

Keywords

burnout, engagement, workplace design, workplace management, human resources management.

1 BURNOUT, ENGAGEMENT DEFINITIONS AND IMPLICATIONS

Employee burnout is a serious workplace issue; it degrades employee quality-of-life as well as professional performance (Appel-Meulenbroek, Le Blanc, and de Kort, 2020). Maslach (2017) identifies the three components of burnout driving these negative outcomes: emotional exhaustion, cynicism, and degraded professional effectiveness. As Maslach reports, "Basically, workers who are experiencing burnout are overwhelmed, unable to cope, and unmotivated, and they display negative attitudes and poor performance."

Maslach and Leiter (2017) describe the "Three basic dimensions of the burnout experience: an overwhelming exhaustion, feelings of cynicism and detachment from the job, and a sense of ineffectiveness and lack of accomplishment. . . . . The exhaustion dimension was also described as wearing out, loss of energy, depletion, debilitation, and fatigue. The cynicism dimension was . . . also described as negative or inappropriate attitudes, detached concern, irritability, loss of idealism, and withdrawal. The inefficacy dimension was originally called reduced personal accomplishment and was also described as reduced productivity or capability, low morale, and an inability to cope."

Employee engagement, conversely, supports worker wellbeing and performance to full potential (Bakker, 2011). Engaged employees "are bursting with energy, dedicated to their work, and immersed in their work activities. . . . more open to new information, more productive, and more willing to go the extra mile" (Bakker, 2011). Engagement, Maslach (2017) reports, is "a persistent, positive affective–motivational state of fulfillment that is characterized by the three components of vigor, dedication, and absorption." Maslach (2017) also states that "work engagement . . . is not the opposite of burnout (although it is negatively related to it)."

In summary, as Albrecht (2015) reports, "Research has shown that employee engagement is positively associated with important outcomes such as organizational commitment, employee well-being, and individual, group, and organizational performance. . . . In contrast, employee burnout has been shown to adversely influence employee health and well-being, turnover, absenteeism, and job performance."

2 MANAGING BURNOUT AND ENGAGEMENT VIA DESIGN: AN OVERVIEW

Maslach (2017) recommends that organizations battle burnout by focusing on employee "workload, control, reward, community, fairness, and values." Maslach and Leiter (2017) comprehensively describe the six, interrelated, burnout predictors/risk factors Maslach notes in 2017: "Workload

[issues arise when]. . . . job demands exceeding human limits.. . . acute fatigue. . . need not lead to burnout if people have an opportunity to recover. . . . Control. . . . includes employees' perceived capacity to influence decisions that affect their work . . . and to gain access to the resources necessary to do an effective job. . . . insufficient reward (whether financial, institutional, or social) increases people's vulnerability to burnout. . . . Community is the overall quality of social interaction at work, including issues of conflict, mutual support, closeness, and the capacity to work as a team. . . . Fairness is the extent to which decisions at work are perceived as being fair and equitable. . . . Values are the ideals and motivations that originally attracted people to their job."

Bakker (2011) links job resources with engagement. He defines job resources as "those physical, social, or organizational aspects of the job that may (a) reduce job demands and the associated physiological and psychological costs; (b) be functional in achieving work goals; or (c) stimulate personal growth, learning, and development."

Workplace design can support lower levels of burnout and greater employee engagement (Appel-Meulenbroek, Le Blanc, and de Kort, 2020). Focusing on the six burnout predictors/risk factors identified by Maslach (i.e., workload, control, reward, community, fairness, and values), design can generate conditions of positive affect and wellbeing inconsistent with burnout and supportive of engagement (e.g., Al Horr, et al. 2016; Newsham, et al., 2009; Veitch, 2012; Veitch, Stokkermans, and Newsham, 2013). Similarly, design strategies can directly make employee engagement more likely (e.g., Veitch, Stokkermans, and Newsham, 2013).

Considering the six burnout predictors/risk factors outlined by Maslach (2017) during the design process is consistent with developing spaces that supports the fundamental human motivations outlined by self-determination theory (SDT) (Deci, Olafsen, and Ryan, 2017). Deci, Olafsen, and Ryan report that when a workplace experience supports employee efforts to achieve competence, autonomy, and relatedness positive psychological situations inconsistent with burnout and appropriate for engagement are more likely to be found (2017). Workplace design can support achieving the three basic human needs identified by self-determination theory and research indicates that when these needs are more fully satisfied via design, employees are likely to be more engaged (Appel-Meulenbroek, Le Blanc, and de Kort, 2020).

Design is not "magic", and alone cannot alleviate the burnout-/engagement-related effects noted; management programs and similar factors also affect the presence/absence of burnout and engagement (e.g., Albrecht, 2015).

3 CURTAILING BURNOUT AND FOSTERING ENGAGEMENT BY SUPPORTING PROFESSIONAL PERFORMANCE

Maslach (2017) reports that a sustainable, manageable workload makes burnout less probable. Lack of user perceived environmental support for the task at hand and lower levels of environmental satisfaction can contribute to employee burnout and lower engagement levels (Appel-Meulenbroek, Le Blanc, and de Kort, 2020). Investigators have directly linked providing a workplace that supports professional activities with lower levels of burnout/greater employee engagement (Barnes, Wineman, and Adler, 2020).

Researchers have comprehensively assessed how workplace design can support professional work activities and this support makes workload overload less likely. Al Horr and colleagues (2016), after reviewing over 300 papers, linked eight factors to satisfaction and performance: indoor air quality and ventilation, thermal comfort, lighting and day lighting, noise and acoustics, office

layout, biophilia and views, look and feel, and location and amenities. Links between enhanced workplace ventilation and augmented professional performance are also reported by MacNaughton, Pegues, Satish, Santanam, Spengler, and Allen (2015) while ties between natural light and professional performance are also conveyed by Edwards and Torcellini (2002).

There are many additional examples of research linking professional performance to workplace conditions. For instance, looking at the color green can boost creative performance (Lichtenfeld, et al., 2012; Studente, Seppala, and Sadowska, 2016) as can being in warm light (Weitbrecht et al, 2015). Also, experiencing cooler colored lights can enhance our ability to concentrate (Weitbrecht, et al., 2015). One hundred more feet of functional zone path overlap makes it significantly more likely that individuals will collaborate (Kabo, Hwang, Levenstein, and Owen-Smith, 2015), which can support professional performance. Research also indicates that floor plans support professional performance when opportunities for employee proximity, distraction-limited zones, and visibility are carefully managed, for example (e.g., Coradi, Heinzen, and Boutellier, 2015).

Nieuwenhuis, Knight, Postmes, and Haslam (2014) link the presence of green leafy indoor plants in an environment to enhanced professional performance (as did Raanaas, Evensen, Rich, Sjostrom, and Patil, 2011) as well as to higher levels of employee engagement.

A useful way to think about how workplace design influences worker performance and engagement is to review how aspects of the physical environment shape mood. Veitch (2018) ties more positive moods based in environmental experiences to employee engagement generally as well as to higher levels of professional performance. Appel-Meulenbroek, Le Blanc, and de Kort's (2020) review of research links experiencing positive emotions and feeling more engaged. Veitch, Stokkermans, and Newsham (2013) developed a statistical model indicating that lighting appraisals influence aesthetic judgments and mood (in that order), which in turn affect work engagement.

Experiencing biophilic place design has been linked to more positive moods and enhanced cognitive performance (Yin, et al., 2018). Biophilicly designed spaces apply the same design principles in structures built today that were present in places where we felt very comfortable during our early days as a species. For example, humans prefer to be in spaces where they feel secure but can see all of the nearby area – a high-backed restaurant booth is an example of a space that provides both security and a view.

Hoendervanger, Ernst, Albers, Mobab, and van Yperen (2018) generally link environmental satisfaction, and the resulting more positive moods, to employee engagement

Steelcase reports that their worldwide research determined that employees who are more satisfied with their work environments are more professionally engaged ("Boosting Employee Engagement: Place Matters," 2014). Disengaged workers did not feel that their work environments supported their ability to, for example: "Concentrate easily (85%); Easily and freely express and share my ideas (84%) . . . Feel a sense of belonging to my company and its culture (84%); Work in teams without being interrupted or disrupted (87%) . . . Socialize and have informal relaxed conversations with colleagues (65%)."

Negative workload-related experiences are less likely when employees have design-based at-work opportunities for cognitive refreshment (Veitch, 2012). Adequate cognitive restoration has been tied to lower levels of employee burnout (Thompson and Bruk-Lee, 2019). Ward and Parker (2020) positively link restorative experiences to greater employee engagement and to reduced burnout; they report a similar tie between job resources' support for the task at hand generally, greater engagement, and lower burnout levels.

Cognitive restoration is encouraged, for instance, by seeing nature, via window views or relatively realistic images/art scenes or green roofs (Kim, et al., 2010; Lee, et al., 2015; van den Berg, Koole, and van der Wulp, 2003; Veitch, 2012), looking at water, even in a generally manmade environment (White, et al., 2010); and viewing aquariums (Cracknell, 2012). Urban settings can also be restorative (Berto, et al., 2010), but it is challenging for people without professional training to identify restorative urban environments. Hearing nature sounds, such as gently rustling leaves and burbling brooks, has been tied to cognitive restoration (e.g., Benfield, et al. 2014).

4 USING ENVIRONMENTAL CONTROL TO SUPPORT DESIRED MENTAL STATES

Maslach's (2017) work indicates that when employees feel comfortably in control of their professional experiences the likelihood of burnout decreases. People respond most positively emotionally and cognitively to opportunities for control when they are presented with a carefully curated set of options, around six (Iyengar and Lepper, 2000), that, in an environmental context, align with the probable use of a space. Investigators have directly linked comfortable levels of environmental control to lower levels of professional burnout (e.g., Laurence, Fried, and Slowik, 2013, did so in the context of personalization, privacy, and other design factors).

Multiple researchers have tied lack of control of noise in healthcare facilities to greater levels of employee burnout (e.g., Mackrill, Cain, and Jennings, 2013).

Steelcase research links employee ability to select where to work and higher engagement levels (Steelcase Inc., 2016).

5 NONVERBAL MESSAGING TO MINIMIZE BURNOUT AND MAXIMIZE ENGAGEMENT

Maslach (2017) indicates that professional recognition/reward (financial, social, or otherwise), fairness, and organizational support for values perceived as positive decrease the likelihood of burnout. To make burnout less likely, not only must appropriate rewards, values, etc., be in place, but workers must read nonverbal messages from the work environment that confirm their presence. Workplace design can send nonverbal messages indicating professional recognition/reward (e.g., Commission for Architecture and the Built Environment and the British Council for Offices, 2006; Moezzi and Goins, 2011; Schwartz and Porath, 2014; Veitch, 2012; Vischer, 2007) and can signal that employment-related decisions, etc., are fair (e.g., Vischer, 2005) as well as convey organizational values (e.g., Becker and Steele, 1995). Becker and Steele (1995) report that users think that messages sent via the physical environments are more likely to express an organization's true culture, priorities, etc., than written mission and value statements. To be effective messages sent must be positively interpreted in light of users' organizational (Cameron and Quinn, 2006) and national (Hofstede, Hofstede, and Minkov, 2010) cultures.

Pearce and Hinds (2018) investigated employee place identity, which they define as "whether employees feel the space aligns with their self-image and enhances their sense of belonging." The researchers found, after talking with workers worldwide, that stronger place identity was tied to greater engagement. To build place identity, Pearce and Hinds recommend, for example, that employees be allowed to customize their work environments and thereby convey desired messages to others.

Newsham, Veitch, and Hu (2017) tie working in spaces that signal that they are environmentally responsible to higher levels of professional engagement via an analysis of data from a large Canadian financial organization.

6 DEVELOPING COMMUNITY TO OPTIMIZE BURNOUT AND ENGAGEMENT

Maslach (2017) indicates that a feeling of community, based in trust, etc., among co-workers reduces the likelihood of burnout.

Workplace design can support the positive development of employee communities, via, for example, spatial layout (Allen and Henn, 2007) and tactile experiences (Ackerman, Nocera, and Bargh, 2010). Sommer's work (1969) indicates that interpersonal orientations can support development of social bonds, or not; he learned that people are more likely to form relationships with others they are speaking with when the front edges of their chairs are at 90 degree angles to each other. Also, for instance, people in a group will more likely interact in ways that support the development of community when all of their heads are at approximately the same height above the floor as they work (e.g., they are not sitting on seats of different heights) (e.g., Baranowski and Hecht, 2018; Bertamini, Byrne, and Bennett, 2013; Makhanova, McNulty, and Maner, 2017).

Also, for example, Sellaro and colleagues (2015) found that people are likely to trust each other more when they are smelling lavender. People seen in front of warm colors are felt to have warmer personalities (Choi, Chang, Lee, and Chang, 2016). In addition, people feel more powerful in cool colored spaces than they do in warmer colored ones (Dubois and Mehta, 2012). Our interactions with others are more positive when they take place in relatively warmer, dimmer light (Wessolowski, et al., 2014). Similarly, being in spaces with lights at 150 lux has been linked to feeling more interdependent with others present (compared to when lights 0f 1500 lux are in use) (Steidle, Hanke, and Werth, 2013).

Spreitzer, Bacevice, and Garrett (2020) link providing employees with opportunities to pleasantly socialize, such as at centrally located coffee bars, and to collaborate effectively, via team spaces, for example, to higher levels of engagement.

7 DESIGN RECOMMENDATIONS

Workplace design recommendations, informed by scientific studies and empirical research, can support minimization of burnout and optimal levels of employee engagement. Physical work environments that recognize the fundamental human motivations identified by SDT (Appel-Meulenbroek, Le Blanc, and de Kort, 2020) and the six factors that contribute to burnout (Maslach, 2017), can make it less likely that employees will be burned out, and more likely that they will feel engaged. All design decisions are made in the context of an organization's cultures (organizational, group, national), competitive environment, etc., so desired outcomes can be made more likely but not guaranteed via design (see, for example, Albrecht, 2015).

The research discussed above indicates that workplace design that reduces the probability of burnout while augmenting that of engagement has the following parameters:

7.1 Supports the Task at Hand

Align design with employee tasks at hand (e.g., Appel-Meulenbroek, Le Blanc, and de Kort, 2020; Barnes, Wineman, and Adler, 2020), considering, for instance optimal stimulation level (Stone, 2003; Wohlwill, 1966, i.e., developing less stimulating environments for spaces where people, alone or in groups, will need to concentrate/focus, and more stimulating spaces for tasks that do not require as much concentration/focus).

Create spaces whose form is consistent with research linking performance on probable work tasks to particular design elements (e.g., Lichtenfeld, Elliot, Maier, and Pekrun, 2012; Studente, Seppala, and Sadowska, 2016) or to workplace design generally, (Al Horr, et al., 2016; Veitch, 2012). For instance, the presence of green leafy plants in workplaces seems particularly likely to optimize performance and reduce burnout, all while increasing engagement (Nieuwenhuis, et al., 2014).

Design in work conditions that are more satisfying/preferred generally (Veitch, 2012).

Design biophilicly (e.g., Browning, et al., 2012; Newsham, Veitch, and Hu, 2017; Yin, et al., 2018) and in an environmentally responsible way (e.g., Allen, et al., 2016).

Develop spaces that boost mood (e.g., Hoendervanger, et al., 2013). This includes for example, as Hoendervanger and colleagues as well as Veitch and teammates (Veitch, Stokkermans, and Newsham, 2013) report, spaces with higher levels of environmental satisfaction.

7.2 Creates Opportunities for Cognitive Refreshment

Support cognitive refreshment via views of nature, real or in images/art, water, etc.; (Kim, et al., 2010; van den Berg, Koole, and van der Wulp, 2003; Veitch, 2012); refreshment has been tied to lower levels of burnout and greater engagement (Thompson and Bruk-Lee, 2019; Ward and Parker, 2020). Soundscaping can also support cognitive refreshment (e.g., Benfield, et al. 2014).

7.3 Encourages Comfortable Levels of Environmental Control

Sustain comfortable levels of environmental control, potentially, for instance, via activity-based workplaces (e.g., Laurence, Fried, and Slowik, 2013; Spivack and Milosevic, 2018).

7.4 Facilitates the Development of Bonds Between Employees

Design to support the development of employee bonds/community via spatial layout (e.g., Allen and Henn, 2007; Sommer, 1969) and sensory experiences (e.g., Ackerman, Nocera, and Bargh, 2010), for instance.

Develop spaces that support positive socializing between employees as well as those that facilitate effective collaboration. (e.g., Spreitzer, Bacevice, and Garrett, 2020).

7.5 Manages Nonverbal Messages Sent Via Design Actively

Send, via design, nonverbal messages consistent with employee perceptions that they are valued by their employers, and that indicate fairness and support for values (e.g., Commission for Architecture and the Built Environment and the British Council for Offices, 2006; Veitch, 2012; Vischer, 2007). Consultation with users is necessary to verify “meanings” drawn.

8 CONCLUSION

Design that reduces employee burnout and enhances engagement is already being considered by workplace developers. Ayoko and Ashkanasy (2020) report, for instance, that firms such as Google are incorporating retreat/refreshment/meditation spaces into workplaces to battle burnout.

Application of design-related research tied to burnout and engagement is thus both timely and crucial for employee wellbeing and performance.

Workplace burnout has a negative effect on individual and organizational wellbeing, while engagement has positive implications for the same people and groups. Research on burnout, engagement, and workplace design indicates ways that the form of the physical environment can be used to make burnout less likely and engagement more probable.

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The ‚human' workplace – health-relevant factors for learning and working spaces

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ABSTRACT

While working for different companies in designing new learning and working spaces, as well as doing a lot of change management for employees and users of these new spaces, the question became obvious: is it possible to plan healthy spaces with all networked health relevant factors from the beginning?

First questionnaires, workshops and observations with the users were used to find the relevant topics. Following an intensive workshop with various specialists in the field was conducted, the essential factors were determined and discussed. The goal was to cover all relevant influencing factors and develop a checklist for the early planning phase to eliminate the negative effects on health and well-being for the future users.

Particular emphasis was placed on the three areas defined by the World Health Organization as critical to health: mental-social-physical well-being in the workplace. All three levels play an essential role in human satisfaction with regard to work and learning and the environment for working and learning spaces. These findings and checklists were also tested in a research project conducted for the Ministry of Education and Research in Germany (Prägewelt – Präventionsorientierte Gestaltung neuer Arbeitswelten) and further tools were developed. These tools help on one side the planners to design the right spaces with the help of the developed checklists and on the other side the users to understand the design and use it in the right way to stay healthy at the workplace.

The user is seen as an important factor, but it also became clear that he also has an essential role and one's own responsibility to his/her health. The organization has to provide the right basis to help and support health relevant factors and the user hast to understand, accept and use these in the right way.

In Germany there are more than 40 billion euros per year in lost production due to illness an inability to work caused by illness (cf. Spath et all 2011, p. 40).

Keywords

new learning and working spaces, knowledge space, flexibility, variability

1 INTRODUCTION

While working for different companies in designing new learning and working spaces, as well as doing a lot of change management for employees and users of these new spaces, the question became obvious: is it possible to plan healthy spaces with all networked health relevant factors from the beginning?

The influences on health and well-being of employees are multifactorial: the design of the workspaces (especially open space offices), the materials used, the indoor climate, the lighting, physical influences such as noise or psychological factors such as colors, exchange possibilities with colleagues and, last but not least, the furnishing of the workplaces themselves all plays a role. And this means that by far not all factors influencing well-being and health in an office or administration building are covered, because internal processes as well as team dynamics and management influences must also be taken into account.

To get a deeper inside especially in health issues for employees the author was part of a research project, which also developed tools for more healthy workplaces.

There is a lot of research on the satisfaction of employees at the workplace. For our research project, first the relevant literature was evaluated. For instance, the study from Lukas Windlinger (2007) on the perception of stress in different types of offices. As well as the study by Fraunhofer on the importance of the workplace environment (2016) which was written after a large survey was conducted. There is also the Gallup study on the engagement of employees, were they found that in 2019, the percentage of "engaged" workers in the U.S., those who are highly involved, enthusiastic about and committed to their work and workplace, reached 35%. That means 65% are not satisfied with their employer and the environment they work in.

In Germany alone there are more than 40 billion euros per year in lost production due to illness an inability to work caused by illness. (cf. Spath et all 2011, p. 40)

The user is seen as an important factor, but it also became clear, in the course of the project, that he also has an essential role and one’s own responsibility to his/her health. The organization has to provide the right basis to help and support health relevant factors and the user hast to understand, accept and use these in the right way.

2 THE RESEARCH PROJEKT

The joint project "PräGeWelt - Prevention-Oriented Design of New (Open Space) Work" was started to examine the current change in office space and asks about the consequences for work and health of employees in the new, open office spaces (Open Space). The aim was to develop approaches for a health-promoting design of open-space office environments on the basis of a holistic, interdisciplinary analysis.

PräGeWelt was funded by the Federal Ministry of Education and Research (BMBF) under the program "Innovations for the production, services and work of tomorrow" and was supervised by the Project Management Agency Karlsruhe (PTKA) at the Karlsruhe Institute of Technology (KIT). Science partners and practice partners worked together in the network. It was started in 2016, with a duration of 3 years. A web site was developed, and a first report was published in 2019. (http://praegewelt.de/). Two public workshops were held, the developed tools were tested and the final report was just finished in 2020.

2.1 Approach of the research project

Guidebooks, guidelines or checklists often focus on the spatial design of open-space offices. This research wanted to find out which factors have an influence on the satisfaction of the users of an Open Space office and how to increase the satisfaction of the employees.

The basis for the study were scientific studies, which were carried out by an interdisciplinary research association (sociology, psychology, architecture) in and with a total of 22 companies.

With five of these companies we were also able to work on improvement possibilities for existing open-space offices. This resulted in two tools, among others, which will be published on the project website. In addition, two guidelines (on change management in connection with the implementation of new office concepts and on leadership in Open Space) were developed, which will also be available for free download on the project's homepage (www.praegewelt.de).

The empirical studies in the research project are based on the assumption that there are different perspectives on open space offices. The perception and impact of open-space offices do not depend on a single influencing factor (such as the size of the office) or on spatial conditions alone, but on the interplay of several different factors. Accordingly, the study not only recorded spatial characteristics and their perception by employees and managers, but also relevant characteristics of the organization (including structure, culture, development, including the process of change towards an open-space office), the work (including organization, cooperation, requirements, activity components) and the person (including socio-demographics, office biography, manners).

22 companies were visited, and 840 employees were involved in an online survey. Workshops were held with 13 technical and industry experts as well as 42 company experts and this group of persons were interviewed in detail.

2.2 Perceptions and conflicts

An important contradiction was discovered: Everyone is aware of the importance of the issues of increasing pressure to perform, constant availability, growing complexity and increasing dynamics - both for the health and performance of employees. However, these issues have only ever played an indirect role in the planning and implementation of new office spaces. Whether the design of new workspaces can help to reduce the pressure to perform - or on the contrary contribute to its intensification - was an important question for all interviewees.

Companies associate various objectives with the new construction or conversion of an office, of which these are the most important ones: The most common is the goal of more efficient use of space, closely followed by qualitative goals: The office environment should become more communicative, because it is believed that personal interaction has a special value; more attractive, in order to motivate, attract or retain employees; more flexible, in order to be better able to cope with growing diversity and increasing dynamics.

But companies also pursue contradictory goals. As a consequence, open space offices are characterized by specific areas of tension, which are perceived by employees as a burden or challenge. There are three main areas of tension in particular that characterize every new office: + Concentrated vs. Cooperative: The open space office should promote cooperation, but also enable concentrated work.

+ Confidential vs. Open: The open space office should offer openness (transparency, visibility), but must also allow confidentiality.

+ Individual vs. Flexible: The open space office should guarantee flexibility but must also offer options for individuality (of working methods, choice of workplace, etc.).

These areas of tension reflect the different, even contradictory goals that are to be achieved with an open space office. This is why they also have special characteristics: On both sides there are positive expectations of the office. But because both poles are on the same scale, the positive expectations are contradictory: more of one is almost automatically less of the other. These tensions belong to the new office world and are the reasons for a lot of health issues.

That's what our research showed clearly: There are typical problem constellations and areas of tension that ensure that the open space office not only has advantages, but also disadvantages. This is precisely what causes stress and mixed feelings among employees and managers in our study. There is no such thing as the perfect open space office. Nevertheless, there are great differences in perception and evaluation of the same office concept.

Our research shows that there are a number of influencing factors for satisfaction and dissatisfaction with the open space office and that the design and equipment of the open space plays an important, but by no means the only role: An office is not only a physical space, but above all a social space.

2.3 Success factors

The open-space office is never final or perfectly implemented. Open Space needs to be flexible, "re-shapable" and therefore always a little "unfinished". In this way it meets today's requirements: structures, organization charts, working methods, technologies - everything is constantly in motion. If you want to implement changes successfully, flexible, open structures help: The working environment can adapt to changing team sizes, team divisions, working methods and technologies again and again.

In the research project we developed four factors, which are essential for the success of a new office project.

Mindset / credibility: If the working spaces are to be profoundly transformed, this can only be successful if companies are willing and able to consistently pursue the change process and represent it in a credible manner. Credibility is at its highest when really everyone is involved, including management and executives.

Participation / co-determination: Involving the worker's council in the process at an early stage increases the legitimacy of the changes and the chance that regulations (such as work agreements on the use of home office or on working time arrangements) will be agreed upon that benefit the workforce. Involving the employees is a must. The companies studied are aware of the widespread skepticism among the workforce with regard to change processes and generally do not make decisions without asking their employees. For example, at different points in the change process, surveys are conducted to find out what employees want and how satisfied they are with the changed work environment.

Competence: In order to achieve the goals, set, a small group of people is needed who are convinced of their project and who will make sure that the process moves forward. Since the redesign of working spaces will initiate changes at various levels, this should be accompanied by an appropriately interdisciplinary project team.

Realization: There is a typical distribution of roles in the redesign of offices: upper management is the driver of the change process. Ideally, the control is carried out by the project team. In addition, the companies have had good success in trying out new working spaces first of all in limited pilot areas: as a practical test and learning field, but also as an illustrative example to increase the willingness of the workforce to get involved. Employees talk to each other and experiences are exchanged.

Open space therefore means that self-organization, team routines and management culture must also change – it is not enough to design new spaces. Open space stands for change - and is itself to be understood as perpetual change.

3 HEALTH AND THE OFFICE

The fact that working in a digitalized world is becoming faster, more complex and more flexible was a topic in all interviews. And how to maintain motivation, performance and health in the long term, was therefore a major question for the interviewees.

Everyone agreed that the organization of the office space and the office environment is very important for the well-being, motivation and health of employees. The focus here was mostly on ergonomic issues (such as height-adjustable desks), integrated recreational activities and support of movement (such as long distances to the photocopier or the coffee kitchen). So even where health is an issue in office planning at all, it is primarily about physical health.

People hope that an attractive design will create a pleasant space environment, which will then have a positive effect on health and motivation through well-being and satisfaction.

3.1 Guidelines

Every Open Space office consists of areas of tension, of advantages and disadvantages. And yet the perception of the employees differs from case to case. Every office is different - and in one office, employees are more satisfied and see fewer disadvantages, in another, they are more dissatisfied and report major problems. We have learned from these differences: The perfect Open Space does not exist - but it can be made better or worse.

First of all, the working space must fit: To the person, their way of working and their tasks, to the work requirements, but also to the culture of the company. The higher the perceived fit between office design and organizational culture, the more satisfied respondents are with their office environment. The same applies to the fit with the work task and personal work style.

Second to get a good and fitting design, the people working there must be involved and accompanied in the process from the beginning. The spaces have to fit the working habits and processes, as well as the culture of the company.

3.2 Findings

1. **autonomy** (choices, appropriation of space)

People want to have creative possibilities in their lives. Autonomy here does not mean complete independence, but choices. This can be taken up very well, especially in an open space office, by ensuring that there are sufficient and diverse support areas. Flexible furniture, which allows to adapt the workplace accordingly, also promotes a feeling of autonomy through the possibility of appropriation.

2. **affiliation** (identification, sense of place, spatial symbolism)

The basic need for belonging is satisfied when one feels connected with other people, e.g. by caring for each other. This connection can be felt not only with people but also with nature or a place (nature relatedness). In an office landscape, therefore, it is not only the corporate culture, the team climate and the relationship with the manager that is decisive, but also the space can contribute to identification. All design details that remind one of other people or the brand can strengthen the feeling of connectedness.

3. **competence** (self-efficacy through good support / tools)

Every person also wants to make a difference with his/her actions, to find his/her way in life. In space, this need can be satisfied on one hand by good orientation possibilities, on the other hand by a really supporting design of all activities. If one always has the right space with the appropriate tools available, it is easier to become effective, feel well and be healthy.

4. **privacy**

Another elementary human need is the need for privacy. Private sphere establishes itself in: 1) the possibility of retreating from others, 2) controlling how much information others have about us and 3) regulating the interaction in the moment.

The need for privacy, like all needs, is individually different and also culturally influenced. In the spirit of diversity, an open space office should offer enough settings in which one can influence how much privacy others can invade.

5. **territoriality**

Territorial behavior means the marking and delimitation of one's own area. The behavioral repertoire includes marking boundaries, physically and mentally, decorating and personalizing and a certain degree of control over this area. In non-territorial office concepts, this loss of one's own territory should be counteracted by strengthening identity at group level and by defining clear rules to prevent informal territory formation. The latter can be achieved, for example, through workshops on the rules of cooperation.

6. **personal space and interpersonal distance**

This is the distance or space that is maintained in social interactions. Personal space surrounds a person, has no visible boundaries, is formed by culture and socialization and determines the degree of desired intimacy. When designing the physical space, care must be taken to respect cultural characteristics and not to force too much density or narrowness through the layout.

7. **control** and appropriation of the space

The theory of cognized control states that the person wants to experience perceived control. This is achieved by giving explainability, predictability and influenceability. For the space, this can mean that windows can be opened or that there are controllers where the employees themselves can influence temperature, ventilation, etc. Display panels that prepare for upcoming events/work steps/guests etc. also contribute to the life of the controller by being predictable.

8. **justice**

In order to feel justice, it is important not to inexplicably favor or disadvantage anyone. This should also be expressed in the space through equivalent sitting areas. A gradient can be observed from the periphery of a large office space to the inside. Inside, there is less daylight, no visual contact to the outside and less shielding. On the other hand, the glare outside the window can be more unpleasant or dizziness can occur when looking into the depths. With the layout, you must ensure that workplaces are of equal value. Special equipment, such as a second screen, can enhance less attractive workstations.

4 CONCLUSION

The user is seen as an important factor, but it also became clear that he/she also has an essential role and one’s own responsibility to his/her health. The organization has to provide the right basics

to help and support health. But on the other side the individual is responsible for his/her wellbeing and health and also has to do his/her share in it.

In the research project we found these three main areas of tension in every office space. These all have a contradiction between two poles that cannot be realized simultaneously - you can either just do one or the other perfectly.

A basic prerequisite for the functioning of an open-space office is its acceptance by employees and managers. The credibility with which it is run and mutual trust play an important role.

Tool Box

As part of our findings we have developed some tools to use during the planning process as well afterwards when using the spaces. We tested these tools at the companies of our study as well as at a conference, were everybody participating could take part in different workshops and test those tools. The reactions on these workshops helped to create our final tool box.

The **PräGeWelt-Balance-Workshop**: This workshop serves to jointly identify the main areas of tension of Open Space, create awareness and to derive and implement processing possibilities. Result of the workshop is a photo-documentation of identified areas of tension and the derivation of measures to balance out or to deal with the areas of tension. Available here: PräGeWelt – Balanceakt Open Space: Typische Spannungsfelder offener Arbeitswelten meistern

With the **PräGeWelt reflection tool**, on the other hand, individual learning processes are supported in the appropriation of the new working environment. The reflection tool offers the possibility to initiate and support learning processes on an individual level. It pursues a holistic approach and offers methods for individuals to promote proactive use of space, to reflect the individual perception of stress and to prevent stress. Available here: PräGeWelt – Reflexionstool: Bausteine zur Verbindung von Change Management und betrieblicher Gesundheit in neuen Arbeitswelten

The results of the PräGeWelt project show that health in office spaces can only function holistically. The levels of organization, team and individual should be considered integrative when designing health-promoting working environments. In this context there are many change management methods for teams. However, there are hardly any methods for individuals to organize themselves and prevent stress. The reflection tool is intended to offer such a possibility.

Health is a high good. It is therefore legitimate to work out the facets of health determinants and consider them in detail when creating a workplace for human beings.

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Designing for health: strategies for enhancing employee health by workplace design

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ABSTRACT

Purpose: Health has taken a leading role in office design and investments. In the knowledge-intensive world, employees are acknowledged to be organisations' most important asset, their health and well-being is an important investment in the current office market. In this paper, the purpose is to identify different design strategies for creating healthy workplaces to give direction to design and future research in this rapidly expanding area.

Theory: Workplace design is able to harm or support health in different ways. For instance, exposure to toxic emissions, loud noise and daylight directly affect physical health. Mental health is affected by work environments causing or buffering stress, or by constraining or fulfilling basic human needs. Psychological theories of arousal, environmental load and stress explain how the amount and appraisal of stimuli affect wellbeing. An imbalance between demands imposed and resources offered by the working environment can cause burnout. Indirectly, the office space design could influence health by nudging healthy behaviour.

Design/methodology/approach: A literature review was conducted to deduct design strategies for health from existing research on health effects of workplace design. Academic search engines were used to find peer-reviewed papers that measured the relationship between features of interior office space, and health conditions or healthy behaviour of the office workers. From the initial database of 2816 papers, 59 were included for further analysis.

Findings: Related to interior office space, three design strategies for employee health were identified. The most traditional strategy, designing for comfort, aims to create a comfortable environment by fulfilling the bodily and psychological needs of the users, and preventing harm, stress, and frustration. Designing for revitalization aims to decrease office workers' stress by offering an environment that supports physical recovery and renewal of psychological resources. Designing for healthy behaviour aims at stimulating physical activity, healthy nutrition, or relaxing activities.

Originality/value: This research contributes to a nuanced and positive perspective on healthy offices. By identifying strategies for prevention of harm as well as strategies for creating positive influences, it reveals promising directions for further research and salutogenic design. By outlining existing empirical research it provides a foundation for evidence-based workplace design within the different design strategies.

Keywords

Workplace design, office, health, wellbeing, design strategy.

1 INTRODUCTION

Employees are often referred to as the greatest asset of organizations (e.g., Haslinda A, 2009; International Labour Office, 2015). Research has shown concerning signs regarding the health of office workers. For example, 43% of office workers in Europe report backaches, 42% report muscular pains in their neck or arms, and 35% overall fatigue (Eurofound, 2017). Workers reporting work-related stress have a10 to 40% higher risk of cardiovascular disease (Kivimäki and Kawachi, 2015), and the estimated costs of the work-related stress are from US$221 million up to US$187 billion (Hassard et al., 2018). People spend approximately 60%-90% of their time indoors (Kunkel et al., 2015), including approximately 24% of their weekly time at work, based on a standard 40-hour work week. Considering the time spent at work, the health impact of the physical and social work environment can be substantial.

Workplace design is able to harm or support health in many different ways, from building material's toxic emissions that directly affect physical health and daylight influencing the biological clock to spatial arrangements influencing behaviour and decoration fostering feelings of belonging. Already the Greeks and Romans were aware of the adverse effect of polluted air (Sundell, 2004). Research on air quality within buildings has been developing since the 1980s (e.g., Jones, 1999; Tham, 2016) and gained a visible role in current scientific and public discussions. More recently, research on healthy offices has expanded into the area of workplace design, studying an array of features related to interior space (Engelen et al., 2019; World Green Building Council, 2014). Additionally, in building research the scope of health has widened from merely physical to including psychological aspects of wellbeing.

Psychologically, the office environment could affect health negatively by causing stress, e.g. annoyance, overload, or undesired distraction, or positively by buffering stress through e.g. perceived control and inspiration. For instance, Kaplan's (1995) Attention restoration theory explains that reduced demands on information processing and environments like nature trails, parks or museums can help recuperation from mental fatigue, caused by depletion of the attention capacity of a person. Similarly, the office environment can contribute to the constraint or fulfilling of basic human needs, such as autonomy, competence and relatedness (Ryan and Deci, 2000). The application of the job demands-resources theory has shown that an imbalance between demands imposed and resources offered by the working environment causes burnout (Bakker and Demerouti, 2017). Indirectly, office space design could influence health by nudging healthy behaviour through interventions in the choice architecture of employees (Thaler and Sunstein, 2008).

Further theoretical and practical development of this vast and multidisciplinary area requires streamlining of methods and measures and adopting a more holistic approach. Until now, research on wellbeing in buildings often lacks clarity of design objectives and wellbeing conceptualizations (Engelen et al., 2019; Forooraghi et al., 2020; Hanc et al., 2019). Therefore, the aim of this study is to find patterns in the ways that workplace design could support employee health, to guide future research and goal-oriented design.

2 METHOD

To identify different design strategies for employee health a systematic literature study was conducted. Since an initial search in Google Scholar on "office and health" did get over 1.3 million hits, several test searches were conducted to discover relevant and effective search terms. In the

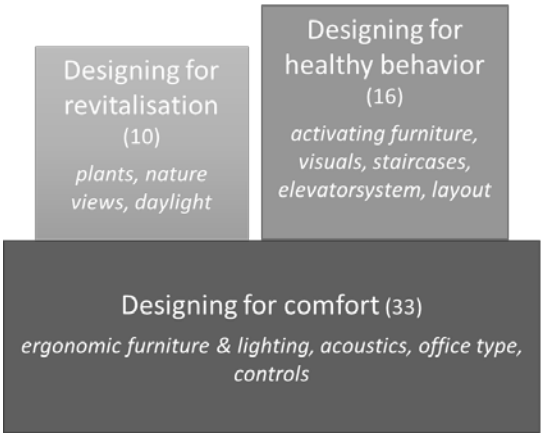
final searches six health related terms (“health”, “well-being”, “wellbeing”, “stress”, “burnout” and “musculoskeletal”) combined with six workplace related terms (“physical work environment”, “office environment”, “office setting”, “workplace design”, office design”, and “office building”) were used in two large data bases, Scopus and Web of Science. Only papers in English were searched, published in peer-reviewed journals between 1993 and 2018. The initial databased included 2816 records which were screened in three rounds: title, abstract and full text. Papers were excluded (a) if they did not address office buildings but, for example, health care facilities, factories, schools, or neighbourhoods; (b) if office design was not studied but for example, indoor climate, behavioural interventions, or devices; (c) if the population did not represent office workers but instead, for example, health care professionals, children or elderly people; or (d) if health or wellbeing was not addressed in the study, but it was limited to, for example, satisfaction, productivity, or performance.

Focusing on the relatively new area of workplace design for health, only elements that are part of the interior office design were included, such as form and arrangement of spaces, surfaces, lighting, furniture, and other objects (Ching and Binggeli, 2018). This means that research on building maintenance, facility services, and performance of technical installations was excluded. Regarding health the definition from the World Health Organization (WHO, 2006, p.1) was followed, including physical as well as mental and social well-being. A template was used to collect the same information from each of the remaining 59 papers, such as purpose and aim, research design, dependent variables related to health, independent variables related to workplace design, and main results. Applying content analysis to identify the different design strategies among them, the findings were collected, grouped, and regrouped, as suggested by Miles and Huberman (1994) and Tuomi and Sarajärvi (2012). First they were grouped by the features of interior space that were studied in relation to health, revealing themes within workplace design, such as light, layout and furniture. Next, the papers were grouped by their health scope and purpose, reflecting possible design objectives related to health.

3 IDENTIFIED DESIGN STRATEGIES

The content analysis of the 59 included papers reveals three design strategies for enhancing health and wellbeing of office workers that are based on either psychological theories, for instance, about environmental stress, and behavioural change, or on the biology of the human body.

Figure 1. Overview of identified design strategies, related design features and number of papers



3.1 Designing for comfort

Among the included papers, the strategy *designing for comfort* is the most prominent approach and has the longest tradition. This strategy aims to create a comfortable environment, fulfilling the bodily and psychological needs of the users, and preventing harm, stress, and frustration. It can be considered the basic level of designing for health. The majority of the papers, 33 out of 59, followed this approach. In seven studies the aim was to reduce musculoskeletal discomfort by applying ergonomic furniture (Amick et al., 2012; Grooten et al., 2017; Karakolis and Callaghan, 2014; Van Niekerk et al., 2012; Robertson et al., 2009, 2013; Roossien et al., 2017). Another six papers studied different light levels (Van Duijnhoven et al., 2018; Lamb and Kwok, 2016; Thayer et al., 2010), lighting systems (Fostervold and Nersveen, 2008; Joines et al., 2015) or perceived lighting quality (Veitch et al., 2008) as a means of increasing physical comfort. In eleven papers the health risks of different office types was investigated (Bodin Danielsson et al., 2014, 2015; Brennan et al., 2002; Foley et al., 2016; Haapakangas et al., 2018; Jaakkola and Heinonen, 1995; Lindberg et al., 2018; Meijer et al., 2009; Morrison and Macky, 2017; Pejtersen et al., 2011, 2006). In these papers the health conditions and well-being of office workers in private rooms were compared with those working in small rooms, medium and large open spaces, flexible offices or activity-based offices. This showed that a larger size of the room, that is the intended amount of occupants, increased the risk of health complaints. The remaining papers in the category of designing for comfort studied stress resulting from noise (Jahncke et al., 2011; Schlittmeier and Liebl, 2015; Seddigh et al., 2015; Shafiee Motlagh et al., 2018) or lack of control (Bluyssen et al., 2011; Boerstra et al., 2015; Knight and Haslam, 2010; Toftum, 2010; Wells, 2000).

Remarkably, the papers provide relatively few details on the relationship between the physically comforting design features and the psychological well-being of the occupants, where according to Vischer (2007) psychological comfort links psychosocial aspects to the workspace design. She draws a hierarchy of comfort levels, with physical comfort being the threshold of acceptable workspace, functional comfort required to perform tasks, and psychological comfort affected by the degree of instrumental control or empowerment of users. It would be interesting to know, for instance, what causes the negative experience of the open-plan office and how you could overcome them by using a well-designed activity-based working (ABW) environment, since ABW is experienced more positively. According to Wohlers and Hertel (2017), the implementation of ABW is an ongoing trend. They developed a theoretical model of the benefits and risks of ABW, connecting the openness of the main work environment to potential stressors, such as territoriality, autonomy, privacy, proximity, and visibility, and consequences, for example, identity, group cohesion, and need satisfaction.

3.2 Designing for revitalization

A second design strategy identified in the included papers takes a step forward from reducing or preventing discomfort and offers an environment that facilitates physical recovery or renewal of psychological resources. One category of examples on *designing for revitalization* include studies that assessed the beneficial influence of plants in the workspace (Bjørnstad et al., 2016; Evensen et al., 2015; Fjeld, 2000; Qin et al., 2014), and real and artificial nature views (Bjørnstad et al., 2016; Kahn et al., 2008; Kweon et al., 2008; Xue et al., 2016) on fatigue and physiological stress. The second category includes studies on the capability of daylight (Bjørnstad et al., 2016; Boubekri et al., 2014) and artificial lighting (De Kort and Smolders, 2010; Viola et al., 2008) to decrease tiredness and stress and increase alertness, vitality, and sleep quality. The hypotheses in these studies were based on, for example, psychological theories of stress recovery (Ulrich, 1991) and attention restoration (Kaplan, 1995).

This design strategy has a connection to biophilic design (Kellert et al., 2008), based on the biophilia hypothesis of the innate human need for contact with nature. Gillis and Gatersleben (2015) found substantial evidence demonstrating the benefits of certain attributes of biophilic design, such as the presence of natural elements for human well-being. More empirical research, namely, controlled field studies on biophilic design, is required to confirm their findings in office environments. Furthermore, to develop this design strategy, research is required regarding spaces and amenities for intentional relaxation in the office, for example, facilities for power naps, meditation, games, and sports, and how people could be motivated to use these facilities to recover from stress.

3.3 Designing for healthy behavior

This strategy aims to explicitly stimulate healthy behaviour, for example, physical activity, healthy nutrition, and relaxing activities like moderate exercise through sports or games. This paper presents 16 papers following this approach, and all targeting the employees' sedentary behaviour and stair use, either through specific furniture to decrease sitting time (Barbieri et al., 2017; Carr et al., 2016; Graves et al., 2015; Grooten et al., 2017; Healy et al., 2013; Roossien et al., 2017; Torbeyns et al., 2016), prompts to increase stair use (Avitsland et al., 2017; Kwak et al., 2007; Lewis and Eves, 2012; Nocon et al., 2010; Swenson and Siegel, 2013), or building features to increase walking (Duncan et al., 2015; Engelen et al., 2016, 2017; Jancey et al., 2016; Nicoll and Zimring, 2009; Wilkerson et al., 2018), such as open staircases, skip-stop elevators, longer distances to communal facilities, or better connectivity between spaces. Excessive sedentary time is associated with musculoskeletal problems and chronic diseases, including obesity, type 2 diabetes, cardiovascular disease, and some cancers (Neuhaus et al., 2014).

Designing for healthy behavior is the newest of the three strategies, with the oldest paper dating from 2009 and the majority published between 2015 and 2017. It is heavily based on the rise of the nudging concept, promoted as a seemingly easy and possibly effective means to influence behavior. A nudge means a gentle push "to alter people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler & Sunstein, 2008, p.6). Applied into workplace design it could range from a visual reference to desired behaviour, for instance based on social norms, to making healthy options more visible, easy and fun.

To develop this design strategy, a more profound insight is first required regarding possible healthy choices in the office environment and conditions for forming lasting habits. The included papers in this review are limited to a particular design for decreasing sedentary behaviour, and few longitudinal studies have been conducted to assess the long-term effectiveness.

Next, designers can develop prototypes of nudges and researchers can test acceptation and effectiveness in the short and long term in controlled field studies. The actual behaviour change is best measured by nonobtrusive observation and automatic registration, not (only) by questionnaire, because people are typically not very capable of reflecting on their own behaviour. Nudging could also be applied to influence healthy nourishment (e.g. Arno and Thomas, 2016; Kroese et al., 2016) and encourage social contact and relaxation.

The majority of the included papers, regardless which strategy was investigated, focus on bodily comfort, reducing stress or increasing mood. Social well-being, referring to social interactions, relationships and belonging (Fisher, 2014), is an underexposed subject, although it can be a significant factor in the relationship between workplace design and office workers' health and vitality (van Scheppingen et al., 2015). According to the job demands and resources theory (Bakker et al., 2014), aspects of social well-being, such as expressing identity, support from colleagues, and

feeling part of the team, are important job sources and as such could function as a buffer to burnout. It would be interesting to link these to workplace design features.

4 CONCLUSIONS

This paper identifies and explains possible design strategies for health-supporting workplace design, deducted from a literature study including 59 papers, spanning 26 years. Three different design strategies to enhance employee health by workplace design were identified. The most traditional strategy, designing for comfort, aims to create a comfortable environment by fulfilling the bodily and psychological needs of the users, and preventing harm, stress, and frustration. Designing for revitalization aims to decrease office workers' stress by offering a restorative environment supporting physical rest or renewing psychological resources, for example by applying biophilic design. The strategy of designing for healthy behaviour stimulates physical activity, healthy nutrition, or relaxing activities, for example, by application of prompts, special furniture, or specific building features.

The identified strategies invite interior designers, architects, and facility managers to look at healthy offices from different perspectives, beyond providing basic safety and more often taking a positive and salutogenic approach to workplace design (Ruohomäki et al., 2015), and moving the emphasis from only prevention to also amplition (Le Blanc and Oerlemans, 2016). The covid-19 pandemic re-directs us to the need for a safe physical distance and hygiene in the office to prevent spreading the virus, but we should not forget the human need to connect with each other and to get inspired by the environment. Not to mention the acoustic impact of all those hard surfaces and splash guards. For academics, the study summarises the different approaches, showing the gaps and providing directions for future research, such as studying the impact of different interior interventions within one design strategy. Additionally, since this study is limited to design strategies found in the literature, it would be interesting to elaborate and expand these strategies based on the current practice.

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Do Changes in the Work Environment Predict Changes in Privacy Appraisal and Associated Outcomes? – A Longitudinal Study

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ABSTRACT

Introduction: Privacy fit is a frequently reported issue in open office environments, yet its context predictors and its consequences remain understudied.

Theory: To investigate these points, this study builds on Altman's (1975) privacy regulation model and the cognitive appraisal theory (Folkman & Lazarus, 1985) as a transactional model of stress. It focuses on the fit between workers' desired and achieved levels of privacy and on the appraisal of privacy fit and its stressful nature.

Methods: This research was designed to examine context predictors of change in privacy fit and coping appraisal, as well as changes in the consequences of privacy fit during an office move. Data was collected over two points of measurement from 61 office workers who moved from a standard open-plan office to an office that is activity-based. The first questionnaire was distributed six weeks prior to the office move and the follow-up questionnaire approximately eight months after. With its longitudinal design, this study extends past research by demonstrating the changing nature of privacy fit and revealing predictors of change in privacy fit and coping appraisal.

Results: Cross-lagged autoregression analysis of change confirmed suggested predictors such as increase in variety of settings and in adherence of others to protocols that positively influenced post-move privacy fit. Further, change in coping appraisal post-move was predicted by an increase in perceived environmental and behavioural flexibility. Changes in privacy fit and appraisal were associated with increases in job and workplace satisfaction and decreases in emotional and mental work fatigue post-move.

Originality/Value: Results could inform physical workplace design as well as cultural interventions in organisations. To our knowledge, this is the first study investigating the psychological process of privacy experience by using a transactional model of stress.

Keywords

Privacy, cognitive appraisal, office design, work fatigue, work satisfaction

1 INTRODUCTION

Despite the interest in work privacy in open-plan offices, which dates back several decades, evidence of the stress-related consequences of poor work privacy has been limited. Even though theoretical assumptions exist (e.g., Flynn, 2014; Oseland, 2009), there is little empirical evidence of how environmental and social context factors in new work environments, such as activity-based working (ABW), influence privacy regulation, and whether these context factors could prevent the stress-related consequences of poor work privacy. In an attempt to fill these gaps in the literature, this study investigates the impact of an office move from standard open-plan to an ABW configuration on workers' privacy experience and related consequences by taking a stress perspective.

1.1 Work privacy fit and expected outcomes

Work Privacy Fit

The present study employs a multidimensional conceptualisation and operationalisation of work privacy, which builds on Altman's privacy regulation framework (1975) that is related to person–environment (P–E) fit theory (cf. Edwards et al., 1998). As such, work privacy is regarded as a control process of input and output of information and social stimuli in the work environment. Four distinct dimensions of work privacy are considered: distractions (regulation of indirect social stimuli/input), interruptions (regulation of direct social stimuli/input), task privacy (regulation of visual output), and conversation privacy (regulation of acoustical output).

Expected Outcomes

Overall, there is limited evidence of the stress-related consequences of poor work privacy. There is ample empirical evidence associating privacy with job as well as workplace satisfaction, which is consistent across studies using different and often reductionist operationalisations of privacy (e.g., Kim & de Dear, 2013; Oldham, 1988; Sundstrom, 1986). There is some prior evidence of the relationship between poor privacy fit and emotional fatigue (e.g., Laurence et al., 2013), whereas P–E fit research gives sufficient empirical support for poor P–E fit being associated with emotional fatigue (e.g., Edwards & Harrison, 1993; Jamal & Baba, 2000; Vandenberg et al., 2002). Further, a link between mental fatigue and poor privacy fit (e.g., Cohen, 1978; Laurence et al., 2013; Sundstrom & Sundstrom, 1986) has been suggested, whereas only scarce evidence exists to support this relationship; evidence primarily focuses on the regulation of acoustical social stimuli (e.g., Cohen & Spacapan, 1978).

The present study aims to validate findings on satisfaction using a multidimensional operationalisation of work privacy, given that previous studies used a reductionist approach. Further, the present study aims to extend the current evidence base by assessing whether poor privacy fit is associated with emotional and mental fatigue. Furthermore, as job demand is an established contributor to satisfaction and fatigue at work (cf. Frone & Tidwell, 2015), the assessment controls for its effect.

1.2 Coping appraisal

This research draws on stress theory, specifically cognitive appraisal theory (Folkman & Lazarus, 1985), to shed light on why poor privacy fit might have stress-related consequences. Cognitive appraisal theory suggests that negative emotions at work are fundamentally controlled by appraisal processes; the appraisal process is crucial in determining whether environments or relationships at work are experienced as stressful (Lucas et al., 2012). Hence, the study examines

whether one's individual assessment of being able to cope with poor privacy fit (coping appraisal) is related to the levels of satisfaction and fatigue that one experiences.

1.3 Context factors

Overall, there is limited evidence of the relationship between environmental and social context factors and work privacy in ABW environments (cf. Engelen et al., 2018); most privacy research has been conducted on old versions of open-plan offices that have fallen out of fashion. Nonetheless, it has been postulated that ABW or ABW-related characteristics are helpful in regulating interpersonal contact in open-plan spaces (e.g., Flynn, 2014; Oseland, 2009). The following ABW-related context factors have been suggested as critical to privacy regulation:

(1) Setting variety, which refers to a multitude of work settings that differ in their designs to support various work tasks. It has been postulated that these are helpful in regulating interpersonal contact in open-plan offices (Oseland, 2009), although existing evidence is primarily reduced to non-peer-reviewed industry research (e.g., Flynn, 2014).

(2) Protocols, which refers to office etiquette on how to use different types of work setting correctly to prevent misunderstandings (Oseland, 2009). There is some evidence of the importance of unspoken rules that cue acceptable behaviour at work related to privacy (e.g., Justa & Golan, 1977; Steele, 1986) and on the usefulness of protocols in decreasing disturbances by colleagues (e.g., Bellingar et al., 2006; Brennan et al., 2002; Hedge, 1982; Kupritz & Haworth, 2005).

(3) Location autonomy, which refers to employees' ability to choose their preferred work location in and outside the office. Conceptually, location autonomy is related to job autonomy (Medik & Stettina, 2014; Szilagyi & Holland, 1980), which provides the freedom to decide how one's job is structured and conducted (e.g., Leach et al., 2003). Although proposed as useful in regulating interpersonal access (Flynn, 2014; Wohlers & Hertel, 2017), the evidence base is scarce (e.g., Robertson et al., 2008).

This study addresses the limited available evidence and aims to explore preventative measures that impact on poor privacy fit, privacy-related coping appraisal, and their undue consequences. Therefore, the relationships between ABW-related context factors, privacy fit, and coping appraisal are examined respectively.

1.4 Hypotheses

Hypothesis 1a: Changes in privacy fit over time are accounted for by changes in context factors (setting variety, protocol adherence, and location autonomy).

Hypothesis 1b: Changes in privacy-related coping appraisal over time are accounted for by changes in context factors (setting variety, protocol adherence, and location autonomy).

Hypothesis 2a: Changes in satisfaction and fatigue over time are accounted for by changes in privacy fit when controlled for job demand.

Hypothesis 2b: Changes in satisfaction and fatigue over time are accounted for by changes in privacy-related coping appraisal when controlled for job demand.

2 METHODS

2.1 The field situation

This study was conducted in the context of an office relocation in a global architecture and engineering company in the UK, involving approximately 1,000 staff members. The original office had a standard European open-plan configuration with basic ancillary spaces and shared and assigned desks dispersed across two floors. The new office was configured to support ABW with a wide variety of ancillary and workspaces, and shared desks arranged by teams across five floors. Change management activities at biweekly to monthly intervals up to 12 months post- move addressed protocols on setting use and autonomous working with regard to location choice.

2.2 Procedure and study design

Managers of teams with more than five members were asked to participate; 11 managers agreed for their teams to be involved, which resulted in a sample population of n = 479. The first questionnaire was distributed six weeks before the move and the second approximately eight months after the move. Managers followed up with three reminders. An incentive of six lottery prizes was given by the company at the time of each survey; participants were asked on each occasion to create a respondent ID to match responses to both questionnaires for later analysis.

2.3 Participants

A total of 479 employees were invited to participate in the study. A total of 238 eligible questionnaire responses were collected at Time 1, and 135 at Time 2. A total of 85 respondents participated in both questionnaires, of which 24 were discounted because of excessive missing data. Sixty-one longitudinal responses were retained. The respondents of those 61 retained questionnaires were aged between 20 and 65 years (M = 34.50, SD = 10.0). Twenty-four of the participants were female, 35 male (2 missing). In terms of representativeness, the sample was considered adequate regarding gender ratio (organisation: 65% male, 36% female)[1], job role (five categories ranging from ‘junior or graduate position’ to ‘associate, director, or partner’; all roles were represented between 5% and 25%), and response rate of the participating departments relative to size (11 departments ranging from ‘architecture’ to ‘building engineering’ were represented between 10% and 67%)[2].

2.4 Measures

Descriptive and reliability statistics for, and correlations among, the variables are provided in Table 1.

Work Privacy Fit

Privacy fit was measured by the Privacy At Work inventory (PAW) V.1, a self-reported inventory of 12 x 12 items assessing first, the frequency of privacy needs and subsequently, the frequency of privacy fit during the previous four weeks on two 7-point Likert scales ranging from *(1) Never* to *(7) All the time*. Privacy fit scores were weighted with privacy need scores in accordance with Kahana’s (1982) P–E fit assessment procedure.

Coping Appraisal

Privacy-related coping appraisal was assessed using four items from Dewe’s (1991) six- item

[1] Preliminary analyses indicated that there was no difference in privacy fit distribution by gender. Hence, gender was not included for further analyses.

[2] Five departments were represented with < 10%, three were represented with 11–20 %, two were represented with 31–40 %, and one was represented with 67%.

coping appraisal scale and adapted for this study; two items from the original scale were excluded as they were not considered relevant or unspecific (cf. Weber, 2019). As the majority of the four items reflected 'uncontrollable situations' (Peacock & Wong, 1990, p. 232) and only one item reflected 'controllability by oneself' (p. 232), another item was added reflecting the latter theme, which is important to the coping appraisal construct. In line with the original measurement, a 5-point Likert scale ranging from *(1) Strongly disagree* to *(5) Strongly agree* was used. Low scores reflect high coping appraisal and the perception of being able to do something about the situation.

Outcome Variables

Workplace satisfaction was assessed using a three-item measure by Oldham (1988) with a 7-point Likert scale ranging from *(1) Strongly disagree* to *(7) Strongly agree*. Job satisfaction was assessed using a three-item scale by Lee and Brand (2005) with a 5-point Likert scale ranging from *(1) Strongly disagree* to *(5) Strongly agree*. Emotional and mental work fatigue were assessed using a 2 x six-item measure by Frone and Tidwell (2015) on a 5-point Likert scale ranging from *(1) Never* to *(5) Every day*. Overall, high scores reflect high levels of satisfaction and fatigue.

Independent Variables

Variety of settings was assessed with a one-item measure taken from the 'Leesman survey', which is an industry service survey for assessing office adequacy (Leesman, 2017). Participants rated whether the design of their office encouraged them to use different settings that best supported their work tasks. Adherence to protocols was assessed by a one-item measure developed for this study based on a definition by Oseland (2009). Location autonomy was assessed with three items developed for this study. An example item is *In the last 4 weeks, even if I could have worked somewhere else, I felt I should work at my desk.* All items were assessed on a 7-point Likert scale from (*1) Strongly disagree* to *(7) Strongly agree.* Overall, low scores reflect little variety of settings, little adherence of others to protocols, and low levels of location autonomy.

Control Variable

Job demand was assessed using a four-item measure by Elovainio et al. (2015). Two items (intensive work and conflicting demands) from the UK Health and Safety Executive's Management Standards (Edwards et al., 2008) were added. Items were assessed on a 7-point Likert scale ranging from (*1) Strongly disagree* to *(7) Strongly agree*. High scores reflect high levels of job demand.

Table 1

Means, standard deviations, Cronbach alpha, and zero-order correlations between study variables.

	Variable	*M*	SD	*α*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.	Privacy fit T1	-1.34	4.50	.88	-																			
2.	Privacy fit T2	-0.66	5.10	.87	.48**	-																		
3.	C. appraisal	3.04	0.98	.87	.48**	.57**	-																	
4.	C. appraisal	3.25	0.97	.87	.40**	.61**	.50**	-																
5.	E. fatigue T1	2.70	1.16	.97	-.20	-.32**	-.37**	-.07	-															
6.	E. fatigue T2	2.60	1.18	.98	-.13	-.38**	-.25	-.21	.69**	-														
7.	M. fatigue T1	3.61	0.98	.95	.02	-.05	-.09	.13	.66**	.47**	-													
8.	M. fatigue T2	3.37	0.97	.95	-.12	-.37**	-.17	-.20	.56**	.65**	.33*	-												
9.	W. satisfaction	4.28	1.54	.93	.17	.14	.50**	.15	-.48**	-.36**	-.27*	-.19	-											
10.	W. satisfaction	5.16	1.51	.93	.44**	.70**	.45**	.61**	-.28*	-.33**	-.05	-.32*	.21	-										
11.	J. satisfaction	3.51	0.74	.64	.21	.33**	.43**	.36**	-.48**	-.33**	-.20	-.23	.55**	.36**	-									
12.	J. satisfaction	3.64	0.73	.75	.27*	.48**	.29*	.59**	-.18	-.30*	.07	-.18	.29*	.58**	.53**	-								
13.	Protocols T1	4.25	1.56	-	.13	.14	.25*	.22	-.16	-.11	.08	.16	.21	.17	-.01	.11	-							
14.	Protocols T2	4.18	1.74	-	.12	.47**	.34**	.43**	-.24	-.30*	-.15	-.29	.28*	.44**	.39**	.39**	.21	-						
15.	Autonomy T1	4.25	1.57	.81	.21	.26*	.32*	.53**	-.12	-.07	-.01	-.13	.38**	.29*	.41**	.34**	.03	.31*	-					
16.	Autonomy T2	4.09	1.63	.73	.16	.43**	.35**	.57**	-.08	-.15	-.04	-.26*	.21	.40**	.36**	.21	.03	.37**	.63**	-				
17.	Settings T1	3.46	1.44	-	.35**	.21	.40**	.25*	-.26*	-.21	-.09	-.10	.60**	.19	.39**	.21	.11	.15	.32*	.18	-			
18.	Settings T2	4.80	1.57	-	.35**	.54**	.38**	.56**	-.18	-.14	-.05	.04	.30*	.62**	.25	.36**	.33**	.44**	.30*	.32*	.30*	-		
19.	J. demand T1	3.61	0.78	.81	-.11	-.03	-.17	.01	.49**	.33**	.42**	.39**	-.13	.13	-.27*	-.03	-.15	-.27*	.05	0.11	-.17	0.17	-	
20.	J. demand T2	3.65	0.76	.89	.05	-.04	.01	.03	.36**	.27*	.27*	.36**	.00	.00	-.26*	-.10	-.03	-.36**	.10	0.01	-.03	0.03	.56**	-

Note. $n = 61$, *$p < .05$, **$p < .01$ (2-tailed).

3 ANALYSIS

3.1 Causal directions across time

Autoregressive cross-lagged analysis, as opposed to panel analysis, was conducted to assess causal directions across time (Bollen & Curran, 2006), due to the study's high attrition rate. Cross-lagged models are in line with principles of causal inference (measuring putative causes prior to the effects and thereby supporting temporal precedence of the cause) (cf.

Kearney, 2017). Tests were carried out to ascertain whether changes in context variables account for changes in privacy fit and coping appraisal (H1), and whether changes in privacy fit and coping appraisal account for changes in outcome variables (H2). Overall, 10 hierarchical regression models were tested.

3.2 Sample design considerations

A priori power calculations were conducted with G*Power (Faul et al., 2007) considering multiple regression analyses. An *a priori* power calculation with power (1-β) of .95, and α = .05 indicated that a sample of $n = 70$ would be required to detect large effects ($f2 = 0.35$) in regression models with seven predictors (to test H1). An *a priori* power calculation indicated that a sample of $n = 63$ would be sufficient in detected large effects in regression models with five predictors (to test H2). These results suggest that large effects could be found with the acquired sample size.

4 RESULTS

4.1 Hypothesis 1 – Impact of context factors on privacy and coping

Hypothesis 1a was partially supported as changes in variety of settings ($\beta = .29$, $p < .01$) and protocol adherence ($\beta = .30$, $p < .01$) predicted changes in privacy fit post-move, but not in location autonomy ($\beta = .17$, $p > .05$). Together, both variables explained 22% of variance in the final model, $F(7, 53) = 8.44$, $p < .001$.

Hypothesis 1b was partially supported as changes in variety of settings ($\beta = .31$, $p < .01$) and location autonomy ($\beta = .25$, $p = .03$) predicted changes in coping appraisal but not in protocol adherence ($\beta = .11$, $p > .05$). Together, both variables explained 16% of variance in the final model, $F(7, 53) = 10.16$, $p < .001$.

4.2 Hypothesis 2 – Impact of privacy and coping on satisfaction and fatigue

Hypothesis 2a was partially supported as changes in privacy fit predicted changes in emotional fatigue ($\beta_{ef} = -.24$, $p = .04$) and mental fatigue ($\beta_{mf} = -.36$, $p < .001$) post-move after controlling for job demand. Time 2 privacy fit explained 4% and 10% of variance in the final models testing emotional fatigue, $F(5, 55) = 8.44$, $p < .001$, and mental fatigue, $F(5, 55) = 14.42$, $p < .001$. Further, changes in privacy fit predicted changes in job satisfaction ($\beta_{js} = .32$, $p = .01$) and workplace satisfaction ($\beta_{ws} = .62$, $p < .001$) post-move after controlling for job demand.

Privacy fit explained 7% and 29% of variance in the final models testing job satisfaction, $F(5, 55) = 7.18$, $p < .001$, and workplace satisfaction, $F(5, 55) = 12.46$, $p < .001$.

Hypothesis 2b was partially supported as changes in coping appraisal predicted changes in emotional fatigue ($\beta_{ef} = -.22$, $p = .05$) and mental fatigue ($\beta_{mf} = -.30$, $p < .001$) post-move after controlling for job demand. Time 2 coping appraisal explained 4% and 7% of variance in the final models testing emotional fatigue, $F(5, 55) = 11.26$, $p < .001$, and mental fatigue, $F(5, 55) = 12.57$,

$p < .001$. Further, changes in coping appraisal predicted changes in job satisfaction (β_{js} = .50 $p < .001$) and workplace satisfaction (β_{ws} = .53, $p < .001$) post-move after controlling for job demand. Time 2 coping appraisal explained 18% and 21% of variance in the final models testing job satisfaction, $F(5, 55) = 10.17$, $p < .001$, and workplace satisfaction, $F(5, 55) = 8.631$, $p < .00$

5 DISCUSSION

The present study was designed to assess the directional relationship between privacy fit and privacy-related coping appraisal and associated stress-related consequences at work due to changes in context factors as a result of a move to an ABW office. Therewith, the study extends prior cross-sectional correlational evidence on these relationships (e.g., Laurence et al., 2013; Sundstrom, 1986). An autoregression approach was used to estimate the directional influence that variables have on each other over time, and to draw conclusions about causal influences between variables (Kearney, 2017).

5.1 Impact of context factors on privacy and coping

Results suggest that post-move privacy fit was influenced by changes in the physical environment (variety of settings) and the social environment (protocol adherence). Presumably, the new office enabled workers to choose a distinct setting for a certain task in a context where there is a mutual understanding of acceptable interaction levels between colleagues. These findings validate previous suggestions (Flynn, 2014; Keeling et al., 2016; Oseland, 2009) and reviewed findings (Brennan et al., 2002; Hedge, 1982) on the usefulness of setting variety and protocols in regulating interpersonal contact at work.

Further, results suggest that post-move privacy-related coping appraisal was influenced by changes in the physical environment (variety of settings) and the social environment (location autonomy). This suggests that the more varied participants perceived their work settings to be and the more they felt a sense of autonomy in choosing their work locations in their new office, the more positively they appraised their capacity to cope with poor privacy fit. The relationship between appraisal and autonomy is in line with related appraisal research findings on job autonomy and job stress (e.g., Prem et al., 2016). This supports previous suggestions (Flynn, 2014; Wohlers & Hertel, 2017) and findings (Robertson et al., 2008), that location autonomy is an important context variable for privacy regulation at work.

5.2 Impact of privacy and coping on satisfaction and fatigue

Results showed that privacy fit and coping appraisal changes related to changes in job and workplace satisfaction and emotional and mental fatigue post-move. By taking a privacy fit perspective (Altman, 1975), the results verified previous evidence (which used limited approaches to privacy) and suggestions on detrimental impact of poor privacy fit (e.g., Laurence et al., 2013; Sundstrom & Sundstrom, 1986) and poor coping appraisal.

6 LIMITATIONS

First, the use of a single sample of workers may limit the generalisability of findings to other open-plan office workers within and outside the UK. Second, the sample size is small due to substantial attrition (43%), which limited the choice in advanced statistical testing and reduced the statistical power in the regression analysis. Third, this study cannot account for any spurious effects of

organisational changes outside the scope of this study. Fourth, the study cannot account for any re-test effects and inclusion of construct-irrelevant variance. Fifth, the study cannot determine causal relations between variables to the same extent as can an experiment with random assignment and independent manipulation of putative causes (Selig & Little, 2012).

Further, it was not possible to model the unique effect of several causes simultaneously (Selig & Little, 2012). Furthermore, the study did not test the effects of change management interventions at any stage. However, the study results suggest causal explanations of one variable over another.

7 CONCLUSION

Overall, the results of the present research add to a growing body of literature investigating privacy at work and stress-related consequences. From a theoretical perspective, the usefulness of studying the dynamic nature of privacy fit and individual coping experiences when examining stress-related consequences of privacy became evident. From an empirical perspective, the study supports assumptions and single evidence on the undue consequences of poor privacy fit (satisfaction and fatigue). Further, it highlights how individual differences in coping appraisal shape one's privacy-related stress experience at work. Furthermore, the results add to limited evidence of the relationship between privacy and context factors in ABW environments. Both social and environmental context factors seem to be important resources when managing privacy demands.

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SESSION 4: HEALTH AND WELL-BEING@WORK

Workspace-Related Needs of Knowledge Workers – Based on Their Work Activity Profile

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ABSTRACT

Workplace design often has to answer: (a) which different office settings does an organization need, (b) what amount of each setting is required and (c) what should each setting look like. With respect to these questions, we provide an empirical foundation by combining an activity typology and a needs analysis of the office workers. In an applied R&D project, we developed an initial, still rough rationale for such a combined approach and examined it in a feasibility study. Our approach was to classify empirically the workforce into distinguishable work activity types and to identify their particular needs regarding office settings. This offers a foundation to come up with specific suggestions about the (needs-based) quality and quantity of office features. By factor analysis, 15 work activities were reduced to four work factors. Based on their factor loadings, four groups of knowledge workers were formed by cluster analysis. Each group significantly differs from the others at least on one factor. The correlations of the four groups with 40 occupant needs show (for such an exploratory approach) astonishingly sound results. They suggest that recommendations for specific office design qualities and quantities can be derived from such a combined activity and needs survey. This seems to be favorable especially for larger organizations, when being urged to provide a greater amount of suitable work environments. To our knowledge, this is one of the first studies correlating office work activities with user needs. Although the results are exploratory and need to be replicated, our approach provides a new perspective for a work-related and empirical design of office space.

Keywords

Knowledge Work, Office Design, Typology, User Needs.

1 INTRODUCTION

Through discussions with practitioners, we discovered three decisions which have to be made when planning an activity-based office environment: (a) which particular activity settings[3] to include in a layout plan, (b) how many of the chosen settings to include and (c) how to design these settings in detail. According to the paradigm of activity-based workplace design (e.g.

[3] To us, activity settings are specific work environments within the office, like for individual work, formal meetings, informal talks, but also coffee breaks, etc.

Appel-Meulenbroek et al. 2011), analyzing the office worker's activities offers the potential to provide data for the useful choice of layout settings (decision (a)). Bauer et al (2018) went one step further and proposed seven work profiles based on bundling work activities (such as silent worker, communicator, traveler, etc.) Such or similar typologies are capable of providing information on the number of activity settings required (decision (b)). In order to make the third decision (c) and to recommend useful design of activity settings, office user needs should be collected and assigned to those activity-based work profiles (Budie et al., 2019). Thus, Vischer (2008) developed physiological, functional and psychological needs. Physiological needs are, for example, those for a pleasant interior quality (Bluyssen, 2009). Functional needs include those for privacy and retreat (Seddigh et al., 2015), while psychological needs include those for an inspiring environment (Dul, Ceylan, Jaspers, 2011). However, Vischer does not show a connection between these needs and work profiles. Recently, Gerdenitsch et al (2018) demonstrated the importance of the need supply fit in modern offices. They also focused on various psychological needs such as those for control, privacy or proximity. However, a distinct connection of these needs to activities seems to be missing still. This is where our research activity comes in: we want to find a connection between activity profiles and needs. In our opinion, only such a connection enables us to answer the third question about the specific design of layout settings.

We therefore posed two exploratory research questions:

1) How do we construct a functioning organizational diagnostic tool to collect activities as well as needs of office workers in order to make these three design decisions?
2) What data does such a tool provide and what patterns can be identified within activities and between activities and user needs?

2 METHOD

In an applied research, development and consulting project with the corporate facility management of a Swiss information and telecom provider, we developed an online questionnaire including work activities and needs. Based upon literature research (Brill & Weidemann, 2001; Batenburg & van der Voordt, 2008; Haynes, 2008; Appel-Meulenbroek, Groenen & Janssen, 2011; Maarleveld & De Been, 2011; Baumgartner et al., 2014; Degenhardt, Burri, Gisin, & Schulze, 2014; Leesman Corp., 2014), 15 knowledge work activities were identified and selected (see table 1). These 15 activities are not fully exhaustive, but intend to cover about 80% of an average knowledge worker's daily vocational life. Based on previous research and development projects (Steffen & Schulze, 2015; Schulze, Ryser, Steffen, Flepp & Burkhard, 2017) and discussions with practitioners, we derived 40 specific needs for specific interior features and affordances, e.g. to have the possibility to retreat or to be accessible for others. In addition, we also included needs for specific room atmospheres like coziness, prosaic sobriety, or the expression of status (see table 2).

In July 2016, 184 of the company's knowledge workers were invited to participate, 128 persons responded (response rate 70%, women 24%, men 76%, average age 48 years). The sample consisted of personnel having a clear knowledge/clerical job description and known experience with mobile work, desk sharing and activity-based offices. The participants were invited to measure the importance of the working activities in their daily working life with a 5-point Likert scale, ranging from "not important at all" to "very important," plus a blank option for "not

assessable." For assessing their office-related needs, the participants were asked "How important is it to you (personally) to have in the office…" followed by the corresponding office feature, affordance or room atmosphere. The answering option was also a 5-point Likert scale, ranging from "insignificant" to "indispensable." The original language of the questionnaire was German.

Our exploratory analysis includes two main steps: first, a factor analysis reduces the 15 work activities to work factors, in order to group the 128 respondents based on their individual factor loading. Second, the four factors are correlated with the 40 user needs. These correlations are then discussed, if they are expectable and meaningful in regard to the activity-based office concept.

3 RESULTS

An exploratory principal components analysis of the 15 work activities was conducted. The scree-plot chart suggested a four-factor solution. Therefore, a second analysis with four fixed factors including a VARIMAX rotation was performed. The results of this analysis are shown in table 1.

Table 1 Rotated factor loadings of a principal components analysis of the 15 knowledge work activities.

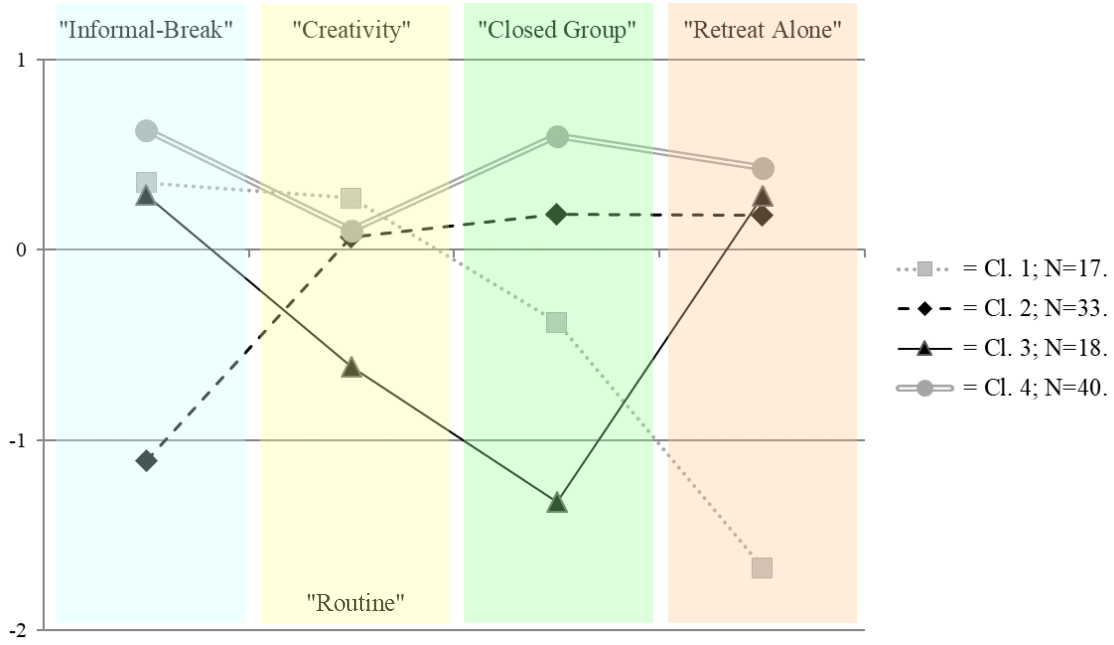
N=128. Factors Work activities	"Informal Break"	"Creative" / "Routine"	"Closed Group"	"Retreat Alone"
Taking relaxed / passive breaks	0.80	-0.12	0.10	-0.09
Eating / drinking something	0.77	0.05	-0.14	0.20
Taking active breaks / doing sports	0.65	-0.15	0.24	0.00
With others: informal communication	0.61	0.11	0.01	0.05
With others: co-working	0.51	0.15	0.25	-0.21
With others: spontaneous meetings	0.49	0.38	-0.01	-0.12
Alone: routine work at the computer	-0.04	-0.79	0.03	0.07
Alone: routine work with physical files	0.07	-0.79	-0.03	-0.12
Alone: creative work	0.09	0.67	0.42	0.13
With others: formal (planned) meetings	0.02	0.06	0.65	0.46
With others: teachings / training	0.27	0.09	0.65	-0.18
With others: confidential meetings	-0.10	-0.06	0.64	0.19
With others: workshop meetings	0.29	0.41	0.63	-0.03
Alone: concentrated / focused work	0.01	0.13	-0.06	0.76
Alone: phone calls / video calls	-0.02	-0.05	0.23	0.61
Eigenvalue (initial)	*3.367*	*2.154*	*1.603*	*1.122*
Percent of explained variance (rotated)	*18.052*	*14.151*	*13.549*	*9.226*

The first factor consists of restorative activities plus informal or spontaneous interactions. Literature suggests (e.g. Flepp et al., 2017) that communication during breaks often is related to work or organizational topics. Therefore, we labeled this first factor "Informal Break." The second consists of two different activities – creative and routine work – having opposite signs. This signifies that they are excluding each other. Thus, participants considered *either* creative work *or* routine work to be important in their daily life (which seems to be meaningful regarding

the content of these two activities). When compared to any other variable, positive correlations refer to creativity while negative correlations refer to routine. This factor has therefore two labels: “Creative” and “Routine.” The third factor consists of rather formal interactions, typically performed retreated in a separate room. Therefore, we labeled this third factor “Closed Group.” The fourth factor consists of two activities performed alone (focused work and phone/video calls), also typically performed retreated in a separate room. We labeled this fourth factor “Retreat Alone.”

For all of the 128 participants, the individual value of each factor was calculated. With these four individual values, an exploratory hierarchical cluster analysis of the participants was performed.[4] The dendrogram chart suggested a four-cluster solution. 108 of the participants (i.e. 85%) could be meaningfully assigned to one of the four clusters. The results are shown in figure i.

Figure i The four clusters of knowledge workers and their activity profiles found on the basis of the work factors.



The first cluster (···■···) is the smallest in our data set. It consists of N=17 participants with rather high levels of informal and creative work activities, an average level on formal/enclosed meetings and a distinctively low level of working retreated alone. The second cluster (- ◆ -) is clearly bigger with N=33 participants, having a distinctively low level of informal encounters or breaks, but rather high levels of creative work, formal meetings and focused work. The third cluster (—▲—) is also rather small with N=18 participants. The members of the cluster show high levels of informal encounters and focused work alone, but rather routine tasks and distinctively less formal meetings than the others do. The fourth cluster (—●—) is the biggest with N=40. Its profile is very similar to the third cluster – except in the informal/break activities, where it has the distinctively lowest level. ANOVAs showed at least one significant cluster difference on each of

[4] The fewer variables included in the analysis, the higher the chance of finding distinct clusters. For this reason, we choose to include the four factor loadings in the cluster analysis instead of the 15 work activities themselves.

the four work activity factors. Finally, the individual values of the work activity factors were correlated with the 40 office feature-related user needs. These correlations were also exploratory, i.e. not testing specific hypotheses or assumptions. The results are shown in table 2, indicating only the significant correlations.

Table 2 Significant correlations between office feature-related user needs and work factors (as indicators for how to design the work activity settings).

Office space-related need for / to… ** equals p < 5% probability of error,* *** equals p < 1% probability of error.*	"Informal Break"	"Creative" "Routine"$^{-1}$	"Closed Group"	"Retreat Alone"
retreat alone.				.33**
retreat with others.	.27*			
(spontaneous) encounters.	.37**			
exchange (with others).	.36**			
be seen (for being addressed).	.44**			
find other people easily.	.37**			
find a room easily.				
protection of information or material.		-.43**		
individual design of the work space.		-.21*		
quickly changing the setting.	.29**	.33**		
stay alone in a room for a longer time.				
stay with others in a room for a longer time.	.30**	.21*		
space for working material.	.21*	-.31**		
space for personal items.		-.23*		
visually presenting something.		.24*	.24*	
space/room with polyvalent use.	.28**		.23*	
space/room to eat or drink something.	.38**		-.19*	
space/room to relax or take a break.	.50**			
space/room to move or be active.	.53**			
a clearly arranged atmosphere.				
a prosaic atmosphere.				
a creative atmosphere.		.33**	.24*	
an atmosphere expressing status.				
a non-hierarchic atmosphere.				
a cozy atmosphere.		-.22*		
an esthetic atmosphere.	.20*			
an atmosphere expressing our brand.				
an atmosphere fostering (team) inclusion.	.24*			
an atmosph. fostering professional distance.		-.28**	.22*	
an atmosph. fostering personal authenticity.				
an atmosph. fostering a sense of security.		-.18*	-.19*	
an atmosphere fostering productivity.				.23*
room cleaning services.				
facility management services.				
catering services.	.36**			
child care services.				

4 INTERPRETATION AND CONCLUSION

Our diagnostic tool successfully assessed office work activities and physical work environment user needs. The first design decision (which activity settings to choose) can be answered by the factors found. Instead of 15 different kind of work settings, the users could need only five:

- Informal relaxed interactions, derived from the "Informal Break" factor.
- Formal focused interactions, derived from the "Closed Group" factor.
- Focused individual work, derived from the "Retreat Alone" factor.
- Routine work, derived from the "Creative / Routine" factor (negatively correlated).
- Creative work, derived from the "Creative / Routine" factor (positively correlated).

The amount needed (second design decision) can be estimated with the profiles. A simple rationale would be to count every cluster with an average factor loading above 0 fully, with average above -1 half and below -1 not at all (except for the routine and creative settings). E.g. the setting for informal relaxed interactions would be mainly used by the 75 persons of the clusters 1, 3 and 4. These amounts do not provide the exact amount of settings needed, but they can be put in relation to the entire layout space available (e.g. in form of percentages).

Table 3 Suggestions for work activity settings, derived from the work factors (specific for the sample).

Work activity setting	Estimated amount of users	Need-based suggestions for design
Informal relaxed interactions	75	- Polyvalent, segmented in mainly open areas and enclosed spaces with possibility of changing easily. - Offering catering amenities (food and drinks). - Providing possibilities for spreading or storing working material (for a short time). - Supporting group identification and providing an esthetic interior.
Formal focused interactions	82	- Polyvalent, enclosed spaces. - Providing possibilities and material for creativity and visual presentation. - Providing a rather formal interior design, supporting the professional roles of its users.
Focused individual work	91	- Enclosed spaces for one person, with focus on productivity.
Routine work	18	- Spacious and customizable workspaces with sufficient privacy. - Interior design expressing both coziness and professional role.
Creative work	90	- Providing possibilities and material for creativity and visual presentation. - Having the ability to stay in the setting for a longer time (e.g. several days) and also have the possibility to switch easily (e.g. divide the group into smaller breakout sessions).

The third design decision can be made when reflecting the correlations of the work factors with the user needs. E.g. the informal relaxed interactions setting needs to be polyvalent, recreational (including food and drinks), providing space for working material, mainly open but also have a space to retreat. Table 3 contains sample-specific estimated amounts of users and suggestions for need-based design features for the five work activity settings. Regarding the feasibility aspect of our study, the tool we created seems to have worked out for this sample in regard to providing

information for the three design decisions. In practice, the results should be compared with information from other sources, e.g. work diaries, observations in the offices or qualitative interviews with the office users. But if resources for such an in-depth user needs analysis are lacking (e.g. due to time and/or organization size), this tool has the potential to provide substantial information quite efficiently.

The second research question refers to the rationale of combining the office users' work activities and their needs. Our approach was first to group the users by activity factors (instead of 15 single activities) in order to find work profiles. Second, we correlated the factors to the needs. The main question is now: do the profiles and correlations provide meaningfully interpretable data or only "statistical noise"?

The four factors appear astonishingly coherent, especially in regard of the rather small sample size. Two factors ("Retreat Alone" and "Closed Group") contain activities which typically are performed rather focused and in a retreated or enclosed setting. One factor ("Retreat Alone") is performed (physically) alone, while the other consists of interactions with others. The "Informal Break" factor instead refers to all (possible) interaction activities which are less focused, planned or formal. They include breaks and recreation, which can be performed either alone or with others and to which spontaneous encounters are less interrupting (e.g. compared to focused individual work). Therefore, all these informal and recreational activities can easily be performed in a rather open setting. This applies for "Creative / Routine," too. Both activities do not necessarily need an enclosed setting, an open one even being favorable (Harris, 2018).

Our four factors can be compared with the ones found by Appel-Meulenbroek, Kemperman, Liebregts, and Oldman (2014). They analyzed the 21 work activities of the Leesman® index with N=32,006 participants. They also found four factors, explaining together about 46% of the variance within the data (our factors explain about 53%). One of their factors also includes enclosed group interactions (e.g. "Business Confidential Discussions"), but also "Individual Focused Work Away From Your Desk." In another factor, "Individual Focused Work Desk-Based" correlates with "Telephone Conversations" (similar to our study) – but also "Informal Unplanned Meetings" and "Planned Meetings" (different to our findings). And they also had "Informal Social Interaction" in the same factor with "Relaxing / Taking A Break." But in general, the aggregation of work activities in the factors of our data appears to be more coherent, probably because of the more homogenous sample. In reverse conclusion: it would be very interesting to compare our factors with those generated from a more stratified or homogenous sample in the meanwhile +600k Leesman database.

Based on this rather coherent and sound set of work factors, one could assume that they correlate in an expectable way with corresponding user needs. When looking at the results in table 2, this expectation is only partially met. The factors hardly correlate negatively with assumable "non-matching" needs (except the second factor, where a negative correlation is referring to "Routine"). For example, the "Informal Break" factor has the most correlations (only positive). Some are quite expectable, like "need for the possibility to have (spontaneous) encounters" or "need for space/room to relax or take a break." But it also correlates with "need for space for working material" and "need for an esthetic atmosphere," both of which we would not have expected to be important for informal encounters. Instead, we would have expected a correlation with "need for a cozy atmosphere," which turned out to be insignificant. On the other hand, the "Retreat Alone" factor has only two significant correlations, both positive with "need for having the possibility to retreat alone" and "need for an atmosphere fostering productivity," which are

quite expectable. However, this mode also lacks other (significant) correlations like “need to stay alone in a room for a longer time” or “need to have space for working material,” which we would have expected. Comparable conclusions could be made for the “Creative/Routine” and “Closed Group” factor as well. Despite this inconsistent picture: to our knowledge, this is one of the first studies correlating office work activities with user needs and further research is therefore highly suggested.

The same applies to the clusters we found, although they seem to be rather distinct, too. Regarding the explorative and hands-on method and the small sample size, it would be more expectable to find “statistical noise” only. Instead, at least two clusters vary on each of the factors significantly. Each cluster has a distinctive characteristic working mode profile: the first cluster is low on “Retreat Alone,” the second low on “Informal Break,” the third low on “Closed Group,” and the fourth is high on all four factors.

Our clusters can be compared with the knowledge worker profiles of Jurecic, Rief and Stolze (2018). They found seven profiles in a sample of over N=13,000. As clustering parameters, they used four core work activities (brief coordination with others, intensive cooperation with others, face-to-face meetings with others, concentrated solitary work) and three work characteristics (spontaneity of activities; complexity of tasks; novelty of work). Although these parameters differ clearly from ours, a basic comparison shows that their “silent worker” profile has resemblances with our cluster 3: both have a higher level of solitary and routine work, plus a lower level of meetings. Other profiles like their “caller” or “traveler” have resemblances with our cluster 1: lower levels of solitary work, compared to higher levels of interaction with others. But for our clusters 2 and 4, there seems to be no resemblance whatsoever in the profiles of Jurecic et al. (2018). In consequence, further research is highly suggested for the cluster approach as well.

Although being explorative, our analysis showed that the combined assessment of working activities and office-related user needs has great potential to generate data for evidence-based office design decisions. It replicated the basic assumption that meaningful work activity factors can be aggregated and knowledge worker profiles can be found based on their work activities. In addition, we have some indication for the interaction of working modes and user needs. The interaction of the work activities with office features is evident by the activity-based office concept itself. The interactions of office features with user needs have been identified by Budie, Appel-Meulenbroek, Kemperman and Weijs-Perree (2019). They also emphasize the importance of how users react to the satisfaction or dissatisfaction of their needs after moving into a new office environment. In consequence, work patterns and user needs should not only be taken into consideration when designing the physical and technical office concept, but also when planning the transition process of the employees. To achieve this, we strongly emphasize further research in these two constructs, especially to all researchers having access to greater occupant samples and databases. And in regard of the fast changing nature of modern office work, we recommend reappraising the set of knowledge work activities continuously.

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Switching behaviour in activity based working environments - An exploration of the reasons and influencing factors of switching behaviour in ABW

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ABSTRACT

Purpose: Opposed to underlying assumptions of ABW offices, previous empirical studies ascertained a tendency that employees do not frequently switch between different activity settings. Even though ABW is more and more becoming the default office concept, employees' switching behaviour has not been investigated in depth. This study aims to understand employees' switching behaviour by determining reasons to switch and not to switch and various influencing factors of switching behaviour.

Theory: Switching behaviour is defined as switching between different places within an office building with work-related, preference-based and/or social purpose, including breaks. Switching behaviour is divided into mandatory and voluntary switching. Mandatory switching is switching due to scheduled activities (meetings) as well as switching due to confidentiality issues. Voluntary switching refers to discretionary switching that may be motivated by a perceived mismatch between either activity or preference, and environment. According to previous research, dissatisfaction with environment can cause switching between different settings in an ABW office.

Design/methodology/approach: A questionnaire study was conducted across Switzerland and Belgium, and 124 employees from various organizations and departments participated in the questionnaire. Frequency analyses were conducted to determine reasons (not) to switch, and multinomial logistic regression analyses were performed to identify influencing factors of switching frequency.

Findings: Findings show that the majority of the respondents switch multiple times a day, which runs counter to the previous research. In addition, the study revealed clear evidence that mandatory switching frequency is independent of various factors suggested in this study. This indicates that the distinction of mandatory and voluntary switching is valid. Furthermore, privacy, acoustics, distraction, proximity to team/colleagues were ascertained as reasons to switch, and place preference/attachment, proximity to team were determined as reasons not to switch.

Originality / Value: Overall, this study contributed to understanding switching behaviour better by defining, distinguishing switching behaviour, and identifying reasons (not) to switch and influencing factors of switching frequency. These findings can provide more knowledge of switching behaviour to workplace or facility management practitioners so that they can understand their employees' needs and behaviour better and integrate this into workplace concepts and design.

Keywords

Activity-based Working, switching behaviour, person-environment interaction, workplace management

1 INTRODUCTION

During the 1980s, the CoCon-office (Communications and Concentration) was firstly introduced, aiming to support the productivity of knowledge workers. People could use different types of office settings for different types of activities in a CoCon-office (Worthington, 1997). In 1990s, the low occupancy rate of this and other office types contributed to the idea of sharing workplaces. The development of mobile technologies and open structured offices further enabled the development of activity-based working (ABW), which refers to a shared work environment without assigned workstations (Appel-Meulenbroek, 2011). A fundamental assumption of ABW is that different settings are offered for different activities in the office, which should optimally support the respective activity (e.g. Becker, 2004, Stone & Luchetti, 1985). Shared work settings in APBW include non-assigned standard workstations, meeting rooms, informal communication areas and other zones, each designed to support a specific activity e.g. concentration, collaboration, communication, creativity, confidentiality, and contemplation (Harris, 2015). However, contrary to the basic underlying assumption of ABW, empirical studies have ascertained a tendency that workers do not switch frequently, or not at all, between different activity settings (Hoendervanger et al., 2016; Qu et al., 2010; Appel-Meulenbroek, 2011; Göçer et al., 2017).

To understand switching behaviour better, this study will determine reasons (not) to switch and influencing factors of switching behaviour in ABW. This can help that workplace management can align workplace concept and design with employee's behaviour and needs, so that employee satisfaction and productivity can be improved.

2 THEORY

Switching behaviour refers to switching between places within an office building. This means that switching behaviour includes switching between different work settings, switching between different floors, switching between different workstations in the same work setting. In addition, switching refers to short-term switching such as switching from one place to another place and come back to a former place within few minutes as well as to long-term switching.

Switching behaviour is defined as switching between different places within an office building with work-related, preference-based and/or social purpose, including breaks. Switching behaviour is divided into mandatory and voluntary switching. Mandatory switching is switching due to scheduled activities (meetings) as well as switching due to confidentiality issues. Voluntary switching refers to discretionary switching that may be motivated by a perceived mismatch between either activity or preference, and environment. According to previous research (Göçer et al., 2017, Hoendervanger et al., 2016) dissatisfaction with environment can cause switching between different settings in an ABW office. It can be assumed that a mismatch between activity, preference, and environment leads to switching as suggested by the person-environment fit theory (Kristof-Brown & Guay, 2011). Person-environment fit theory helps to

define the match between workers' characteristics, their work environment, and tasks (Hoendervanger et al., 2019). In addition to mismatches ("push-factors") this study also covers pull-factors, i.e. aspects that attract employees to switch to other places. For example, employees may switch to different places, if they perceived that a better place is available, even their current place is satisfactory. Additionally, as suggested by Göçer and colleagues (2017) a desire to explore various places can act as a pull factor.

This study is designed to examine whether a mismatch between employee activity and work environment causes switching between different places. The environment is divided into three dimensions: physical environment, social environment, and technological environment. In addition to mismatches, practical drawbacks of switching can prevent office users from switching (Hoendervanger et al., 2016). Therefore, also reasons not to switch are examined.

3 METHOD

A quantitative study of employees in ABW office concepts was conducted in order to investigate frequency of switching between different places, reasons to switch and not to switch, and influencing factors of switching between different places in ABW. A questionnaire was developed that covered the mismatch between activity and environment (Figure 1). A link to the questionnaire was distributed to workplace management practitioners in various organizations by email by the authors. The respondents were invited to participate in the research and were asked to distribute the email further to colleagues in various departments of their organizations. Therefore, diversity of sample selection was achieved since all respondents have multiple positions, experiences, different departments, organizations. To collect data only from the respondents who are currently working in ABW, all respondents were asked to answer whether they work in ABW or not, before starting the survey. A description of ABW was presented so that the respondents had a clear understanding of ABW and could report accurately.

A total of 144 respondents from Switzerland and Belgium participated in the survey, and 124 respondents were working in ABW offices.

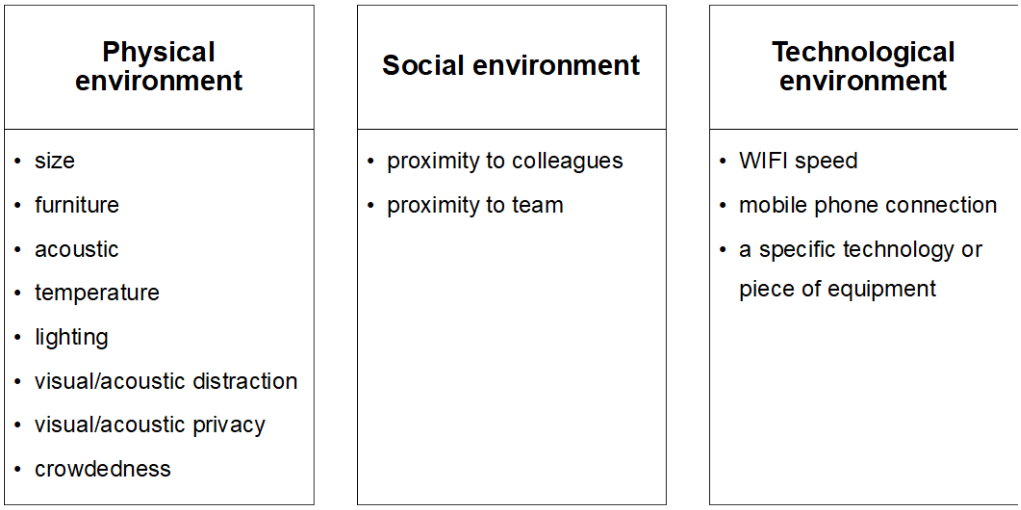


Figure 1: Attributes of environment to measure the mismatch between activity and environment

4 RESULTS

First, two frequency analyses were conducted to examine the frequency of mandatory switching (Figure 2), and the frequency of voluntary switching (Figure 3).

Figure 2: Frequency of mandatory switching

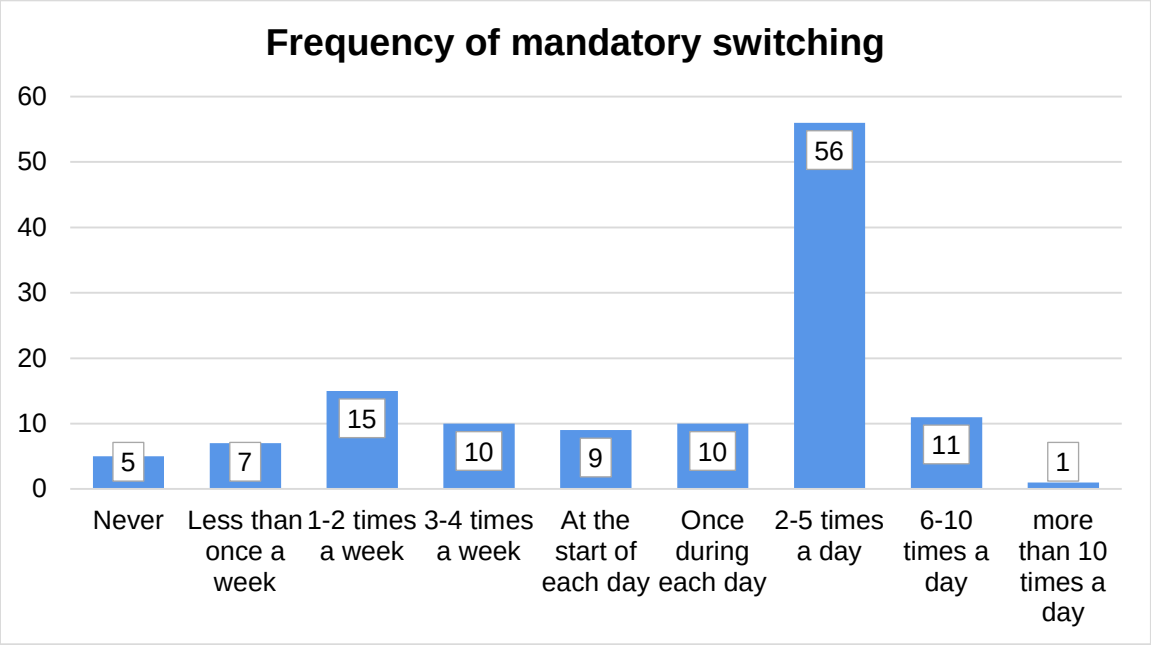
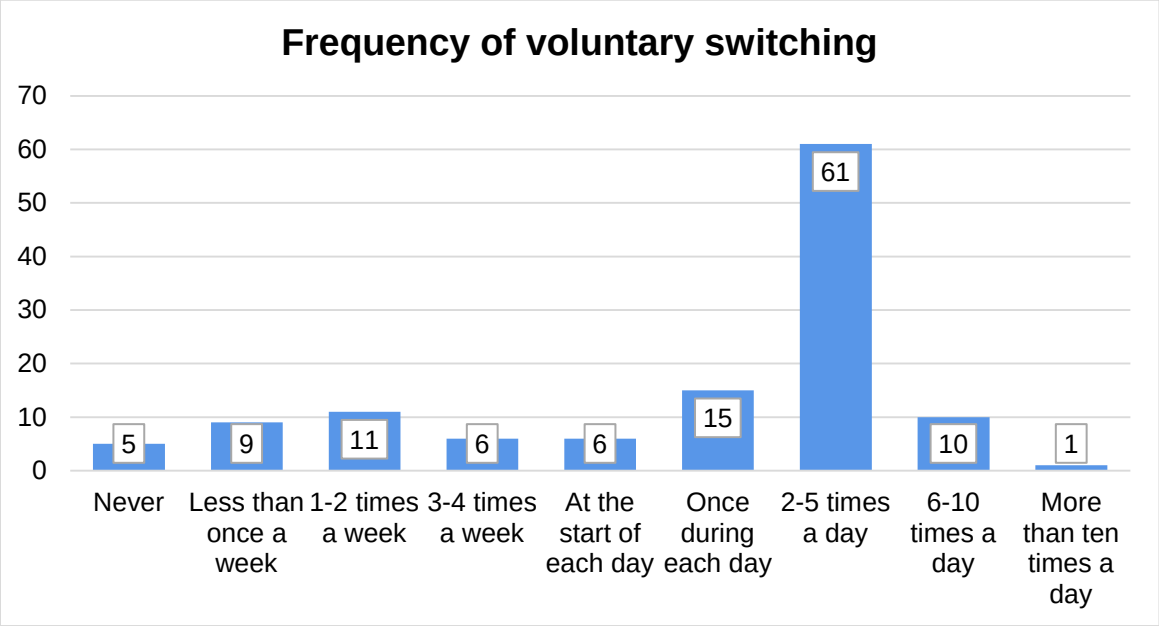


Figure 3: Frequency of voluntary switching



Regarding the reasons to switch, first the pull factors (A better place is available, I would like to explore more places) were examined by frequency analysis. Results show that 48 out of 116

participants who answered this question agreed that the availability of a better place is a reason to switch for them, while this was not the case for 39 and 29 were neutral (Figure 4). For the second pull-factor disagreement was more frequent with 58 participants who indicated that the wish to explore more places is not a reason to switch for them; 23 are neutral and 35 agreed (Figure 4).

Figure 4: The results of the frequency analysis of pull factors (n = 116)

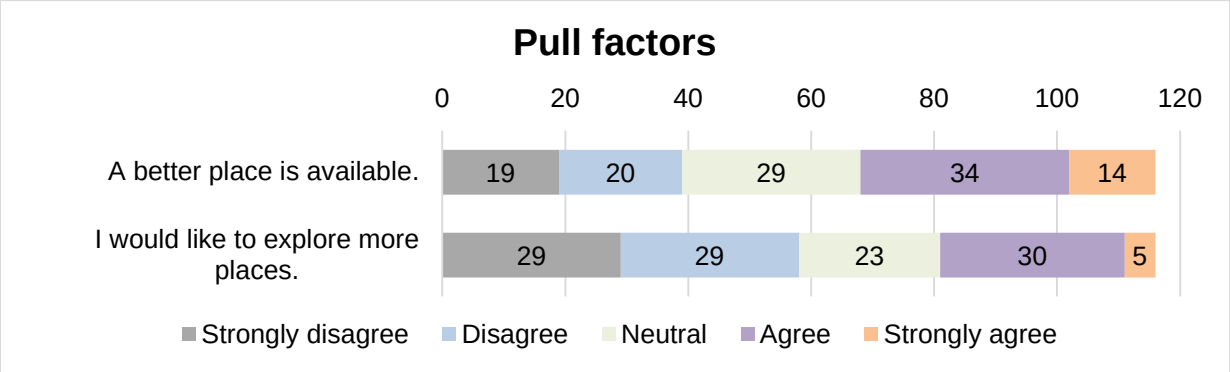
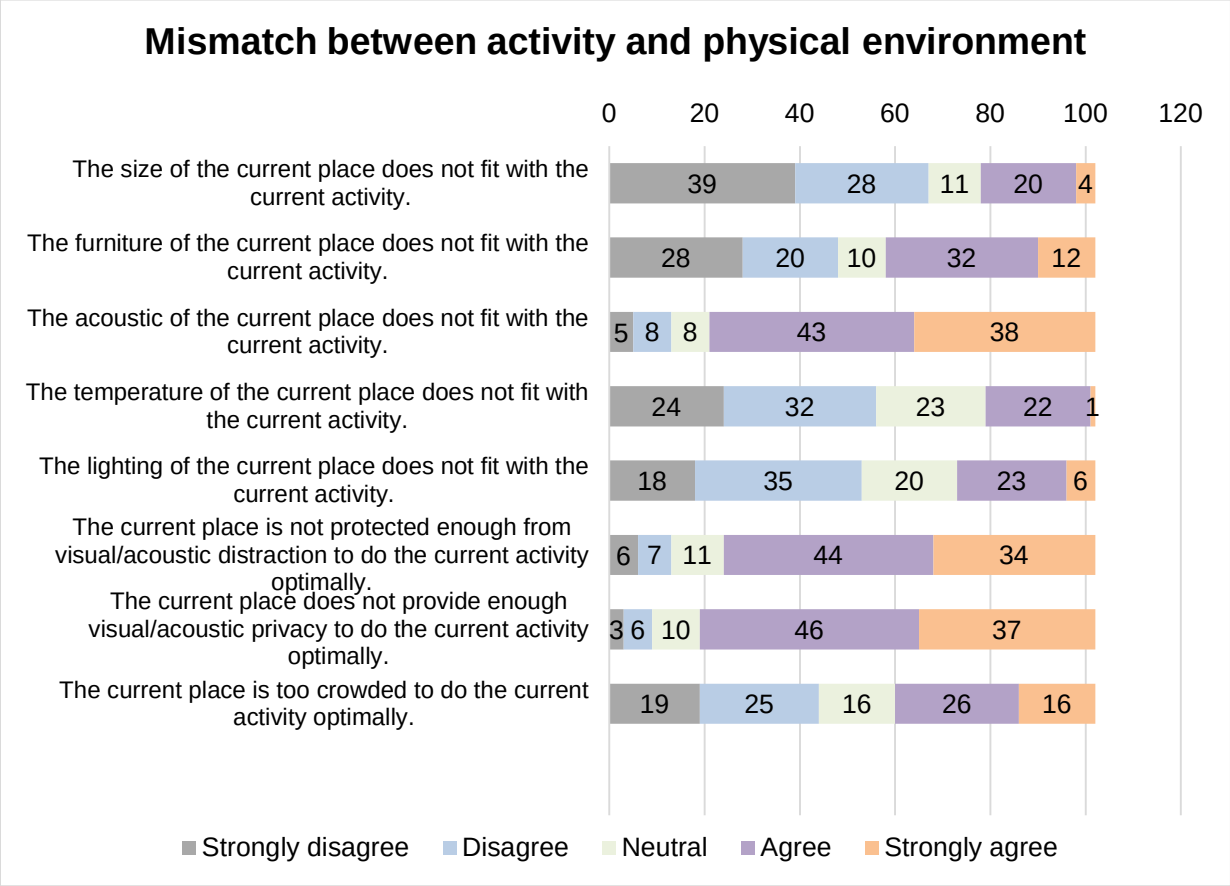


Figure 5: Mismatch between activity and physical environment (n = 102)



The results of the frequency analyses for the “push factors”, i.e. mismatch between current activity and environment are presented in Figure 5 - Figure 7. The main reasons to switch are acoustics, visual or acoustic distractions, and a lack of visual or acoustic privacy at the current

place that lead to a mismatch with the current activity (Figure 5). As regards the social environment, distances to colleagues or the team are reasons to switch that occur with similar frequencies (Figure 6). Mismatches between current activity and technological environment mainly concern the (lack of) availability of specific technologies/equipment (Figure 7).

Figure 6: Mismatch between activity and social environment (n = 102)

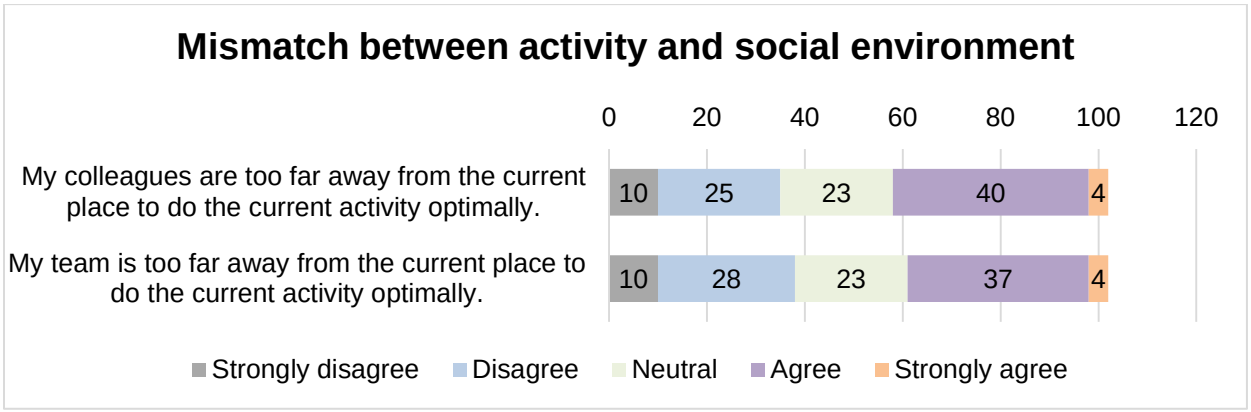
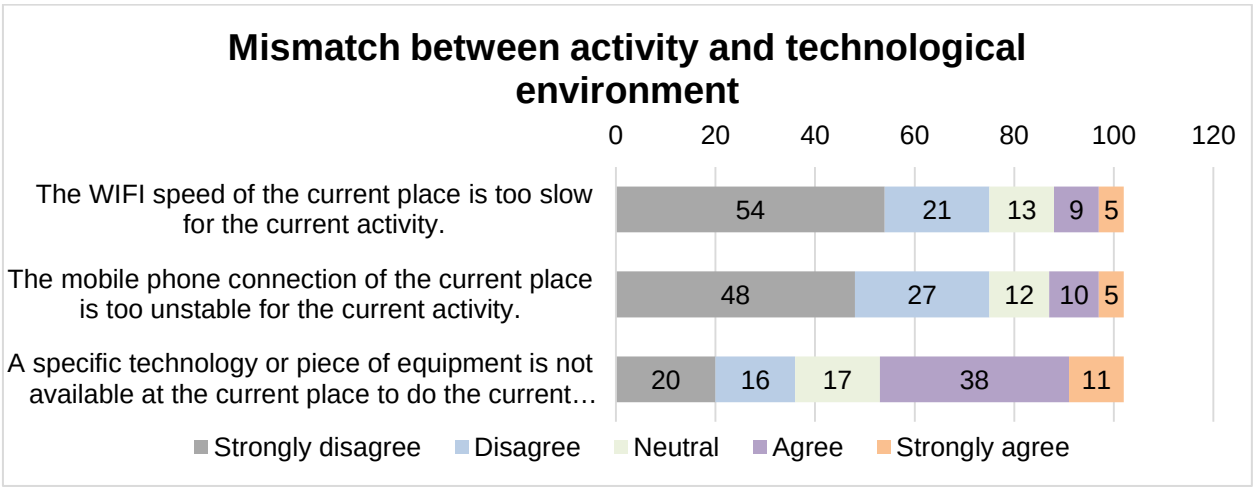


Figure 7: Mismatch between activity and technological environment (n = 102)



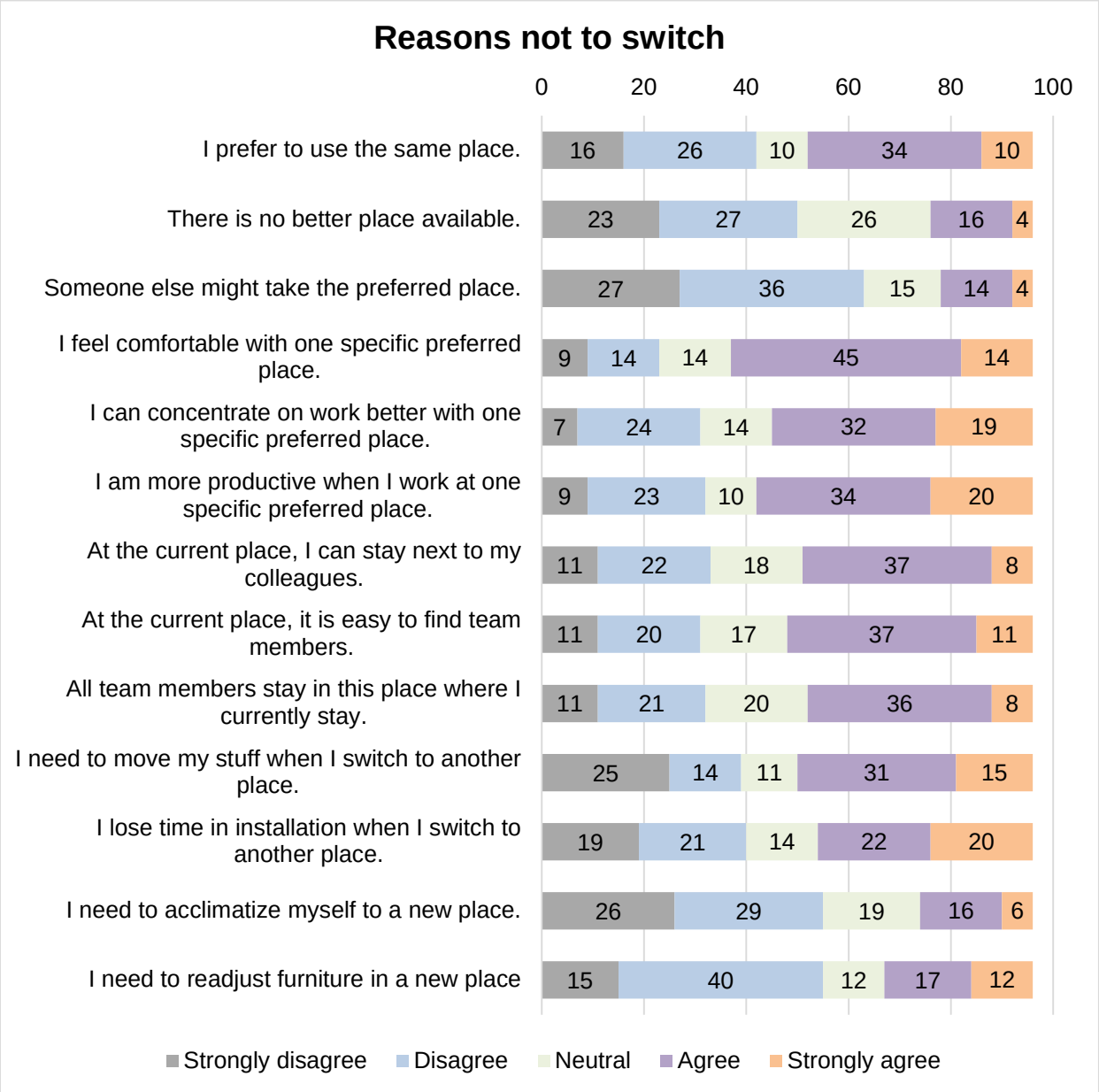
Frequencies of reasons not to switch, i.e. assessment of practical drawbacks of switching, are presented in Figure 8. The figure shows that various reasons seem to be considered similarly important to participants of the study. The main clusters of reasons are attachment to a specific preferred place, proximity to colleagues and team, the need to move things and to lose time in installation at a new place, and the preference to use the same place.

In order to analyse the relationship between reasons (not) to switch and mandatory and voluntary switching frequency, multinomial logistic regression analyses were conducted. To do so, three switching frequency groups were created that have also been used by Hoendervanger and colleagues (2016):

- Group 1: Never or less than once a week
- Group 2: Once until five times a week
- Group 3: Once or multiple times a day

Multinomial logistic regression analysis for the relationship between the mandatory switching frequency and pull factors, as well as various factors regarding the mismatch between activity and environment was not statistically significant (χ^2 (30, N=100) = 33.26, n.s.).

Figure 8: Reasons not to switch (n = 96)



A second multinomial regression analysis was performed to examine the relationship between the mandatory switching frequency and various reasons not to switch. The regression model was statistically significant (χ^2 (24, N=96) = 65.89, p<0.001; Nagelkerke R2= 0.622). The reference category was the group 3 (once or multiple times a day). Thus, each predictor has two parameters, one for predicting mandatory switching frequency in group1 (never or less than once a week) rather than the one in group3 (once or multiple times a day). Another predictor was one for predicting mandatory switching frequency in group2 (once until five times a week) rather than the one in group3 (once or multiple times a day). The result shows no significant effect for

the mandatory switching frequency in group1 rather than the one in group3 and various reasons not to switch. However, there was a significant ($p<0.01$) positive relationship between one reason not to switch (I do not switch because someone else might take the preferred place) and the mandatory switching frequency in group2 rather than the one in group3.

Multinomial logistic regression analysis for the relationship between the voluntary switching frequency and pull factors, various factors regarding the mismatch between activity and environment was statistically significant (χ^2 (30, N=100) = 51.78, $p<0.01$; Nagelkerke R2= 0.508). The reference category was the group1 (never or less than once a week). Significant effects were found between the voluntary switching frequency and pull factors, various factors regarding the mismatch between activity and environment.

Regarding the item 'Desire to explore more places', the comparison between group1 and 2 revealed a significant ($p<0.01$) positive relationship, indicating that employees will be more likely to switch once until five times a week than never or less than once a week, when they would like to explore various places. Also, the comparison between group1 and 3 found a significant ($p<0.05$) positive relationship, which indicates that employees will be more likely to switch once or multiple times a day than never or less than once a week when they would like to explore various places. Additionally, for the item 'Size of the current place' the comparison between group1 and 2 revealed a significant ($p<0.05$) negative relationship, indicating that employees will be more likely to switch never or less than once a week than once until five times a week, when they switch more due to the size of the current place. Similarly, the comparison between group1 and 3 showed a significant ($p<0.05$) negative relationship, which indicates that employees will be more likely to switch never or less than once a week than once or multiple times a day when they switch more due to the size of the current place. Next, regarding the factor 'Temperature of the current place', the comparison between group1 and 2 showed a significant ($p<0.05$) negative relationship. The result indicates that employees will be more likely to switch never or less than once a week than once until five times a week when they switch more due to the temperature of the current place. Regarding the factor 'Temperature of the current place', the comparison between group1 and 3 was not statistically significant. Lastly, regarding visual/acoustic privacy, the comparison between group1 and 3 found a significant ($p<0.05$) positive relationship. It indicates that employees will be more likely to switch once or multiple times a day than never or less than once a week, when they switch more due to visual/acoustic privacy. The comparison between group1 and 2 for this item was not statistically significant.

Finally, the multinomial logistic regression model for the relationship between the voluntary switching frequency and various reasons not to switch was statistically significant (χ^2 (24, N=96) = 52.16, $p<0.01$; Nagelkerke R2= 0.538). The reference category was the group3 (once or multiple times a day). The result shows that there was a significant ($p<0.05$) positive relationship between voluntary switching frequency in group1 rather than the one in group3 and one reason not to switch (I do not switch because I prefer to use always the same place). This result indicates that the least frequent switching group (group1) do not switch between different places more due to the reason 'I do not switch because I prefer to use always the same place' than the most frequent switching group (group3). Besides, a significant ($p<0.05$) positive relationship between voluntary switching frequency in group2 rather than the one in group3 and one reason not to switch (I do not switch because someone else might take the preferred place). This result indicates that group2 do not switch between different places more due to the reason 'I do not switch because someone else might take the preferred place' than group3.

5 DISCUSSION

In this study, mandatory and voluntary switching in ABW was examined. The comparison between mandatory switching frequency and voluntary switching frequency reveals three similarities: First, for both mandatory and voluntary switching, the most frequently answered response was 2-5 times switching a day. Second, for both mandatory and voluntary switching, the majority of the respondents answered that they switch once or multiple times a day. Third, the distribution of switching frequency was similar for both mandatory and voluntary switching.

Besides these similarities, there are also differences between mandatory switching frequency and voluntary switching frequency: Various factors (pull factors and push factors) regarding reasons to switch did not affect mandatory switching frequency at all, whereas voluntary switching frequency was significantly influenced from some of those factors. This result indicates that distinguishing mandatory switching and voluntary switching is necessary for understanding switching behaviour in ABW.

The results of the study have a significant meaning since the results are contradictory to results from previous studies (Appel-Meulenbroek et al., 2011; Göçer et al., 2017; Hoendervanger et al., 2016; Qu et al., 2010). While previous research found that the majority of workers do not often switch between places, this study found that the most frequently given response was 2-5 times a day for both mandatory and voluntary switching. Furthermore, for both mandatory and voluntary switching frequency, the majority of the respondents answered that they switch at least once a day. This difference can be explained by the fact that this research broadened the scope of switching, whereas previous research only focused on work/task-related switching. Hoendervanger et al. (2016) also stated that some respondents might have answered the question regarding switching frequency having only standard workstations in mind, and this limitation may explain why the majority of the respondents indicated to switch never or less than once a week. To prevent misunderstanding and give a clear understanding of switching behaviour, the definition of switching behaviour was introduced at the very beginning of the questionnaire.

6 CONCLUSIONS

This study extends the focus of some previous research on switching behaviour in ABW by including not only work-related switching behaviour but also switching with social purposes and break time. Additionally, this study defines switching behaviour and distinguishes between mandatory and voluntary switching of places. The results show that the majority of the respondents in the questionnaire study switch places multiple times a day, which runs counter to the previous research. In addition, the study revealed clear evidence that various reasons and factors suggested in this study had significant effects on the voluntary switching frequency, but no effect on the mandatory switching frequency. This result demonstrates that mandatory switching frequency is independent of various reasons and factors suggested in this study, which indicates that separation of mandatory and voluntary switching is required.

Overall, this study contributed to understanding switching behaviour better by defining, distinguishing switching behaviour, and identifying reasons (not) to switch and influencing factors on switching frequency. These findings can provide more knowledge of switching behaviour to workplace or facility management practitioners so that they can understand their

employees' needs and behaviour better and apply them to workplace design. Future research on switching behaviour in ABW is required that puts switching in relation to work performance, health, and well-being.

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How do corporate drivers and individual preferences for agile working meet? Study of Hong Kong organisations and employees

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ABSTRACT

Purpose: Agile working, also known as activity-based working (ABW) has gained interest from both business and academia. Agile working allows employees to work flexibly, choosing and switching between different non-assigned workstations, with varying degrees of privacy, depending on the task they are working on. The aim of this study is to investigate how corporate drivers and individual preferences for agile working meet. In contrast to places where agile working concepts have been studied extensively, such as the Netherlands, (see Hoendervanger *et al*., 2016; Appel-Meulenbroek *et al*., 2015; De Been and Beijer, 2014) this study focuses on an under-researched region, that of Hong Kong.

Theory: 'Systems-thinking' describes processes that are involved when an organisation transforms from one phase into another. This process takes place at both an organisational as well as at individual levels. The implementation of a workplace concept involves a physiological as well as a psychological change, and the 'System' only operates when both individual and corporate levels align in their approach and implementation (Thakore *et al.*, 2020).

Design/ methodology/ approach: A transdisciplinary lens was applied using mixed methods, combining quantitative and qualitative research techniques. Data collection and analysis were carried out using a combination of a survey questionnaire (systems knowledge) and semi-structured interviews (target knowledge). The research findings are developed to inform the emerging trends (transformation knowledge) that are significant for relevant stakeholders.

Findings: The changing nature of work, productivity and wellness were found to be key drivers for implementation of agile workplace strategies at corporate level, whereas preferences at individual level were found to be positively associated with an individual's exposure level to them. Furthermore, internal constraints such as lack of time and resources were found to limit the efforts of organisations in investing and monitoring impacts and outcomes of agile working, highlighting the need for further research in this area.

Originality/ value: This research is undertaken in the context of Hong Kong where, like the wider Chinese context, there is limited previous research on agile working. While there are a number of non-academic reports, they do not explicitly consider this emerging innovative model

of working and its impact on business performance. The research is initiating a dialogue for investigation for the benefit of business and academia alike.

Keywords

Agile working, Hong Kong, Productivity, Wellness

1 INTRODUCTION

The perception of workplace in a knowledge society is changing. Technological advances, such as digitalization, laptop computers and cloud services have enabled team members to work from any location. This increased connectivity means that the boundaries of the office are blurring and are no longer limited to the physical real estate footprint alone. Instead, spaces beyond the office, such as home, hotel, or modes of transport may also be used to carry out the tasks traditionally carried out in office setting (Harris, 2016). To respond to the needs of the more mobile workforce, organisations may introduce agile workplace concepts. Agile workplaces utilise reduced desk ratios (fewer workstations than there are employees), and provide non-assigned desks as well as other informal and formal meeting areas. This enables employees to work flexibly, choosing and alternating between different non-assigned workstations with varying degrees of privacy depending on task they are working on (Hoendervanger *et al.*, 2016; De Bruyne and Beijer, 2015).

The concepts and impacts of agile working have been studied elsewhere and extensively studied in the Netherlands (Hoendervanger *et al*., 2016; Appel-Meulenbroek *et al*., 2015). There are, however, limited studies on agile workplace strategies in the context of Asian organisations, and more especially of those in either Hong Kong or mainland China.

2 THEORETICAL FRAMEWORK

'Systems-thinking' is a worldview which allows appreciation of holistic systems, having interconnections between system-components, properties such as drivers, outcomes and feedbacks, and can be applied to problems of multiple disciplines (Cerar 2012; Forrester 1994; Voinov 2008). 'Systems-thinking' describes processes that are involved when an organisation transforms from one phase into another. This process takes place at both organisational and individual levels. The implementation of a workplace concept involves a physiological as well as a psychological change, and the 'System' only operates when both individual and corporate levels align in their approach and implementation – they meet (Thakore *et al.*, 2020).

This study focuses on investigating drivers for organisations (considered as 'systems' in the context of this study) to implement agile workplace strategies at the corporate level; and investigates equally important employees' preferences for agile workplaces at an individual level. Drivers are established by analysing the current context of agile workplace literature, whereas the preferences of employees are investigated using empirical evidence.

3 LITERATURE REVIEW

Agile working is discussed in literature as new ways of working, flexible working, or activity-based working (ABW) (De Bruyne and Beijer, 2015; Harris, 2016). Initially, the literature was

searched for the drivers of agile working. Those identified include: changing nature of work and workplace; productivity; (employee) satisfaction; and wellness. Out of all identified drivers, this study has selected to analyse the following drivers in closer detail: changing nature of work and workplace; productivity; and wellness.

3.1 Changing nature of work and workplace

The workplace is no longer seen as just a physical place for carrying out tasks. Increasingly, it is being used as a conveyor of messages on the values and identity of the organisation to staff and visitors (Haynes 2012; Khanna *et al.* 2013) and as a business enabler that allows an organisation to compete and strategically place itself in the marketplace (Botting and Pastakia 2014). In addition, workplace change strategies are being used as tools to facilitate organisational and cultural change (Skogland 2017) and as a way to attract talent (Harris, 2016). Finally, reduced desk ratios may be utilised to facilitate flexible work practices as well as to provide an opportunity for remote working. The reduction of permanent workstations makes sense, as it can contribute to 'spaceless growth', which affects the organisation's bottom line. (Harris, 2015; Skogland, 2017). In addition to economic drivers, the changing demographic of the workforce contributes to the change of workplace. Today's workplace may have up to four different generations working alongside each other, each with their own expectations and needs (Haynes *et al.* 2017; Haynes 2011).

3.2 Productivity

Productivity is defined as the ability of people to enhance their work output through increase in the quantity and/or quality of the product or service they deliver (Walters and Helman, 2020). Workplace productivity may be measured in various ways, such as: conducting employee self-assessment surveys, monitoring employee absenteeism levels, measuring the amount of time spent on a specific task, desk utilisation ratios, real estate costs, staff retention rates and/or revenue breakdown. (Thompson and Jonas 2008; CABE 2005).

Several studies have been conducted to evaluate connections between workplace and productivity (De Croon et al. 2005; Bodin-Danielsson and Bodin 2008; Haynes 2007). Haynes (2007) has established that while physiological aspects such as layout and comfort do contribute to productivity, the most significant impact of all is caused by the behavioural environment. The behavioural environment consists of interaction and distraction, which were found to be the most important positive and negative contributors to productivity, respectively.

3.3 Wellness

Wellness is emerging as an aspect of workplace design (Harris, 2016) and is considered a key contributor to productivity (Alker *et al.*, 2015). Evidence demonstrates that physiological aspects of workplace impact the wellbeing and productivity of employees. For example, good indoor workplace air quality has been linked to increases of up to 61% in employee cognitive performance (Allen *et al.*, 2016); and increased illuminance levels has been found to improve productivity by up to 20% (CABE, 2005). On the other hand, productivity is lost due to employees' ill health, including absenteeism and lateness (Vischer, 2007).

4 METHODOLOGY

The objective of this paper is to investigate how corporate drivers and individual preferences for agile working meet. A methodological approach utilising transdisciplinarity underpinned by

systems-thinking was deemed to be appropriate for this organisational workplace investigation (further theoretical argument for this methodology is presented in Thakore *et al.*, 2020). To achieve this, a transdisciplinarity lens was adopted to frame the research objective (a holistic knowledge). Desk research and a survey questionnaire were then carried out to investigate stakeholders' perspectives on the issues of agile working (to gain systems knowledge). Finally, semi-structured interviews were carried out to engage with industry experts (to gain target knowledge). The results of holistic, system and target knowledge were then analysed. The research findings and its interpretation contributed to the transformative knowledge, which is presented in the Discussion section.

A survey was administered using an online survey tool, and a random sampling technique was used after piloting the questionnaire with volunteers. The survey questionnaire was targeted toward professionals working in an office environment in Hong Kong. The survey investigated the challenges and opportunities of agile working in Hong Kong against previously identified themes, such as productivity and wellness, in the office environments. A Likert scale was used to measure respondents' opinions. Open-ended questions were included to allow additional qualitative information. To validate the survey questions, the first interview was scheduled before the survey was sent out. After that, the survey and interviews ran concurrently. The responses from interviews and survey questionnaires were triangulated to increase reliability of the research findings.

The online survey received 86 responses, a response rate of 15%, which was considered as sufficient in both number and response rate for reliable quantitative analysis . Survey participants' profiles are presented in Table 2.

Table 2 Survey participant profile

Total responses		86
Age	20-30	28%
	30-40	43%
	40-50	15%
	50-60	9%
	60+	3%
	Prefer not to say	1%
Position	Team member	38%
	Manager	21%
	Senior manager	9%
	Director	17%
	Vice president	6%
	President	1%
	CFO/CEO/COO	2%
	N/A	5%
Current work environment	Traditional workspace	54%
	Agile workspace	34%
	Other	12%

Target knowledge was developed by interviewing three organisations using semi-structured interviews. In order to generate results that reflect different typologies of Hong Kong agile workplaces, two large scale organisations with several thousand employees and a smaller organisation with approximately 200 employees was selected. All selected interviewees held senior management positions within their organisations. The responses from interviews and survey questionnaires were triangulated to increase reliability of the research findings.

5 DISCUSSION

5.1 Changing nature of work and workplace

Decrease in real estate cost is one of the key drivers for implementing agile working (Brunia and Pullen, 2014; De Bruyne and Beijer, 2015). Economic drivers such as this were identified to be present in all three participant organisations, but they were not necessarily primary reason for the implementation of agile workplace, according to the interviewees. Rather, an agile workplace was implemented as it was found to better support the business model and facilitate new ways of working. 'Spaceless growth' and attracting talent were noted as by-products of the implementation process rather than main drivers.

The findings of this research indicate that there is growing interest in agile working in Hong Kong. In line with previous research findings (De Been and Beijer, 2014), the majority of survey respondents (36%) preferred to work either in agile workspaces or in spaces that combined both agile and traditional aspects, in comparison to those (14%) who preferred traditional workspaces. Limited studies to date have focused on mapping the preferences of entire workforces in the context of a specific city. Therefore, these statistics provide an exploratory insight into attitudes towards new ways of working in Asia, and specifically in Hong Kong.

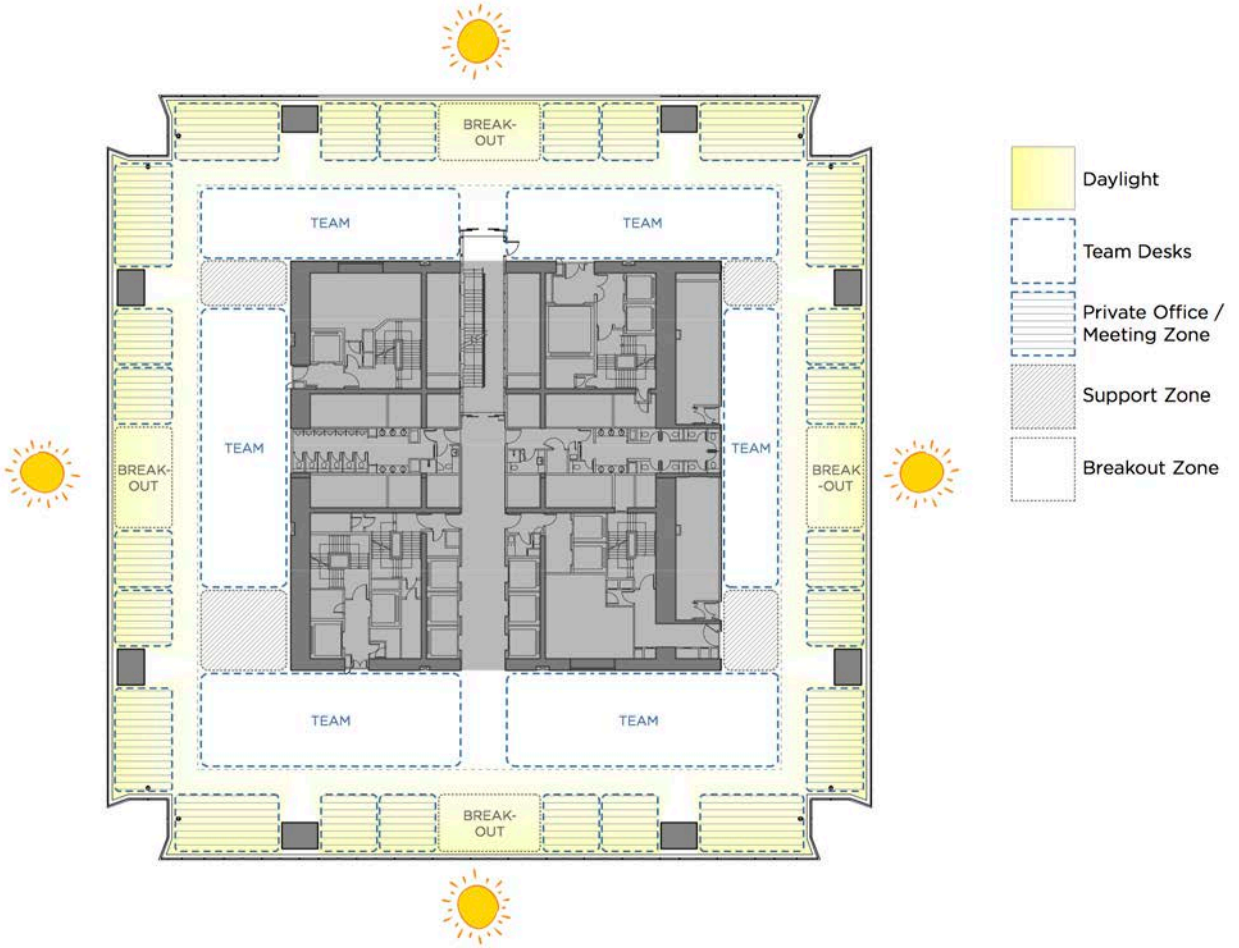
Table 3 Preference of workplace type

		Traditional workspace	Agile workspace	Both	Not sure
Overall results		14%	36%	36%	13%
Results by age	20-30	8%	50%	33%	8%
	30-40	19%	28%	36%	17%
	40-50	0%	38%	46%	15%
	50-60	13%	50%	38%	0%
	60+	67%	0%	33%	0%
Results by current workplace	Traditional	24%	13%	41%	22%
	Agile	0%	72%	28%	0%
Results by position	Team member	3%	44%	31%	22%
	Manager	17%	28%	44%	11%
	Senior manager	25%	50%	13%	13%
	Director	27%	20%	53%	0%
	Vice president	0%	50%	25%	25%
	President	20%	40%	40%	0%
	CFO/CEO/COO	100%	0%	0%	0%

The respondents' preferences were found to be somewhat dependent on their current work environment (see Table 3). Those who currently worked in agile workspaces had a strong preference for agile environments, whereas those who currently worked in traditional offices showed lower interest in agile workspaces and preferred traditional work environments or both instead. This suggests the value of evidence-based testament, whereby understanding the benefits of agile working might have to be experienced first to be appreciated.

The survey results reveal that majority of respondents that stated they preferred to work in agile workplaces identified themselves as 'team members' and fell within an age group of '20-30'. Conversely, although only a small percentage of the participants, those over 60 years of age, preferred the traditional workplace (see Table 3). This suggests differences in generational attitudes, which have also been observed in previous studies (for example McElroy and Morrow 2010; Haynes, 2011; Joy and Haynes 2011). As noted by the interviewees, the blueprint of the traditional Hong Kong office often has senior executive offices with windows along the perimeter wall, and cramped team areas with little daylight in the core of the building (see Figure i). Qualitative data from both the survey and the interviews suggest that in the Hong Kong office environment, the older generation that have gained leadership status at the workplace are hesitant to let go off their private offices, because beside their private space, they may also lose a key symbol of their hierarchical status.

Figure i Interior layout of typical Hong Kong Office



5.2 Productivity

Productivity is a key consideration of any agile workplace strategy (Haynes *et al.*, 2017). The studied organisations indicated that they used some measures to monitor the productivity of certain aspects of their business, such as utilisation rates of meeting rooms. The interviewees also noted that they were aware of further ways of measuring productivity (such as changes to costs, revenue or staff retention) however none of the firms were actively doing so, mainly due to time pressures. Instead, all studied organisations relied on perceived levels when assessing changes in productivity due to agile working. All assumed that the overall productivity was positively impacted by the introduction of the agile workplace, because the data that was tracked, such as meeting room utilisation rates, demonstrated increased efficiencies. The outcomes of self-reported studies can however be subjective as pointed out by previous research, making it difficult to judge and compare the precise impacts on (and between) businesses (*CABE, 2005).*

The findings of this study therefore indicate that measuring productivity in a corporate real-life setting is a challenging task. This is for two reasons: (a) metric tools monitoring productivity tend to focus on quantity of output, rather than quality of output. The interviewees highlighted this issue, noting that measuring productivity by metric tools alone ignored the qualitative output of the team; and (b) the practicality of using quantitative tools such as desk utilisation ratios, real estate costs, staff retention rates and/or revenue breakdown. Future research may focus on developing tools that enable organisations to assess productivity on an ongoing basis.

At the individual level, the survey findings support some positive association of agile workplaces and productivity in Hong Kong. When assessing the overall choice of office type for optimal productivity, there was an even split between ‘agile’, ‘traditional’ and ‘other’ office types (see Table 4). However, when assessing the perceived levels of productivity in terms of current workplace type, those currently in agile workplaces preferred agile work environments for their productivity. This does not entirely align with previous studies from elsewhere, which have found lower perceived productivity in agile workplaces (De Been and Beijer, 2014). The results may however suggest the value of evidence-based testament in context of Hong Kong workplace behaviour, as discussed earlier in relation to preference of workplace type.

Table 4 Preferred office type for optimal perceived productivity

OVERALL RESULTS				
	Traditional workspace	Agile workspace	Both	Not sure
	29%	30%	25%	16%
RESULTS BY RESPONDENTS’ CURRENT WORKSPACE TYPE				
	CURRENT WORKSPACE TYPE			
PRODUCTIVITY BETTER IN:	Traditional workspace	Agile workspace	Both	Not sure
Traditional workspace	35%	17%	24%	24%
Agile workspace	19%	52%	26%	4%

5.3 Wellness

Respondents were also asked if they would prefer an employer that offers wellness features, over one that does not. Most respondents (96%) wished to work for in an office environment that included wellness features. In this context, the features that contributed to wellness at the

workplace included clean indoor air, plenty of natural daylight, a comfortable acoustic design, clean water, provision for sports and healthy food choices, in accordance with WELL Building standard.[5] Results from both the interviews and the questionnaire suggest that there is a desire for 'wellness' to be a part of workplace in Hong Kong. The popularity of wellness may be explained for a few reasons, including a lack of wellness features such as natural light in many traditional Hong Kong offices, general cramped conditions, and the hierarchical atmosphere pointed out by both survey respondents and interviewees.

6 FINDINGS

'Systems-thinking' describes processes that are involved when an organisation transforms from one phase into another, such as from traditional to agile workplace setting. According to this theory, the 'System' only operates when both individual and corporate levels align in their approach and implementation (Thakore *et al.*, 2020).

The literature review demonstrated that the changing nature of work, productivity and employee wellness are some of key drivers for implementation of agile workplace strategies at a corporate level. These drivers were also confirmed to be present in this study; however notably improved productivity was identified as a byproduct rather than primary driver. Instead, the agile workplace was implemented in the case study organisations as it was found to better support the organisation's business model and facilitate new ways of working. Furthermore, the findings highlight that internal constraints such as lack of time and resources limit the efforts of organisations in investing and monitoring impacts and outcomes of agile working. Future research may focus on developing tools that enable organisations to assess criteria such as productivity on an ongoing basis.

The preferences at an individual level on the other hand, were found to be positively associated with an individual's exposure level to agile workplaces. This was found to be true both in the case of perceived productivity as well as preference for agile over a traditional work environment. The research also highlights that, at individual employee levels, there also appears to be a growing preference in Hong Kong for employers that offer workplace wellness features. In this study, all studied organisations had met this demand by including some wellness features within their workplace. However, as this study has already highlighted, an individual's preferences may be dependent on exposure level to them. Therefore, it may be that the positive results in this study correlate with respondents' possible familiarity with workplace wellness features. Consequently, future research may focus on measuring this phenomenon in closer detail by conducting large-scale random sampling studies on preferences of wellness in Asian cities such as in Hong Kong.

In accordance to principles of 'Systems-thinking', this study found some correlations between drivers for agile working at corporate levels in comparison to preferences for agile working at individual levels. In particular, the findings on testament of evidence suggests that the drivers and preferences align more closely as the process matures. This may suggest that early agile workplace concepts (for example within a corporation with multiple offices) face some resistance, however the experience becomes more accepted as employees become familiar with the concept.

[5] https://www.wellcertified.com/certification/v1/standard/

At individual levels, generational divides in attitudes were found to hamper the receptiveness to agile working in Hong Kong. The research findings suggest that in the Hong Kong office environment, the older generation that have gained leadership status and therefore are in, or close to, decision making positions, are hesitant to let go of their private offices, because this will dismantle a key signifier of their elevated hierarchical status. These individuals are however close to retirement age, so such resistance may not present a long-term barrier to uptake.

7 CONCLUSION

This study sets out to investigate how corporate drivers and individual preferences for agile working meet. Data collection and analysis were carried out using a combination of a survey questionnaire (systems knowledge) and semi-structured interviews (target knowledge). The research findings are developed to inform the emerging trends (transformation knowledge).

This research demonstrated that the changing nature of work, productivity and wellness are some of the key drivers for implementation of agile workplace strategies at corporate level. On the other hand, preferences at individual level were found to be positively associated with an individual's exposure level to agile workplaces. In line with previous studies, this study also observed some generational differences in attitudes towards agile working.

While this paper provides assessment on drivers and preferences for agile working, it provides only an exploratory research on the workplace strategies in Hong Kong, and further future research is clearly required to map out the workplace practices and behaviors in Asian cities such as Hong Kong.

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SESSION 5: ACTIVITY-BASED WORKPLACES

Towards an activity-based office ecosystem to support three-dimensional spatial understanding in a transdisciplinary context

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ABSTRACT

Purpose. Amidst today's pressures for workspace efficiency, it is still difficult to build offices that are compatible with the humans working in them. Architects are usually in charge of the physical office space design, together with interior architects and applicable technical designers. Methodologically, in architectural design research (Research by Design), architecture is considered to be transdisciplinary in its nature, including the aspects of design practice and genuine interaction with other disciplines. We do not want to limit the interdisciplinary interaction to only the already established contacts with the technical disciplines. We find the outcomes of knowledge work environment research to be highly interesting in broadening our understanding of a worker's relationship to his/hers work environment. Concepts such as p*erson-environment fit*, the notion from interaction psychology, challenge us to reflect its contents in an architectural design research context. However, the basic concepts such as *environment* and *space* or *spatial solution* are commonly used in work environment research, but their meaning and application are often difficult to apply in a physical spatial context to us, architects. Therefore, we are eager to share the draft of the *activity-based office ecosystem model* nourishing the spatial needs and environmental understanding familiar to the architectural design approach. The purpose of sharing the model is the attempt to contribute to the discussion across disciplinary borders and to deepen the interdisciplinary understanding of the spatial solution of an activity-based office, and to be able to implement the research outcomes in practice.

Theory. This paper builds on a theoretical framework which hypothesizes that defining the spatial solution of the physical activity-based office environment through an interdisciplinary dialog would contribute to understanding of the person-environment fit. Our interdisciplinary dialog has so far involved, in addition to architectural design knowledge, the knowledge of occupational health, adaptive lighting, acoustics and indoor air quality with the support of service design and human-computer interaction. Furthermore, the theory building through defining an activity-based office ecosystem provides grounds for further studies in order to clarify the contradictory research outcomes concerning the functionality of and satisfaction with activity-based offices.

Design/methodology/approach. In this paper the transdisciplinarity forms the methodological framework and it is looked at in relation to the Research by Design (RbD) approach. RbD is a design research method where design has an important role in the research process- it operates in a real-life context with a transdisciplinary approach. We recognize all of the four core aspects of the transdisciplinary approach, considering, as a premise, the *participatory research approach* and the *context of life-world problems*, in our case through intervention-based research. In this paper we focus on the search for *unity of knowledge beyond disciplines* (proposed ecosystem model), but leave the *transcending aspect* of transdisciplinarity to further studies. We also discuss the possible benefits of service design methodology and the use of the concept of affordance in the process of communicating the gained knowledge to the design practice.

Findings. The activity-based office ecosystem model where the research outcomes, both qualitative and quantitative, would be connected to the time-location-based framework in search for understanding and unity of knowledge beyond disciplines.

Originality/value. The structuring of the physical space to *Architectural envelope* and *Interior orchestration* would also include the dimension of being able to communicate the research outcomes to design practice.

Keywords

knowledge work environment, physical environment, activity-based office ecosystem, user-centred design knowledge, transdisciplinary approach.

1 INTRODUCTION

The designing of physical environments for humans is one of the key aspects in architecture, including building design and interior architecture. Although the physical environment is the core substance, very little interest has been paid to the influence of the architectural environment (e.g. Bodin Danielson 2010). However, the interest in the user-centred approach in architectural design research and design practice is growing. The ecosystem-thinking is an attempt to recognize the complexity of physical space affecting a worker's environmental satisfaction. In general, ecosystem is currently used to mean something (such as a network of businesses) considered to resemble an ecological ecosystem, especially because of its *complex interdependent parts* (ecosystem. 2020). The concept of environment may be understood either as non-physical or also including the physical aspect. Therefore, we looked at the original definition of ecosystem in biology where both living and nonliving components were included (e.g. Molles (1999), p. 482; Smith & Smith 2012, p. G-5). We propose that the *physical environment* as such and in detail would also be included in the activity-based office ecosystem as *one of the complex interdependent parts*. The ecosystem-thinking would nourish the holistic transdisciplinary approach of an activity-based office environment. It would also enable us architects to apply an RbD methodological framework and bring the design approach to discussions concerning the knowledge work environment. The RbD approach would also allow the integration of research outcomes to design practice.

Our focus is on the relationship between the *physical environment* and the *worker* forming the main *parts* of the complexity of the activity-based office ecosystem. We, as architectural design researchers, consider the understanding of *interdependences* between *physical environment* and

worker from a user-centered perspective to be incredibly important. We have our own, but limited, methods in which to study these *interdependences* and, therefore, we are open to interdisciplinary interactions with other work environment researchers. Our aim is to be able to implement the research outcomes to architectural practice in order to improve the worker's environmental satisfaction concerning the physical space.

Recently, Babapour Chafi et al (2020) have proposed a concept of artefact ecology having its origin in interaction design within the realm of digital artefacts (e.g. Forlizzi 2008). The artefact ecology recognizes the physical structure (placement, seating arrangement and openness) of an office environment (e.g. Bødker and Klokmose, 2011). Babapour Chafi et al (2020) is using the concept to focus on worker's preferences in the interior design scale. We share their interest in understanding employees' preferences and non-preferences in a spatial context, however our interest is in a more holistic understanding of the three-dimensional physical environment.

Current stage of spatial approach to Activity-based office environments

In work environment research at present, the new ways of working and increased time- and location-independent work (van Yperen et al., 2014) have directed the development of knowledge work environments towards more flexible settings, referred to as activity-based offices (Appel-Meulenbroek et al., 2011), flex-offices (Bodin Danielsson et al., 2014) or activity-based flexible offices (Wohlers & Hertel, 2017) (later in the text: activity-based offices). Activity-based offices are open-office environments with additional half-open and enclosed workspaces, where the workers choose workstations or workspaces that best suit their current work tasks and subjective preferences (Appel-Meulenbroek et al., 2011, Bodin Danielsson et al., 2014; Wohlers and Hertel, 2017). In the work environment research the following terminology is recognized: 'workstation' refers to a setup for an individual user; 'workspace' refers to an open, half-open or enclosed part of an office with single or multiple workstations; and 'work environment' refers to a setting, such as an office, consisting of multiple workspaces.

Person-environment fit, the concept from interaction psychology, refers to the compatibility of people with their environment (e.g. Kristof-Brown et al 2005). It is one of the general key concepts to understand the effects of knowledge work environment on a worker's environmental satisfaction. From the architectural design point of view, the concept of person-environment fit seems to be intertwined with the physical knowledge work environment's three-dimensional spatial design solution. However, when we conducted interdisciplinary intervention-based research in a real-world team-based office (e.g. Markkanen & Herneoja, 2018), we found out it difficult to share our thoughts comprehensively with knowledge work environment researchers. The existing shared concepts did not explicitly comprise the spatial idea familiar to architects. For example, in knowledge work environment research, the physical work environment is often considered as being two-dimensional, as the physical layout or configuration of space e.g. high-density open-plan offices (e.g. Ashkanasy et al., 2014, Davis et al 2011, Laing, Duffy, Jaunzens, et al., 1998). From a spatial approach, it is also challenging when an employee's work environment is discussed with qualitatively enriched concepts as the physical environment, such as *personal space/privacy*, *spatial density/crowding*, *personalization/workplace identity*, and *task/workflow interdependence* (e.g. Gerdenitsch et al., 2018; Ashkanasy et al., 2014). However, these concepts provide an interesting and valuable content for further studies, but, at the same time, it is difficult to interpret the contents to the language of three-dimensional spatial design, since the original source lacks time-location-based references or, at least, precise location-based documentation.

In addition, the fragmented way of discussing the physical environment, such as open spatial solutions, is confusing. For example, one of the characteristics of an open-plan office is considered to be the absence of interior walls (e.g. Ashkanasy et al., 2014, Oldham & Brass, 1979). Although the dividing interior walls are missing, the space is still bordered by the interior or exterior walls or both (although they are farther apart) or only with exterior walls if the office is the size of a whole floor level. Of course, we are not expecting the other disciplines to use the exact language of architecture, but to provide documentation of the space would support the written content and help the architect researcher to attend the discussion.

As a premise, we have understood that previous research on activity-based offices has varied in terms of space efficiency and layouts, making it difficult to generalise findings. The overall appearance of premises, knowledge transformation and interaction, and an improved sense of community are mentioned as positive aspects. The problems have mostly been related to difficulties concentrating due to interruptions (Pullen, 2014; De Been & Beijer, 2014; Ruohomäki et al., 2017). Evidence on the effects of activity-based offices on worker environmental satisfaction is scarce and contradictory (e.g. Bodin Danielsson & Bodin, 2008; Bodin Danielsson et al., 2015). Therefore, we are eager to both bring our spatial understanding to the discussion and to broaden our own understanding of the consequences that physical environments have on the workers i.e. the *interdependences* between *environment* and *worker*.

2 METHODS AND CHALLENGES OF ADVANCING SPATIAL UNDERSTANDING

Definition of Research by Design and concept of transdisciplinarity

For the contextual background, slightly generalizing and simplifying, in architectural design work there is no established user-centred methodology to find out the client's or user's needs other than face-to-face discussions. When considering the architectural design research methodology, Research by Design (RbD) (e.g. Dunin-Woyseth, 2004; Sevaldson, 2010, Verbeke 2013) focuses on understanding the process of design knowledge production. From an ecosystem-thinking point of view, the RbD is operating more with the *physical environment* and its design processes, however the interest towards the *user* (in this paper the *worker*) and his/her *interdependence* with the *physical environment* is only implicitly present through the concept of transdisciplinarity.

The original definition of RbD recognizes the transdisciplinary nature of the context in which a designing architect is operating (e.g. Dunin-Woyseth, 2004; Sevaldson, 2010, Verbeke 2013). Albeit, the approach of RbD is rather architect-centred, the recognition of the transdisciplinary context contains the possibility to have a more user-oriented (if not user-centred) approach. How the concept of transdisciplinarity is defined seems to be one of the key issues affecting how RbD is understood. Transdisciplinarity, as such, is considered to belong to RbD, at least in an implicit way, either *considering architecture by its nature as transdisciplinary* (academia / practice) (e.g. Doucet & Janssens, 2011) or more carefully following the original idea of transdisciplinarity containing the four core elements: *participatory research approach, life-world problems, search for unity of knowledge beyond disciplines* and *transcending contents* i.e. integration of disciplinary paradigms (e.g. Novotny et al., 2001; Hirsch Hardoun et al., 2008, 437-439). We find the latter definition to be more relevant as to evolve further, including the genuine interaction with other disciplines and questions arising from real-world challenges (including *users*, in this article *workers*), while also retaining the designerly way of knowledge production (Herneoja et

al., 2015). In this paper our focus is on the third aspect of transdisciplinarity, the *search for unity of knowledge beyond disciplines*, through the ecosystem-thinking proposal, however the aspects of *participatory research approach* and *life-world problems* are also present in this paper as a premise. The fourth core aspect, the *transcending contents,* we touch upon here only in an implicit way.

Intervention-based research as a form of Research by Design and emerged further needs

In our intervention-based research (e.g. Markkanen & Herneoja., 2018; Herneoja et al., 2015) we were applying RbD with the genuine transdisciplinary approach. The idea of intervention, in general, refers to the *act of interfering with the outcome or course especially of a condition or process* (as to prevent harm or improve functioning) (intervention.2020). In the greater picture, the aim of *intervention-based research* in architecture is to *study real-world environments through change* to capture a holistic overview in order to find better solutions and search for a working theory for designers. From the ecosystem-thinking point of view the intervention-based research aims to understand the *interdependences* between the *physical environment* and the *user* (in this paper *worker*) in his/her own spatial context through making temporary changes to the spatial arrangement. Thereby we are aiming to understand the *interdependences* between the *physical environment* and the *worker* and also *locate* the interdependences in the spatial context.

However, using participatory design (PD) methodology in our interventions (Markkanen & Herneoja., 2018), we recognised that Service Design (SD) methods could be useful to support both architectural design processes and to gain new knowledge on knowledge work environment design processes. SD applies methodology (e.g. Bratteteig et al., 2013), engaging users in the design process. The guiding principles of the SD - user-centred approach, co-creation, visualising, evidencing and holistic approach of the design case (e.g. Stickdorn, 2011) - meet the general approach of PD, but it is more focused on the user and the producer from the position of space-as-a-service. Thereby, the design process would also be more thoroughly integrated to the extended understanding of the worker's relationship to his / her physical environment. In the ecosystem context, by using SD methods in addition of aiming to deepen the understanding of the *interdependences* between the *physical environment* and the *worker*, we are also concerned with how the *gained knowledge could be communicated to the practice*.

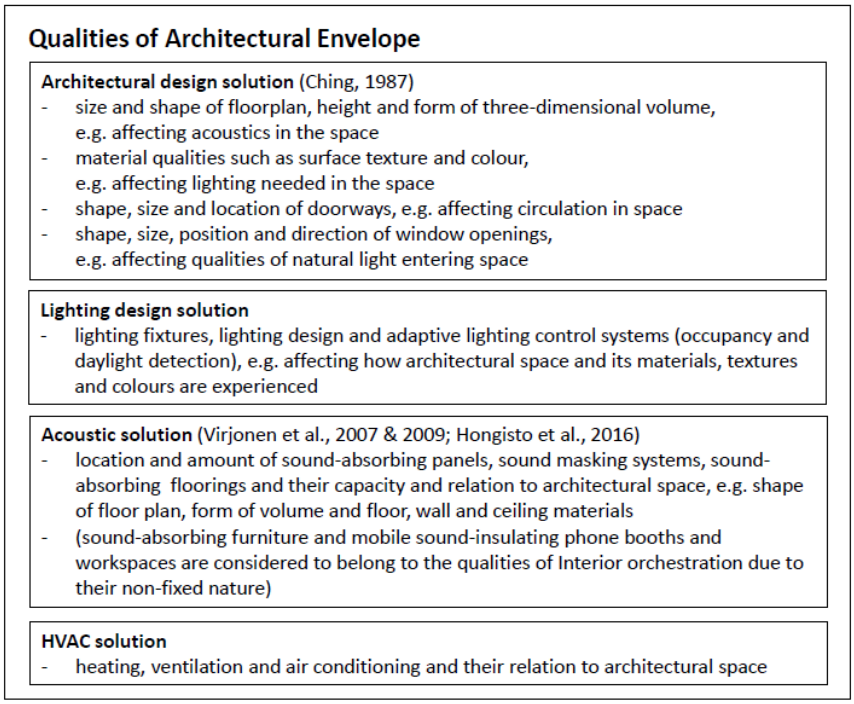
And further we recognized, through our interventions (Markkanen & Herneoja., 2018), that the concept of *affordance* would deepen our understanding of the possible *interdependences* between the *physical environment* and the *worker* from the *action* point of view. The concept of affordance (Gibson, 1977; Norman, 2013) refers to the latent action possibilities that the environment offers the individual. To understand if the nature of affordance is positive or negative, our architectural design knowledge alone does not offer the explanations. For us architects, a relevant shared concept, in addition to a more general concept *person-environment fit,* would be the *need-supply fit* (e.g. Kristof-Brown et al 2005, Gerdenitsch et al 2018) by recognising the affordance of the physical environment. Therefore, in the ecosystem- context it would be incredibly important to know *not only how* the worker uses his / her physical environment, but, more precisely, *where* and *when it takes place.* At present, a worker's current location during his/her workday is possible to track with the aid of context-aware mobile methods solutions (e.g. Markkanen et al., 2019), in order to more precisely reflect the physical environment's affordance to the worker.

3 STRUCTURING OF THE PHYSICAL ENVIRONMENT TO SUPPORT THE COMMUNICATION

In this chapter we focus on how the physical environment should be understood in order to support both the *user-centred approach* and the *implementation of the gained knowledge to the design practice*. In the ecosystem context our emphasis is now on the structuring of the *physical environment* to support the communication of the *interdependences* between *it* and the *worker*.

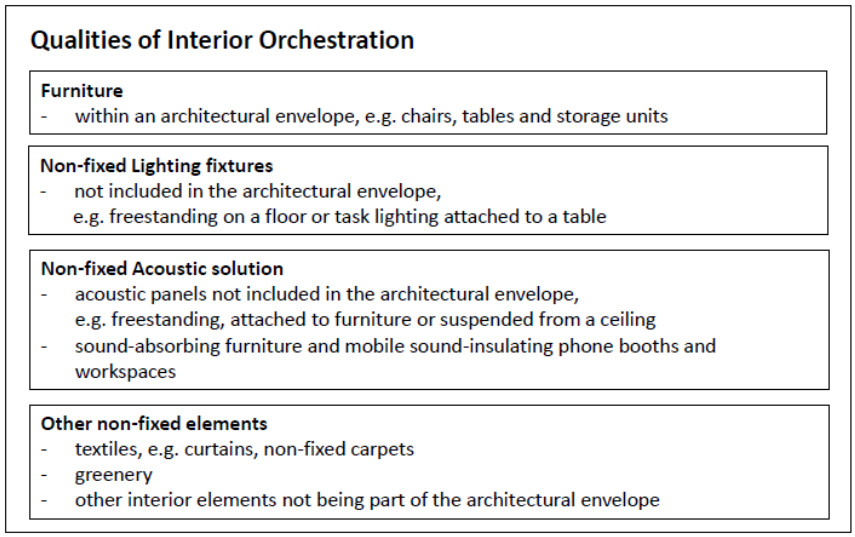
The ambient factors of the knowledge work environment considered in this paper are acoustic quality, architectural privacy, lighting and indoor air quality (e.g. temperature and humidity). They contribute to the concept of indoor environmental quality (IEQ) approached as a measurable technical quality (e.g. BS ISO 17772-1:2017). From the user-centered point of view, the ambient factors of a three-dimensional physical environment are intertwined to influence the worker's experience of the work environment. Therefore, it is not relevant to draw demarcation lines between contents of architectural features or technical systems, or by the responsibilities of different design fields (e.g. architectural, interior, lighting, acoustic, HVAC). It is known that spatial architecture, visual and acoustic privacy, lighting, acoustics, communication landscape, furniture comfort and architectural aesthetics are important to work environments (Vischer, 2008; Vischer and Wifi, 2017). However, it is still important to be able to discuss this spatial solution with the concepts also familiar to its designers to engage design knowledge to the transdisciplinary actions. Therefore, we suggest that *physical environment* would be considered to consist of a twofold entity, fixed environment called *architectural envelope* (Fig. 1) in general consisting of the architectural design solution and lighting, acoustic and HVAC solutions and the *interior orchestration* (Fig. 2) consisting of the non-fixed interior design solution.

Figure 1. Qualities of Architectural Envelope.



Architectural envelope. Building an envelope is a technical term of its origin considered to be the physical separator between the conditioned and unconditioned environment of a building, including the resistance to air, water, heat, (Cleveland et al 2009) light, and noise transfer (Syed 2012). Here the conditioned environment refers to interior and unconditioned environments to exterior spaces. In the definition of a building envelope, Straube et al (2005) includes the finish to meet desired aesthetics on the inside and outside, in addition to material and structural aspects (Straube et al 2005). The finish is understood here as the architectural features of the building envelope. In our case, since not all spaces of the physical work environment are bordered with outside structures (the border between the conditioned and unconditioned environment), the concept of a building envelope as such would be too broad. Therefore, we apply the concept of *architectural envelope* comprising the idea of a closed space with technical solutions and architectural features as in a building envelope, but focusing on the interior part of the envelope that does not require an outer border structure.

Figure 2. Qualities of Interior Orchestration.



Interior orchestration. In general, the first dictionary meaning of the verb *orchestrate* refers to music (orchestrate.2020), to arrange or score (music) for an orchestral performance. The second, general meaning of the verb *orchestrate* is to plan or coordinate the elements of (a situation) to produce a desired effect, especially surreptitiously (orchestrate.2020). The noun *orchestration* is broadly used in different disciplines for specific purposes, e.g. classroom orchestration referring to how a teacher manages, in real time, multi-layered activities in a multi-constraints' context (Dillenbourg 2013), where the classroom as a space is implicitly present as a context. An example of orchestration of the shopping experience in mall spaces refers i.e. to the role of place in the retailer-consumer interaction (Faurholt Csaba & Askegaard 1999), where the physical features (such as space and wall fixture units) are explicitly presented in relation to the user's experience in the shopping context. Interior design process as such has been compared to orchestration and interior designer to a visiting conductor to a symphony's performance (Dohr & Portillo, 2011). They (Dohr & Portillo 2011) also mentioned once in caption the interior

orchestration, but did not define the concept any further. In a non-academic practical design field, interior orchestration has been used to refer to e.g. organizing an interior renovation from the design phase to the implementation or just as a synonym for organising furniture in an interior space. We propose that in a work environment context *interior orchestration* would refer to interior design contents that facilitate employees' activities in relation to their workstation, workspaces or work environment. Regardless of the material dimension, the concept interior orchestration is tightly intertwined to the function (e.g. collaboration or concentration) for which purpose the orchestration is designed for in order to produce a desired effect, in the context of work environments referring to environmental satisfaction.

Structuring the physical environment to architectural envelope and *interior orchestration* refers to the design processes of the physical work environment. The relationship between these two is understood sequentially here, with the interior designed inside the existing architectural envelope. Interior orchestration is more temporary than an architectural envelope, but still dependent on it. For example, the arrangement of furniture may be changed but the overall physical solution of the architectural envelope and the technical systems and solutions integrated to it are mostly fixed. However, the design decisions impacting the architectural envelope sets the conditions both spatially and technically for designing the interior orchestration. The architectural envelope and interior orchestration also form the structuring for the documentation of the physical environment.

4 CONCLUSION

The driving force behind this paper has been to attend the discussion of searching for explanations and understanding to the contradictory findings in former knowledge work environment research by making our insight into architectural design knowledge available. We are not able to deliver answers to contradictory findings, but we have recognized deficiencies and discontinuities due to a lack of shared concepts, such as *environment*, between disciplines conducting knowledge work environment research. In this paper we have shared our way of working through intervention-based research. We have introduced Research by Design methodology, together with the broader interpretation of transdisciplinarity, targeting the understanding and unity of knowledge beyond disciplines. We have discussed the possible benefits of Service Design methodology and the use of concept of affordance in the process of deepening the understanding of the user-centric approach and communicating the gained knowledge to the design practice. One of the key aspects from the architectural design research point of view would be the possibility to connect the research outcomes, both qualitative and quantitative, to the time-location-based framework. Thereby it would be possible to study more carefully the i*nterdependences* of the *physical environment* and the *worker*. The proposed activity-based ecosystem model also comprises structuring the physical space to the Architectural envelope and Interior orchestration to clarify the implementation of the research outcomes to design practice.

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Impact of activity-based work environments on knowledge work performance – quasi-experimental study in governmental workplaces

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ABSTRACT

Work environment change from traditional cell and open-space offices to activity-based work (ABW) generates many concerns among workforce, management and public in general. There are a plethora of relevant drivers for knowledge work productivity and performance, which influence performance simultaneously and not in isolation from each other. This makes identification and isolation of "pure" ABW effects challenging. In addition, alongside the work environment change, there are often other, co-occurring changes having impact on performance taking place in work organisations, like changes in digital tools, work re-organizations, staff changes and strategy changes. In this study, we applied a quasi-experimental design to distinguish the impact of ABW on several dimensions of knowledge work performance in three governmental organizations. The empirical measures that were observed in the study were: perceptions on physical environment, virtual environment and social environment, and individual ways of working, well-being at work and self-assessed productivity. The results show that ABW change is a valid means to secure a diverse and functional enough physical work environment for modern knowledge work. The results also show that well-being at work or productivity will not collapse because of ABW change. Instead, the positive change in the self-assessed productivity, when measured with an overall, subjective personal measure, was greater (but not statistically significant) in the treatment group after ABW change than in control group (no work environment change) within study period. In addition, positive change in group work efficiency was greater (statistically significant) in the treatment group, which moved to ABW environment.

Keywords

ABW, quasi-experimental design, knowledge work performance, evaluation, D-in-D

1 INTRODUCTION

Work environment change from traditional cell and open-space offices to activity-based offices generates concerns among workforce, management and public in general. There is already published studies analyzing the work environment changes and impacts within a certain work community adopting activity-based working (ABW)(e.g. Haapakangas et al. 2018, Haapakangas et al. 2019, Candido et al. 2019). Often, the design of studies is a pre-post evaluation within a single work community experiencing work environment change. In a single sample design, it is

difficult to control potential intervening variables and ascertain causal relationship between ABW and work performance as dependent variable. In this study, we applied a quasi-experimental design to distinguish the impact of ABW on several dimensions of work performance.

2 BACKGROUND AND RELATED WORK

Activity-based offices are claimed to have contradictory effects on knowledge work performance and well-being. While the physical work environment clearly has an impact on knowledge work performance and productivity, it is only one driver among other drivers of work performance. There are a plethora of relevant drivers for knowledge work productivity and performance, which influence performance simultaneously and not in isolation from each other. This makes identification and isolation of "pure" ABW effects challenging. The way productivity and performance is operationalised and measured in the earlier studies also varies. A common way in earlier ABW studies has been to regard *perceptions* of relationship between ABW and productivity and well-being as a valid indicator of objective relationship between ABW and productivity. Instead, both perceptions of ABW and perceived level of productivity and well-being in general should be measured independently. (Haapakangas et al., 2018.)

A comprehensive review of 11 studies about impacts of activity-based working on work performance, concluded that 70% of the studies showed positive impacts of ABW environments on work performance or productivity relative to standard offices (Engelen et al., 2018). In a multisite re-location study from contemporary open-plan office to ABW office revealed, that both perceived productivity and perceived health improved after moving to ABW office (Candido et al., 2019).

Palvalin (2017) has developed a Smart Ways of Working (SmartWoW) framework and tool for observing different facets of knowledge work performance and impacts of work environment changes. The framework includes six dimensions: physical environment, virtual environment, social environment, individual work practices, well-being at work and productivity. Perceptions of physical environment, virtual environment and social environment, and individual work practices are considered as drivers of knowledge work performance, and productivity as a result dimension. Well-being at work is considered as a dual variable - it can be conceptualized both as a driver and a result. (ibid.). The viewpoint of this study is to assess the change of both assets/drivers and outputs/results of knowledge work during the activity-based work environment change.

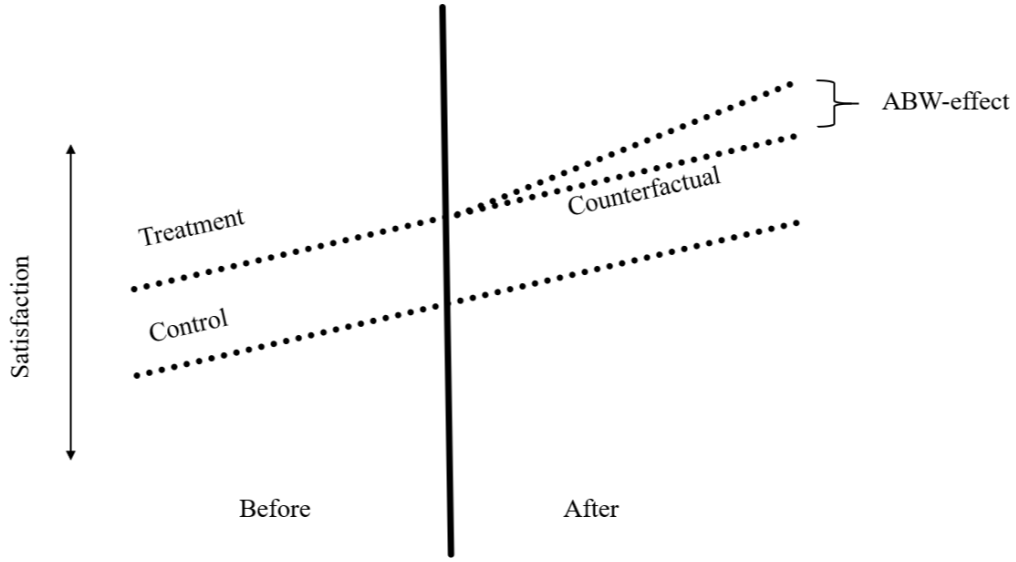
3 DATA AND METHODOLOGY

This study on the impacts of ABW change on knowledge work performance was carried out in three Finnish state organisations with all of their offices sites applying quasi-experimental pre/post evaluation design. Survey data was collected during 2015-2017. One of the government offices included in the study was a ministry, one was a government office with two head offices, and one was a national government office with networked operations across several locations. Employees in all of the included offices carry out multifaceted, knowledge-intensive specialist work that involves working alone, in pairs, in groups and within a network with corporate, community and citizen clients.

The empirical measures that were observed in the study were: perceptions on physical environment, virtual environment and social environment, and individual ways of working, well-being at work and self-assessed productivity.

The pre-post evaluation with quasi-experimental design was constructed so that personnel from every office site of the participating organizations were invited in to the study. Among the sites within each organization there were both sites which were going to have a ABW change project and sites which were going to continue their work in traditional offices. The sites experiencing ABW change represented the treatment group, and sites without ABW change represented the control group. Both treatment and control groups were measured two times – before ABW changes and after ABW changes. The study included 2,347 personnel survey replies, of which 750 were in the treatment group and 1,597 in the control group. For the treatment group there are 229 replies before the ABW change and 521 after the change. For the control group, there are 910 replies before the change and 687 after the change. The survey items were measured with a five-point Likert scale (1 = disagree, to 5 = agree), and overall productivity item with scale 4 (low) to 10 (high). The survey items are presented in Tables 1-6. In the analysis of the survey data the difference-in-difference (DiD) approach was applied (see for example Angrist & Pischke, 2009). Approach was chosen in order to be able to control the effects of other changes co-occurring with the ABW change in the studied organisations.

The difference-in-difference approach to analysis is illustrated in the following diagram:



In the diagram, the average satisfaction of a treatment group on knowledge work drivers and outputs increases over the course of a working environment change. To estimate the causal effect of the change one must obtain a counterfactual - an evaluation of what would have happened in the absence of this change. In this instance one could obtain an appropriate counterfactual by observing change in satisfaction of a control group - employees from the same organization, who did not face changes in the working environment. The difference-in-difference estimator measures the changes of a treatment group relative to a control group.

Consider the following example: on a scale from 1 to 5 the self-assessed quality of work was 4.106 for the treatment group before the working environment change and 4.264 after the change. The difference between these sample averages is 0.158. However, interpreting this difference as causal effect of the working environment change would overstate the effect because over the same time period there was a positive increase in the self-assessed quality of work also for the control group - employees from the same organization who did not face changes in working environment. For the control group, the average self-assessed quality of work was 4.255 at the time period before the working environment changes and 4.317 after the changes. The difference between these sample averages is 0.062. Assuming that the control and the treatment groups have parallel trends over time, the change in control group can be interpreted as the change treatment group would have experienced without the working environment change. If the treatment is randomly assigned, the difference-in-differences (in this case 0.158 – 0.062 = 0.096) can be interpreted as a causal effect of the working environment change. For a more thorough review of this approach see for example Angrist & Pischke (2009).

In a regression notation, the difference-in-difference estimator with additional covariates can be written as follows:

$$Y_{it} = b_0 + \beta_1(After_t) + \beta_2(Treatment_i) + \beta^{DiD}(After_t \times Treatment_i) + \delta(D_i) + \epsilon$$

Where $Y_{it}$is the satisfaction of an individual i at the time period t($t = after, before$). $After_t$is a binary variable which equals 1 in the pre-treatment period and 0 in the post-treatment period. $Treatment_i$ is a binary variable which equals 1 if a person is in a treatment group and 0 if a person is in a control group. Coefficient β^{DiD} for the interaction term ($After_t \times Treatment_i$)is DiD-estimator and $D_i$is a vector including dummy-variables for age-group, gender and organization.

The regression coefficients are estimated by ordinary least squares and standard errors are used for hypothesis testing. In tables 1-6 we report estimates $\hat{\beta}^{DiD}$ for the DiD-estimator from model including age, gender and organization dummies. We also report pre-post group means for treatment and control groups.

4 RESULTS

4.1 Physical work environment

According to the difference-in-difference estimates in Table 1, there was a greater positive change (1PE, 0.735, p<0.001) considering sufficiency of meeting rooms for formal and informal meetings in ABW group. In addition, the positive change in the support facilities provided for spontaneous interaction between colleagues (3PE) was greater (0.233, p<0.05) among ABW group. Th positive change was greater (0.567, p<0.001) in the ABW group also concerning the availability of places where it was possible to discuss confidentially, without fear of being overheard (6PE). However, there was a greater negative change (-0.337, p<0.01) in ABW group concerning the ergonomics of the work stations (4PE) and on having the possibility to work efficiently (7PE, -0.257, p<0.05). In other items measuring the perceptions of the physical work environment (experiences of disruptions and availability of spaces for concentration) there were no statistically significant differences in the changes between the groups.

Table 1 Effects on physical environment

N = 2,325	Treatment before Mean	Treatment after Mean	Control before Mean	Control after Mean	$\hat{\beta}^{DiD}$ Coeff.
1PE Space for concentration	3.619	3.994	3.853	3.964	0.254
2PE Space for meetings	3.009	3.717	3.843	3.783	0.735***
3PE Space for spontaneous interaction	3.759	3.963	4.101	4.042	0.233*
4PE Workstation ergonomics	3.796	3.596	3.862	3.949	-0.337**
5PE Disruptions	2.982	2.865	3.326	3.416	-0.230
6PE Space for confidential discussions	3.338	3.775	3.764	3.660	0.567***
7PE Efficiency	3.702	3.653	3.924	4.076	-0.257*
The scale is from 1 to 5. The difference-in-difference estimates (with covariates) in are in column $\hat{\beta}^{DiD}$. Statistical significance: *** p<0.001, ** p<0.01, * p<0.05					

4.2 Virtual work environment

According to the difference-in-difference estimates in Table 2, somewhat surprisingly, ABW group reported a greater negative change (11VE, -0.174, p<0.01) than the control group both in the possibilities to use instant messaging for communication with colleagues, in the possibilities to have access to electronic calendars of the other employees (10VE, -0.176, p<0.01) and in the availability of appropriate mobile devices (14VE, -0.242, p<0.05). This surprising result might be related to the more pressing need to uniformly utilize as a work community the digital awareness and presence communication tools in the multilocational, distributed work. If the utilization of these tools in the ABW environment is not uniform, the assessment of the possibilities to use these tools comprehensively is also more critical.

Table 2 Effects on virtual work environment

N = 2,278	Treatment before Mean	Treatment after Mean	Control before Mean	Control after Mean	$\hat{\beta}^{DiD}$ Coeff.
8VE Software usability	3.380	3.600	3.987	3.959	0.204*
9VE Information access	3.389	3.692	3.633	3.820	0.028
10VE Electronic calendar	4.707	4.555	4.665	4.696	-0.176**
11VE Instant messaging	4.716	4.753	4.618	4.773	-0.174**
12VE Virtual meeting tools	3.751	3.959	4.295	4.349	0.057

13VE Electronic collaboration spaces	3.438	3.637	3.671	3.647	0.222*
14VE Mobile devices	3.956	3.919	3.966	4.226	-0.242*
The scale is from 1 to 5. The difference-in-difference estimates (with covariates) in are in column $\hat{\beta}^{DiD}$. Statistical significance: *** p<0.001, ** p<0.01, * p<0.05					

On the other hand, ABW employees experienced a greater positive change (0.204, p<0.05) regarding the usability of the main software for doing their work tasks (8VE) and availability of electronic collaboration spaces (13VE, 0.222, p<0.05). In other items measuring the perceptions of the virtual environment, access to information from everywhere (9VE) and the availability of virtual meeting tools (12VE), there were no statistically significant differences in the changes between the groups.

4.3 Social environment

According to the difference-in-difference estimates in Table 3, employees in the ABW group observed a greater positive change (0.338, p<0.01) in the the general acceptance of telework in their work (16SE) than in the control group. In other aspects of the social work environment, there were no statistically significant differences in the changes between the groups. However, overall, during the study period, there were positive before-after -changes in all the items measuring social work environment characteristics both in ABW group and control group. In other words, the social work environment developed into positive direction in both groups, but one cannot deduce any causal impact from ABW change.

Table 3 Effects on social environment

N = 2,317	Treatment before Mean	Treatment after Mean	Control before Mean	Control after Mean	$\hat{\beta}^{DiD}$ Coeff.
15SE Flexible place and time to work	3.633	3.927	4.158	4.331	0.100
16SE Telework	3.504	4.195	4.036	4.401	0.338**
17SE Openness	3.351	3.536	3.620	3.761	-0.004
18SE Information flow	3.482	3.576	3.753	3.821	0.049
19SE Meeting practices	3.044	3.291	3.486	3.562	0.111
20SE IT and communication tool use guidelines	3.181	3.307	3.533	3.592	0.022
21SE Goals for my work	3.917	4.060	4.158	4.247	0.056
22SE Assessment of work results	3.837	3.926	3.956	4.100	-0.085

23SE Balanced task profile	3.982	4.069	4.108	4.188	0.009
24SE Exploration of new ways of working	3.302	3.614	3.565	3.752	0.113
The scale is from 1 to 5. The difference-in-difference estimates (with covariates) in are in column $\hat{\beta}^{DiD}$. Statistical significance: *** p<0.001, ** p<0.01, * p<0.05					

4.4 Individual work practices

Table 4 Effects on individual work practices

N = 2,297	Treatment before Mean	Treatment after Mean	Control before Mean	Control after Mean	$\hat{\beta}^{DiD}$ Coeff.
25IWP Use of technology to avoid unnecessary travelling	3.796	3.772	3.794	4.152	-0.376**
26IWP Use of mobile technology in idle time	3.115	2.755	2.924	3.112	-0.393**
27IWP Task prioritizing	4.276	4.275	4.041	4.208	-0.152
28IWP Use of quiet space for concentrated work	3.123	3.509	3.228	3.488	0.129
29IWP Meeting pre-work	3.842	3.832	3.942	4.040	-0.061
30IWP Taking care of well-being at work	3.489	3.633	3.707	3.799	0.071
31IWP Being up to date about communications	4.075	4.147	4.105	4.098	0.077
32IWP Closing disruptive software in order to concentrate	3.228	3.522	3.612	3.515	0.384**
33IWP Workday planning	3.101	3.238	3.329	3.430	0.071
34IWP Developing work practices	3.411	3.540	3.566	3.647	0.052
The scale is from 1 to 5. The difference-in-difference estimates (with covariates) in are in column $\hat{\beta}^{DiD}$. Statistical significance: *** p<0.001, ** p<0.01, * p<0.05					

According to the difference-in-difference estimates in Table 4, there were somewhat unexpected statistically significant differences in the changes in digital tool practices between the ABW group and the control group. There was a greater negative change (25IWP, -0.376, $p<0.01$) both in the utilization of teleconferencing, instant messaging for reducing unnecessary traveling and mobile technologies (26IWP, -0.393, $p<0.01$) in the ABW group. On the other hand there was a greater positive change (32IWP, 0.384, $p<0.01$) in the routine to shut down disruptive software when one wanted to concentrate in the ABW group. In other items related to the self-management and work methods experimentation there were no statistically significant differences in the changes between the groups.

4.5 Well-being at work

According to difference-in-difference estimates in Table 5, during the study period, there were positive before-after -changes in all of the items measuring well-being at work both in ABW group and control group, but no statistically significant differences in changes between the groups.

Table 5 Effects on well-being at work

N = 2,312	Treatment before Mean	Treatment after Mean	Control before Mean	Control after Mean	$\hat{\beta}^{DiD}$ Coeff.
35WB Joy of work	3.965	4.042	4.070	4.149	-0.010
36WB Enthusiasm	3.882	3.981	3.991	4.066	0.043
37WB Meaningfulness of work	4.167	4.223	4.214	4.295	-0.019
38WB Continuous stress	3.224	3.397	3.531	3.647	0.067
39WB Appreciation of my work performance	3.639	3.696	3.507	3.740	-0.174
40WB Work-leisure balance	3.763	3.852	3.934	4.064	-0.044
41WB Workplace atmosphere	3.902	3.912	3.941	4.035	-0.100
42WB Conflict resolution	3.360	3.397	3.481	3.596	-0.136

The scale is from 1 to 5. The difference-in-difference estimates (with covariates) in are in column $\hat{\beta}^{DiD}$.
Statistical significance: *** $p<0.001$, ** $p<0.01$, * $p<0.05$

4.6 Self-assessed productivity

According to the difference-in-difference estimates in Table 6, the most interesting result of the study concerns self-assessed productivity. ABW group observed greater positive change (49P, 0.166, $p<0.05$) regarding efficiency of the work groups than the control group. There were no other statistically significant differences in changes between the groups in the individual items in the productivity measures on self-assessed productivity. However, the final, summarizing

measure in the survey which asked respondents to rank their overall personal productivity during last month indicated a greater positive change in ABW group than in control group. In the scale 4-10 the self-assessed rank of productivity change was 0.147 points higher among ABW group than in control group.

Table 6 Effects on self-assessed productivity

N = 2,306	Treatment before Mean	Treatment after Mean	Control before Mean	Control after Mean	$\hat{\beta}^{DiD}$ Coeff.
43P Goal achievement	4.018	4.064	4.066	4.138	0.005
44P Task execution fluency	3.965	4.091	4.131	4.167	0.091
45P Spending work time to central goals	3.704	3.837	3.904	3.966	0.076
46P Competence	4.132	4.151	4.228	4.253	0.019
47P Meeting clients' expectations	3.996	3.971	4.150	4.217	-0.071
48P High-quality results	4.106	4.264	4.255	4.317	0.108
49P Group work efficiency	3.643	3.805	3.938	3.913	0.166*
Rank of own work performance in the last month (scale: 4 (lowest), 10 (highest))	8.341	8.443	8.456	8.432	0.147

The scale is from 1 to 5. The difference-in-difference estimates (with covariates) in are in column $\hat{\beta}^{DiD}$.
Statistical significance: *** p<0.001, ** p<0.01, * p<0.05

5 DISCUSSION

There is a difference in the group means between treatment and control groups prior to the treatment period. Holding age, gender and organization characteristics constant, we estimated this difference to be 0.252 ($p<0.01$) points in the perceptions of physical environment and 0.125 ($p<0.05$) points in the perceptions of self-assessed productivity – where the treatment group is statistically significantly less satisfied than control group. In other measures the treatment group appears to be chronically 0.060 - 0.110 points less satisfied, but this difference is not statistically significant. The more pessimistic assessment of physical work environment in treatment group before relocation might be explained by the characteristics of their pre-treatment office – bigger share of respondents in treatment group worked in shared office with assigned seats than in control group.

The more pessimistic post-treatment assessment of physical work environment related to the efficiency in the treatment group might be explained by the learning period to utilize variety of working zones. In cross-sectional study after ABW relocation in four governmental organisation sites higher perceived productivity was associated with higher rate of workspace switching (Haapakangas et al., 2018). Also the working style may explain more pessimistic assessments. Bababour (2018) observed that material and paper-intensive working style inhibits movement in

ABW-office. However, in our approach, we focused on group differences in pre-post treatment differences in means, not in the absolute differences in the post-treatment measures.

6 CONCLUSIONS

The results of the study provide a detailed and comprehensive account of causal impacts the ABW change have on both knowledge work performance drivers and outcomes. In general the results show that ABW change is a valid means to secure a diverse and functional enough physical work environment for modern knowledge work. The results also show that well-being at work or productivity will not collapse because of ABW change. Instead, productivity, when measured with an overall, subjective personal measure, rises moderately after ABW change.

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Analyze Group Work Activity Pattern Through Work Type and Collaboration Network in a Large Organization

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ABSTRACT

Purpose: Workgroups in large organizations tend to share similarities or differences in work activity patterns, and this information is considered essential for office space planning. However, how can we interpret the difference in work activity patterns at the group level? Is it only because of the difference in work type or the other structural factors such as the position in collaboration networks? In this paper, we argue that groups' difference in work activity pattern is a by-product of the organization structure and collaboration network. We claim that understanding the group's type of work and collaboration network, can help us to interpret the work activity patterns so that we can better design the workplace settings according to the needs.

Theory: Social network theory and analysis method is used to explain the similarities of work activity patterns among workgroups in the same organization. The hypotheses we tested are as follows:

Hypothesis 1: Groups in different work types will have different work activity patterns.

Hypothesis 2a: Groups with high network connectivity would be less likely to have a high percentage of individual work time.

Hypothesis 2b: Groups with high network connectivity would be more likely to have a high percentage of team-work time, especially for inter-team work.

Design/methodology/approach: We surveyed a sample of 188 managers from a large Italian company regarding (a) the percentage of time spent on different work activities: individual work, collaboration, and mobile work; (b) the Units that they mostly interact with.

Findings: We found statistical evidence supporting our hypotheses 1 and 2b, such that type of work is significantly correlated with the time spent on individual work, but for teamwork especially inter-team work, network connectivity plays a more important role.

Originality/value: Existing studies address work activity patterns mostly at an individual level and neglect the structural and contextual factors which dominate the collaborations between

groups. This study is the first exploring group work activity patterns through organizational structure and using social network analysis methods to understand the relationships between the two. As for large organizations, space planning and design usually are conceptualized at the department or group level, a more detailed understanding of work activity patterns can play a pivotal role in workplace strategies and space planning.

Keywords:

Work activity pattern, Office space planning, Workplace strategy, Organizational structure, Work collaboration network.

1 INTRODUCTION

1.1 Work activity pattern and space planning

Large debate has been going on about how much space within office buildings should be dedicated to either individual or team work, and about the fit of Activity-based Flexible Offices (AFOs) to different work patterns. The concept of such AFOs is based on the assumption that work activity is diverse and the employee will benefit when each activity is appropriately supported by the setting (Babapour, Karlsson and Osvalder, 2018). The idea of work activity diversity is reflected on the growing acceptance of office furniture choice and layout assortment which aims at better supporting both individual work and team work. In this case, studying work activity patterns is critical for both workplace design and space planning. A successful space planning should be based on an accurate understanding of the activity pattern of the employees, such that the optimal workplace setting could be proposed according to the needs.

However, how to explain the different patterns of work activities between groups in the same organization? The goal of this study is to empirically explore whether the group's job function, gender composition and collaboration network can help us to interpret the work activity patterns across groups especially for teamwork in a large organization. By explaining the differences in activity patterns, this study contributes to the understanding of work in large organizations. Besides its contribution to space planning, the result also has implications for flexible work arrangement policy-making, as identifying which job is suitable for flexible working is still a challenge (Levit, 2018).

1.2 Diversity of work activity

Knowledge work largely depends on information and know-how sharing between individuals and groups of an organization (Kogut and Zander, 1992). Work processes have been switching from being mainly based on individual work to requiring collaboration. Studies about collaboration keep growing in recent management literature as many benefits of collaboration are evident, among which "*increased profit through sharing expertise across business units or companies; reduction in costs through sharing best practices; improved decision making through sharing insights and knowledge; innovation through sharing ideas; and an improved ability to pursue goals that involve distributed units or companies*" (Patel, Pettitt and Wilson, 2012, p. 1). Despite virtual collaboration gaining popularity, face-to-face (F2F) interactions that require meeting in real space and time are necessary. F2F interactions can occur in mainly three modes (Brown, 2017): (1) meetings planned and scheduled in advance; (2) on-demand meetings between a few individuals; and (3) chance encounters.

Besides collaborative activities, some scholars argued that individual tasks are at the core of some job descriptions. Leesman (2017) recognized 21 activities that workers can engage in: (1) Collaboration (collaborating on creative work; collaborating on focused work; informal social interaction; informal un-planned meetings; learning from others); (2) Individual work (individual focused work, desk based; individual focused work away from your desk; individual routine tasks; reading; thinking/creative thinking); (3) Formal meetings (audio conferences; hosting visitors, clients or customers; larger group meetings or audiences; planned meetings; video conferences); (4) Conversations (business confidential discussions; private conversations; telephone conversations); and (5) Other (relaxing/taking break; spreading out paper or material; using technical/specialist equipment or materials). Literature and empirical studies (e.g., Tagliaro and Ciaramella, 2016) suggest that, on a typical working day, the time employees spend carrying out individual tasks equals the time they are involved in collective activities.

A plethora of literature has been done in describing different work activities. Hardy et al. (2008) built up an overview of several work patterns existing in most organizations, calling them "*workstyles*". Here they recognize three main employee categories: 'Residents'; 'internally mobile'; and 'externally mobile' workers. Each of them can be split into further subcategories by different workstyle characteristics, among which: use of owned vs. shared office desks; time in prime office, not at desk; internal and external physical interaction; dependency on paper files or on office systems; and need for mobile or fixed ICT.

In a similar way, Greene and Myerson (2011) schematize four principal work patterns in consideration of the ways of working of knowledge workers: anchor, connector, gatherer, and navigator, from more sedentary to more mobile. They define these patterns as "*character types*", and describe them also based on networking habits. The characteristic way of working of each type reflects into different workplace strategies and layout solutions to accommodate their respective needs.

Leesman (2017) proposes a categorization of work patterns focusing on the activities taking place within the office building. 'Campers/squatters', 'timid travelers', 'intrepid explorers', and 'true transients' differ by the number of different work settings and other locations they use for work.

In recent years, studies have found inconsistent results about the mobile worker's experience in the workplace. Greene and Myerson (2011) denounce that the more mobile the work character is, the less he is likely to be satisfied with the space he works. Indeed, facility managers and the people appointed to space planning seem barely knowing the needs of Navigators, hence find it difficult to address them. Leaman (2003, p. 166) reports that *"the more functions and activities people have to cope with, the less likely they are to say they are productive as well. So open plan often scores worse simply because the number of activities is greater."* In partial contradiction, studies by Leesman (2017) demonstrated that the less a worker is mobile, the less s-/he is likely to appreciate AFOs.

In all, tracking the activity pattern of workers is fundamental as it can inform the choice for layout (e.g. more open or more closed), help quantify the number of necessary desks, meeting rooms and other support spaces, and predict the satisfaction and productivity of the employees in a specific working environment. Different clustering criteria could be adopted to infer different work patterns and, consequently, the best workplace solutions.

1.3 Job function

Job function is an important factor that researchers identified to explain the variance in work activities. The time spent in the different activities may depend on job function groups (Bell and Anderson, 1999). Bell and Anderson (1999) observed a case company recognizing nine job function groups (e.g. administration, managers, analysts, developers, etc.) summing up to five work-styles that required ten different work settings. The same authors declare the most interesting aspect of their analysis being the identification of a high variance in work-styles within a single job function, and the resulting work settings. Therefore, it is of pivotal importance for organizations focusing on how their employees actually work, rather than assuming this information based on the job function, in order to provide them with appropriate work settings. On the contrary, the job function has been for a long time the most decisive factor to inform workplace design and space planning. GSA defines very specific benchmarks for different office configurations and usable square meters depending on the type of industry (e.g. Business services/consulting, Telecommunication, Manufacturing, Government organization, Academic institution, Manufacturer, Media, and Business services/consulting) and the job functions (e.g. Manager, Supervisor, Technical, Support Staff, or Clerical/Junior staff) (e.g., GSA, 2012). However, job descriptions are evolving fast not much empirical research has been dedicated to understanding the composition of various activities in the daily work of different job functions, nor it is clear to what job functions really predicts work activity patterns.

Even though both individuals and groups are relevant subjects in the work environment (Kämpf-Dern and Konkol, 2017), most of the studies have focused on individual work tasks, rather than on groups. Work activity difference at group level is largely unknown. However, information work today is largely based on collaborations and relying on team-oriented project. Groups and teams are also the fundamental units for space planning. Exploring the activity patterns at group level can help us better understand the difference between groups and propose space strategy accordingly. Thus, we would like to test the following hypothesis in this study:

Hypothesis 1: Groups in different job function have different work activity patterns.

1.4 Work collaboration network

Collaboration and communications in modern organizations are complex. As there is a growing percentage of time spent on team work, which is often interdisciplinary and interfunctional aiming at bursting organizational silos, the time spent on collaboration between workgroups might not only be explained by the job function, but also by other structural factors. Workgroups, or teams, are the key relational building blocks of organizations and how groups interact with each other have gained increasing attention in organizational behavior literature (Lazer and Katz, 2003). Studies have found that formal organization structure and spatial collocation have the most significant impact on the rate of communication at a dyad-level (Kleinbaum, Stuart and Tushman, 2008, 2013). The communication frequency at individual level was also found to be related with spatial proximity (Allen and Gerstberger, 1973; Allen, 2007; Kabo *et al.*, 2014). Multiple management groups in the same function unit still work differently based on other reasons, such as their position in the whole communication network. It could be assumed that groups which are engaged in work that requires constant interactions with other groups, might spend less time on individual work. However, the relationship between group network and work activity has not been studied yet.

In this study, we would like to examine whether groups' differences in work activity pattern are related with the work collaboration network. The structure of the work collaboration network might explain the involvement of workgroups in collaboration with other groups. This could affect workplace strategies as the need for collocation, rather than the job function, could determine the most appropriate layout solution. We argue that in addition to the job function, communication networks among workgroups also should be considered while understanding the work activity differences between groups, especially for teamwork. Social network analysis in this case can support mapping of collaboration relationships among the workgroups and offer evidence of the correlation with different work patterns. Therefore, we would like to test if there is a correlation between groups network connectivity and the time spent on different work activities.

Hypothesis 2a: Groups with high network connectivity would be less likely to have a high percentage of individual work time.

Hypothesis 2b: Groups with high network connectivity would be more likely to have a high percentage of team-work time, especially for inter-team work.

2 METHODS

To explore the above mentioned hypotheses, a survey was conducted at an Italian company. The company's administrative headquarters is based in Milan, Italy, and hosts about 800 employees. These are organized into 13 main Departments (level 1), each department includes one or more Units (level 2), and the units are composed of one or more Teams (level 3). There is great variability in the size of teams, units and departments. We surveyed a sample of managers from level 2 and level 3 regarding the way of working of their teams or units, including both work pattern and work networks. A total of 188 people completed our questionnaire. Each responded questionnaire regards a group of 2 to 50 people. Valid responses were aggregated to level 2 for a total number of 72 units to analyze.

Questions about work patterns asked the percentage of time spent on different work activities at team or unit level (depending on the level of the manager). Four options were available, inspired by the characterization of Greene and Myerson's (2011) types: individual work, collaborative work performed within their team (intra-team work), collaborative work performed with other teams (inter-team work), and mobile work.

To test communication relationships, the survey asked managers who their teams/units talk to about work (Krackhardt and Hanson, 1993). In particular, they should list: (a) the 10 organizational groups that they collaborated with more often in non-daily activities; and (b) the 4 organizational groups that they undertook daily activities with. The questions were initially tested with a group of three human resources people, to verify if any questions were ambiguous or could have been met with resistance (Krackhardt and Hanson, 1993). With their help, following on Bell and Anderson's (1999) study, units and teams were grouped into four main categories, based on their job function: Administration, Management, Operation/IT, and Service.

Besides, as some studies suggest that women and men tend to share different interaction patterns in organizations (Brass, 1985; Reskin, 2000), we consider gender composition of a group as a control variable for this study and measured it in terms of the percentage of female employees in a group. The characteristics of the workgroups in the case organization are summarized in Table-1.

For data analysis, we calculated the average time spent on different activities, average age of employees, gender composition of the group and the results were summarized in Table-1. We also performed multivariate linear regression (Table-1 to -5) to estimate the relationships between the independent variables and the activity patterns. We measured the group's degree centrality and closeness centrality in both daily and non-daily communication networks as ways to operationalize the groups' network characteristics. Both centralities were calculated in software UCINET 6.463. In-degree centrality refers to how many times the group was nominated by the others. The normalized in-closeness centrality of a vertex is the reciprocal of farness divided by the minimum possible farness expressed as a percentage.

Table-1: Characteristics of the groups by job function (N=72)

	Administration	**Management**	**Operation/IT**	**Service**	**TOTAL**
Number of groups	9	25	8	30	72
Average employee age	46.286 (SD=3.77)	43.346 (5.84)	45.125 (3.64)	45.885 (6.91)	44.851 (5.94)
Female employee %	56.752 (13.32)	48.828 (23.98)	39.352 (26.61)	41.917 (27.35)	45.842 (24.89)
Work activity					
Individual work %	46.047 (6.27)	31.900 (12.39)	25.677 (11.56)	34.490 (18.02)	33.86 (15.156)
Team work %	48.401 (5.76)	51.490 (16.36)	62.343 (12.14)	52.157 (15.81)	52.631 (15.081)
Inter-team work %	29.417 (10.55)	26.211 (16.69)	21.927 (7.79)	26.696 (14.11)	26.293 (14.133)
Mobile work %	5.552 (6.33)	16.609 (10.53)	11.979 (11.56)	13.353 (8.68)	13.509 (9.893)
Network variables					
In-degree (non-daily)	8.288 (7.42)	7.248 (4.30)	7.575 (2.38)	8.074 (4.24)	7.744 (4.471)
In-degree (daily)	4.235 (3.97)	2.467 (1.64)	2.974 (1.42)	2.964 (2.31)	2.931 (2.266)
In-closeness (non-daily)	24.538 (2.30)	25.320 (2.44)	24.794 (0.69)	24.873 (1.30)	24.989 (1.851)
In-closeness (daily)	16.053 (2.55)	15.149 (3.51)	15.653 (1.78)	15.455 (4.10)	15.433 (3.498)

3 RESULTS AND DISCUSSIONS

Table-1 shows that groups in different job functions have different work activity patterns, supporting Hypothesis 1, namely that groups in different job functions will have different work activity patterns. Moreover, they tend to have different gender composition. For gender composition, the Administration group has the largest percentage of female employees (56.8%) while the Operation/IT groups has the least (39.3%). The Administration groups also report the highest percentage of time spent on individual work, while the least percent of time on teamwork (48.4%) and mobile work (5.5%). The management groups show an opposite work activity pattern. They have the highest amount of mobile work (16.6%), and the second least percent of time on individual work (31.9%). On average, groups spent about half of their work time on teamwork, and about one third of their work time is devoted to individual work. This result suggests that teamwork is the major form of work activity for the employees in this organization,

which seems different to what happens in other case studies where time spent on teamwork and individual work would be approximately the same (e.g., Tagliaro and Ciaramella, 2016).

For the percentage of time spent on individual work, we noticed that there is a significant difference between groups in different work types. On average, Administration groups have the highest percentage of individual work time (46.05%), while the Operation/IT groups have the least amount (34.5%), as shown in Table-1.

For network characteristics, Administration groups have the highest in-degree centrality, such that on average an administration group is nominated as a collaborator by 4.2 groups for daily work, and 8.3 groups for non-daily work. However, the Management groups have the lowest for both daily (2.5) and non-daily (7.2) collaboration network size. Administration groups also have the highest average in-closeness centrality in the daily communication network, but in general, the differences between groups with different work types are small regarding to the in-closeness centrality measure.

The results of multivariate linear regression are summarized in Tables from 2 to 5. We set the Administration group as the reference when type of work is regressed as a categorical variable. For individual work time, we noticed that when work type is loaded together with gender composition such as Model 3 (M3) in Table-2, job function is no longer significant. Result in Table-2 suggests that gender composition is the best predictor for the percentage of individual work time, such that groups with more female employees will spend more time on individual work. The network variables do not explain a significant amount of variance of the result (R-square = 0.048), so that there is no statistical evidence supporting Hypothesis 2a.

Table-2: Regression models results, Individual work % (N=72)

	M1	M 2	M 3	M4	M 5	M6	M 7
INTERCEPT	34.53**	21.43**	9.91	32.67**	50.12	22.41**	-14.41
JOB FUNCTION							
MANAGEMENT	-2.63		-2.16				-3.90
OPERATION/IT	-8.85*		-6.64				-7.09
SERVICE	-0.04		0.11				-0.66
AGE			0.29				0.26
FEMALE %		25.46**	23.9**			25.55**	24.00**
IN-DEGREE (NON-DAILY)				0.76	1.028		0.73
IN-DEGREE (DAILY)				-1.59	-2.18	-0.341	-2.65*
IN-CLOSENESS (NON-DAILY)					-1.15		0.79
IN-CLOSENESS (DAILY)					0.67		0.55
R SQUARE	0.11	0.18	0.27	0.03	0.05	0.18	0.33

Table-3: Regression models results, Team work % (N=72)

	M 1	M2	M3	M 4	M5	M 6	M7
INTERCEPT	53.60**	59.64**	67.36**	52.94**	85.1**	134.4	125.03**
JOB FUNCTION							
MANAGEMENT	-2.11		-2.11			2.07	1.70
OPERATION/IT	8.75*		7.72			7.79*	8.31*
SERVICE	-1.44		-2.04			-1.55	-0.80
AGE			-0.16				-0.11

FEMALE %		-15.13*	-13.84			-18.8**	-15.82*
IN-DEGREE (NON-DAILY)				-1.26*	-1.00		-0.91
IN-DEGREE (DAILY)				3.24**	3.52**	2.92**	4.26**
IN-CLOSENESS (NON-DAILY)					-1.17	-3.28**	-2.44*
IN-CLOSENESS (DAILY)					-0.38		-0.33
R SQUARE	0.06	0.06	0.11	0.10	0.13	0.29	0.32

Note: * $p < 0.05$; ** $p < 0.01$; For job function, Administration is set as the reference group.

However, work type and gender composition alone do not explain the total variance of teamwork percentage among the groups. Our results suggest that the network variables are more significantly correlated. Daily work in-degree centrality is significantly correlated with the percentage of time on both team work and inter-team work, as shown in Model 4 (M4) of Table-3 and Model 6 (M6) of Table-4. Groups with higher in-degree centrality will have a higher percentage of time spent on both inter-team work and team work in general, supporting the Hypothesis 2b, namely that groups with high network connectivity would be more likely to have a high percentage of team-work time, especially for inter-team work. This finding suggests that previous work arrangement design based on job function might have limitations, as the work types might suggest the amount of time spent on individual work, but not on teamwork and the variety of teamwork.

Table-4: Regression models results, Inter-team work % (N=72)

	M 1	M 2	M3	M4	M 5	M 6	M7
INTERCEPT	26.06**	29.49**	51.59**	24.28**	19.34	21.95**	56.46
JOB FUNCTION							
MANAGEMENT	0.15		-0.28				1.92
OPERATION/IT	-4.14		-4.53				-4.22
SERVICE	0.63		1.28				2.27
AGE			-0.48				-0.40
FEMALE %		-7.08*	-8.67				-0.79
IN-DEGREE (NON-DAILY)				-0.69	-0.61		-0.542
IN-DEGREE (DAILY)				2.50*	1.79	1.48*	1.95
IN-CLOSENESS (NON-DAILY)					-0.28		-1.05
IN-CLOSENESS (DAILY)					0.87		0.98
R SQUARE	0.02	0.02	0.07	0.08	0.11	0.06	0.19

Table-5: Regression models results, Mobile work % (N=71)

	M 1	M 2	M 3	M 4	M 5	M6	M7
INTERCEPT	11.74**	18.36**	21.88*	14.04**	-45.33*	-42.99*	-18.06
JOB FUNCTION							
MANAGEMENT	4.33*		3.95*				2.15
OPERATION/IT	0.24		-0.92				-1.25
SERVICE	1.61		2.07				1.43
AGE			-0.12				-0.15
FEMALE %		-9.54*	-9.27				-7.87
IN-DEGREE (NON-DAILY)				0.52	-0.13		0.10

IN-DEGREE (DAILY)				-1.63*	-1.36	-1.71**	-1.63
IN-CLOSENESS (NON-DAILY)					2.75*	2.47**	1.96
IN-CLOSENESS (DAILY)					-0.31		-0.21
R SQUARE	0.10	0.06	0.15	0.07	0.18	0.15	0.26

Note: * $p < 0.05$; ** $p < 0.01$; For job function, Administration is set as the reference group.
Take out BUR2 as an outlier for its high in-closeness centrality.

Table-5 shows complex results about mobile work. We noticed that work type and gender composition are significantly correlated with group's mobile work activity. First, management groups have significantly more time spent on mobile work than the administration groups. Second, groups that have more female employees are having less time spent on mobile work. For network variables, the in-degree centrality and the in-closeness centrality show the opposite relationship with mobile work time. In general, the groups with higher daily work degree centrality will have a lower percentage of time spent on mobile work. It is understandable that the groups collaborating with the others the most might need to work onsite to facilitate the communication. This have implications for workplace strategies, as it can indicate that these groups are less suitable than others for hot desking policies or flexible work. However, the closeness centrality was found to be positively correlated with mobile work, such that the groups in the center of the non-daily work network are spending more time working offsite. This might suggest that specific digital solutions are needed to support the collaboration between onsite and offsite groups. More quantitative results are necessary to verify and explain this data in future studies, and confirm character types described by qualitative methods, such as those by Greene and Myerson (2011).

4 CONCLUSIONS

With this study, we noticed that time spent in teamwork exceeds time spent in individual work in our case organization. We also found empirical evidence about the different activity patterns between groups with different types of work. Job function is significantly correlated with the time spent on individual work, but for teamwork especially inter-team work, communication network connectivity plays a more important role. In this case, we argue that groups' difference in work activity pattern is a by-product of the organizational structure and work collaboration network.

Our results also suggest that the group's gender composition plays a significant role in explaining activity pattern. Groups with more female employees were spending more time on individual work, but less time on teamwork and mobile work. Multiple reasons might explain this result, such as job function. Some studies suggest that women tend to avoid confrontation and disagreement more than men, which reduces their participation in collaborative work activities (Bodin Danielsson and Theorell, 2019). This finding calls for future studies about work activities and collaboration practices focusing on gender differences.

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SESSION 6: EXPERIENCES OF COLLABORATIVE SPACES

Corporate Coworking Spaces – Determinants of Work Satisfaction in Flexible Workspaces

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ABSTRACT

Internal corporate coworking environments are gaining traction in the latest debate. The aim of this study is to obtain a deeper understanding of the factors that determine work satisfaction in a corporate coworking environment and to illuminate determinants for collaborative and interactive work. Survey data were collected through five corporates using an internal corporate coworking space in Germany (n=237). Work satisfaction in this environment was found to be high among the employees. Using regression analysis, major drivers of work satisfaction are the physical environmental factors, communication, concentration and social interaction. Spatial variety, and a supporting working environment to communicate, but also to concentrate were among the factors for work satisfaction. No differences were found between generations. The study reveals new insights into the flexible working environment of corporate coworking spaces and reveals factors influencing work satisfaction, which is commonly linked with organizational outcomes. To the best of the author's knowledge this is the first study that applies workplace factors on corporate coworking environments.

Keywords

corporate coworking space, employee satisfaction, multispace, activity-based working, workplace

1 INTRODUCTION

The workforce is becoming increasingly dynamic and tasks are becoming more complex, more distributed, and more often performed in collaborative teams with a high degree of social interaction (Paarlberg and Lavigna, 2010; Mitev *et al.*, 2019).Corporates respond to these environmental changes with new work environments, such as corporate coworking spaces. Since corporate coworking spaces are developed with these specific requirements in mind, i.e. high social interaction, creative spaces and organizational empowerment, it seems likely that these factors are positively related to work satisfaction with these new working environments (Bouncken *et al.*, 2020). Whereas there is a large body of research on workplace factors for traditional working environments (Kim and Dear, 2013; Appel-Meulenbroek, Clippard, and

Pfnür, 2018), and on office types with shared workspaces (Danielsson and Bodin, 2009; Zamani and Gum, 2019), research on corporate coworking spaces affect in work satisfaction is scarce, though. To address this research gap, we examine which factors influence work satisfaction, conducting a quantitative survey among employees of five corporates, sharing their working environment.

2 THE 'EVOLVEMENT' OF CORPORATE COWORKING SPACES

From a corporate perspective, coworking is interesting for three reasons. First, coworking offers companies spatial flexibility and greater space efficiency, while at the same time representing an investment in the well-being of employees (Weibel and Sapegina, 2018).Second, coworking can help organizations to reflect and transform their current culture of collaboration in a way that is relatively low of friction and resistance, where participants do not see coworking as an imposed measure of change, but rather as an invitation to explore(Back, 2018).Third, coworking can have a positive effect on the ability to innovate by providing a platform for exchange, learning and collaboration (Bilandzic and Foth, 2016; Butcher, 2018; Nagy and Lindsay, 2018). Open innovation theory calls for knowledge sharing and social interaction between the company and the external world and refers to the idea that companies do not have all the skills needed for internal innovation. It is precisely external resources, such as external information, knowledge, research and development, that can foster creativity and innovation in an organization. Nonaka and Takeuchi (2007) pointed out that companies do not always have the best talent within the company, so they must try to use external expertise and skills.

Instead of moving into existing (external) coworking spaces, corporates are starting to create their own internal coworking environments. In contrast to the use of external coworking spaces, advantages such as a stronger corporate identity, better employer branding and real estate economic advantages can be utilized in the corporate settings (Wagner, Gauger, and Pfnür, forthcoming). These corporate coworking spaces represent the next evolutionary step of new working environments and are regarded as a future model for many corporates(Bauer, 2017). Gauger and Pfnür (2019) show different adaptation strategies for internal corporate coworking and differentiate between two development stages:

First, corporates can apply the principles of coworking spaces to their own office environment. This includes for example, the establishment of a community manager to cater the community, the establishment of collaboration tools and platforms, and innovative room concepts for creativity and social interaction. Various departments use these spaces to create a vibrant and diverse atmosphere.

Second, corporates can open their spaces for other external player in order to integrate new talents, contacts, and external viewpoints into the firm. In contrast to using external coworking spaces, this offers the advantage that corporates can specifically control who works in their workplace.

Whereas a positive correlation of workplace factors on employee satisfaction is often subject of research for existing workplace types (Kim *et al.*, 2016) there is no scientific knowledge on the effects of work satisfaction in corporate coworking spaces.

3 THEORETICAL BACKGROUND AND DERIVATION OF HYPOTHESES

Building on the theory of environmental research psychology (Vischer, 2008) and workplace theory (Ayoko and Ashkanasy, 2020), the following workplace factors that exert an influence on employee and work satisfaction are derived from literature.

Indoor environmental quality (IEQ) is commonly measured with temperature/thermal comfort (Danielsson and Bodin, 2009), air (Wargocki *et al.*, 2000), and light (Walch *et al.*, 2005). Thermal comfort is a crucial and complex factor that has an impact on environmental satisfaction (Frontczak and Wargocki, 2011). Park *et al.* (2019) conducted Post-Occupancy Evaluation on 64 buildings and linked indoor air quality with occupants' health, comfort and satisfaction. An increase in satisfaction and productivity is also created by the presence of a good visual environment, including lighting conditions (Serghides, Chatzinikola, and Katafygiotou, 2015; Zuhaib *et al.*, 2018). Efforts to improve IEQ can improve satisfaction, well-being, health and productivity (Varjo *et al.*, 2015; Toyinbo, 2019).

> ***H1:*** *Physical environmental factors are related to work satisfaction in corporate coworking spaces.*

Croon *et al.*(2005) emphasizes that employees must be offered space to exchange thoughts and ideas. Whereas Krupper (2015) and O'Neill(1994) identify a medium positive influence of communication on satisfaction in traditional work environments, the focus on creative space and communication is regarded as essential in coworking spaces. Kim *et al.* (2016) state in their research that interaction between colleagues is better facilitated in non-territorial work. Especially in coworking spaces, the social aspects of work are becoming increasingly important such as "time for interaction, being creative and having private thinking time if the completion of a given task requires it" (Fuzi, Gryszkiewicz, and Sikora, 2018).

> ***H2:*** *The spatial possibilities for communication are related to work satisfaction in corporate coworking spaces*

As employees nowadays spend more time with informal communication than formal meetings, it becomes essential to provide various type of workspaces where serendipitous interactions take place (Cai and Khan, 2010; Davis, Leach, and Clegg, 2012; Zamani and Gum, 2019). Typically, coworking spaces have open social spaces that facilitate social interaction and collaboration (Bouncken *et al.*, 2020). According to open innovation theory to rely on external knowledge is one of the main advantages of coworking spaces for firms and their employees. Thus, opportunities for collaboration and social interaction should be supported by the work environment and contribute to work satisfaction. The combined offer of workspace and social space in coworking spaces enables for instance joint work, knowledge exchanges and individual work satisfaction (Spinuzzi, 2012; Reuschl and Bouncken, 2017).

> ***H3:*** *Collaboration and social interaction are related to work satisfaction in corporate coworking spaces.*

Coworking spaces allow for different work styles. Although high expectations are put on collaboration and social interaction, corporate coworking spaces should support privacy and the possibility to withdraw for concentrated work. Increasing privacy improves the ability of employees to concentrate on tasks and allows tasks to be performed with care (Sykes, 2004).

Hoendervanger *et al.*(2018) state that "activity settings that are intended to be used for concentration work deserve special attention".

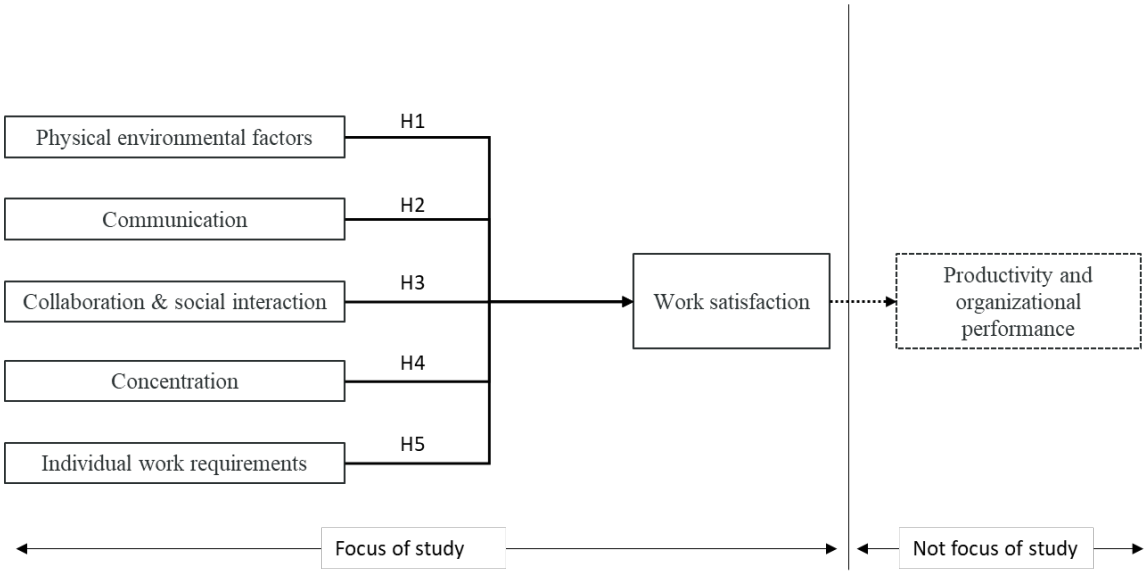
H4: *Concentration opportunities are related to satisfaction in corporate coworking spaces.*

The potential to choose a workplace that fits best with work processes are commonly considered as important elements for satisfaction (Brunia and Hartjes-Gosselink, 2009; Bodin Danielsson, 2010). All necessary work equipment should always be available to employees. In a post-occupancy study, Gerdenitsch *et al.* (2016) show that the perceived fit between work requirements and office facilities was increased and distractions decreased.

H5: *Individual work requirements are related to work satisfaction in corporate coworking spaces.*

Figure 1 summarizes the hypotheses and presents the research model. Literature shows that older employees report lower satisfaction in new working environments, as they might be more sensitive to auditory and visual distractions (Pullen, 2014). Haapakangas *et al.* (2018) state that managers gave higher ratings for well-being. Generation group and the position are therefore regarded as control variables in the model.

Figure 1: Research model



4 METHODOLOGY

The questionnaire was carried out at an international consulting company that has one of its biggest branch offices in Frankfurt, Germany. There, five corporates of the holding work collaboratively on four floors, sharing their 4,240 sqm workspace (we regard this as the first implementation stage of corporate coworking space, see also section 2.2). Users work in the construction industry, consultancy, in construction management, environmental research, and engineering. The office contains of 27 shared meeting rooms and around 220 individual workstations. The collaboration areas reach from two to three groups of people up to rooms where more than ten people can work together. Individual workstations are provided as

individual offices, shared offices, open benches with up to six workstations and workstations without directly surrounding walls. An exemplary overview of the floor plans is shown in the appendix. In addition, the employees can work in the common break area, the marketplace, or the multitude of meeting middle and relaxation zones. Apart from the assistance workstations, all employees share the workstations according to the desk sharing principles. Employees have lockers and portable storage systems to carry their personal items during the day and lock them after work. At the time of the evaluation only the employees of the five corporates work in the coworking space. In the future, an expansion of coworking to external companies is also conceivable. This model is particularly interesting for related branches or joint projects. Further on, a collaboration with start-ups is being considered.

4.1 Data Sample

In order to evaluate employee satisfaction with the new corporate coworking concept, the survey was launched in April 2019 during a period of 14 days and aimed at 459 employees, receiving 237 questionnaires, which corresponds to a response rate of 51.63 %. For the evaluation of the satisfaction survey, a net response rate of 200 is assumed (43.57 %). Items were combined from existing survey instruments like WODI light (Maarleveld, Volker, and van der Voordt, 2009), the Leibnitz Institute for the social science (Fischer and Lück, 2001), and the Office21 survey by the Fraunhofer Institute, IAO (Bauer *et al.*, 2018). A five-point-likert-scale was used for all items to measure perceived fit.

Table 1 reports the employees characteristics of the sample. The characteristics of our sample are representative for the whole companies' structure.

Table 1: Sample Descriptive Statistics

	N	%
Occupational position		
Management	28	14.00 %
Project Manager	115	57.5 %
Assistance	57	28.5 %
Generation		
Millennials	112	56.00 %
Non-Millennials	88	44.00 %
Work Concept		
Prefer to use the same desk	123	64.50 %
No preference to use the same desk	71	35.50 %
Change of Workplace		
Once a day	162	81.00 %
More than once a day	38	19.00 %

64.5 % claim that they prefer to use the same desk every day, which can be interpreted that they have not implemented the hot-desking attitudes into their working behavior. This result can be due to territory and privacy needs, which has been frequently noted in studies (Oldham, Cunnings, and Zhou, 1995; Hoendervanger *et al.*, 2018). Furthermore, efficiency and utilization doesn't seem to be of high relevance so far, as there is no need to search for a free desk every day. Nevertheless, 81 % of the employees change their workspace at least once a day, and 19 %

at least twice a day, which means that they make use of the ABW and change their workspace according to their needs and task, whereas they prefer to return to their same desk, when performing their ordinary tasks. This is in line with other studies (Zamani and Gum, 2019). It should be emphasized that the spatial structure and the working concept are reminiscent of current ABW environments. However, in the present case this is carried out via the organizational structure of several corporates and thus shows a novelty to cases already considered in the literature since collaboration, concentration and communication must be considered in new scales.

4.2 Data Reduction

A principal component analysis (PCA) was performed for data reduction.Table 2 presents the results of the PCA and shows the items that are included in the analysis. The Kaiser-Meyer-Olkin-Measure is 0.846 (>0.6),[6] the Bartlett's test for sphericity (χ^2 (351) = 200.4600, $p \leq 0.001$) which indicates that the factor analysis should yield reliable factors. The five components explain 74.25 % of the variance (C1 – 43.24 %, C2 – 12.62 %, C3 – 8.34 %, C4 – 5.64 %, C5 – 4.42 %).

Table 2: Principal Component Analysis

	1	2	3	4	5
Physical environmental factors (Cronbach's Alpha = 0.823; CR= 0.830; AVE= 0.494)					
Satisfaction with indoor climate	0.749				
Satisfaction with lighting	0.732				
Satisfaction with brightness	0.689				
Function as a feel-good atmosphere	0.674				
Appealing space design	0.666				
Communication (Cronbach's Alpha = 0.852; CR= 0.850; AVE= 0.496)					
Rooms for ad-hoc meetings		0.853			
Ad-hoc meeting room availability		0.821			
Access to ad-hoc meeting rooms		0.79			
Meeting room availability (for scheduled meetings)		0.593			
Possibility for withdrawal for phone calls		0.55			
Satisfaction with overall communication		0.542			
Concentration (Cronbach's Alpha = 0.795; CR= 0.811; AVE= 0.389)					
Possibility for concentrated work			0.770		
Background noises			0.735		
Quiet work zones			0.707		
Distraction of phoning colleagues			0.605		
Visual distraction			0.546		
Privacy	0.405		0.495		
Spatial conditions for phone calls			0.429		
Collaboration & social interaction (Cronbach's Alpha = 0.751; CR= 0.810; AVE= 0.589)					

[6] Some authors recommend a minimum of .5 (Cleff, 2015; Hartas, 2010; Field, 2013), some a value of at least 0.6 (Möhring & Schlütz, 2013; Tabachnick & Fidell, 2013)

Team performance	0.813	
Collaboration supportive environment	0.785	
fast, informal meetings/chats with colleagues	0.699	
Work Requirements & equipment (Cronbach's Alpha = 0.459; CR= 0.460; AVE= 0.350)		
Work equipment		0.636
Room equipment with furniture		0.453

Notes: Extraction method: principal component analysis. Rotation with a Varimax rotation with Kaiser normalization. Cronbach's Alpha threshold=0.70, Composite Reliability threshold=0.60.

Components 1 to 5 reflect our hypotheses H1 to H5. At first sight surprising, the factor appealing space designs loads on physical factors (H1), and noise loads on concentration (H4), which is in accordance with some studies (Hedge, 1982; Danielsson and Bodin, 2009; Kim and Dear, 2013). E.g. Danielsson and Bodin (2009) note that design factors are grouped in environmental factors, whereas noise is rather grouped in privacy than physical factors "since it is so closely related to privacy issues" (Danielsson and Bodin, 2009). Kim and Dear (2020) cluster IEQ factors into positive and negative impacts on employees' workspace evaluation and find out that visual privacy as environmental factor is positively related to workspace satisfaction. Interestingly, the item privacy contributes in our PCA almost as much to environmental factor as to the concentration factor, thus underpinning the results of Kim and Dear (2020).

4.3 Variable Construction

The dependent variable is *work satisfaction*. We refer satisfaction not only to the perception of the office environment, but also to the perception of work and the employer himself (see Appendix for items). Cronbach's Alpha reaches a value of 0.872 (≥ 0.8).

The independent variables are derived by performing a principal component analysis. Five components with eigenvalue ≥ 1 are obtained. These are: physical environmental factors, communication, collaboration and social interaction, concentration, and individual work requirements. The position in the firm and generation group[7] are controlled for by constructing dummy variables.

5 RESULTS

Table 3 presents the OLS regression to test the relation between the derived factors with work satisfaction. Model 4 explains 48.6 % of variance in work satisfaction. The control variables position, and generation group explain only 1.1 % of variance in model 1. Position becomes statistically significant in models 2 to 5, which yields that the higher the position is, the higher the work satisfaction is. There are no generational differences in work satisfaction. Regarding the workplace factors, i. e. physical environmental factors (H1), communication (H2), social interaction (H3), and concentration (H4) are all significant predictors of work satisfaction. The strongest influence comes from the physical environmental factors, which are significant on the 1 %-level and explain 35.8 % of variance in satisfaction. There is no support for individual work requirements (H5), which do not seem to affect work satisfaction in a coworking environment.

[7] For reasons of anonymity it was not possible to collect the age, but only the generation group.

Table 3: Regression Models with Work Satisfaction as Dependent Variable

	model 1	model 2	model 3	model 4	model 5
Independent variables					
Physical environmental factors		0.779*** (0.348)	0.508*** (0.091)	0.411*** (0.095)	0.401*** (0.096)
Communication			0.415*** (0.079)	0.299*** (0.083)	0.297*** (0.083)
Collaboration & social interaction				0.157** (0.075)	0.151** (0.076)
Concentration				0.245** (0.105)	0.229** (0.108)
Individual work requirements					0.068 (0.100)
Control variables					
Management position	0.155 (0.130)	0.325** (0.105)	0.222** (0.097)	0.224** (0.095)	0.226** (0.095)
Millennial	0.117 (0.130)	0.103 (0.104)	0.164* (0.096)	0.107 (0.095)	0.100 (0.095)
Constant	9.780*** (0.089)	6.501*** (0.348)	5.939*** (0.358)	5.144*** (0.416)	4.982*** (0.479)
Adjusted R^2	0.011	0.369	0.442	0.486	0.484
N	166	164	160	156	156
F-value	1878.000	32.717***	32.453***	25.433***	21.787***
Durbin-watson-statistic	2.300	2.059	2.082	2.056	2.057

Notes: OLS regression shows unstandardized coefficients of workplace factors and control variables on work satisfaction. *, **, and *** denote significance at the 10 %, 5 %, and 1 % level, respectively.

6 DISCUSSION & CONCLUSION

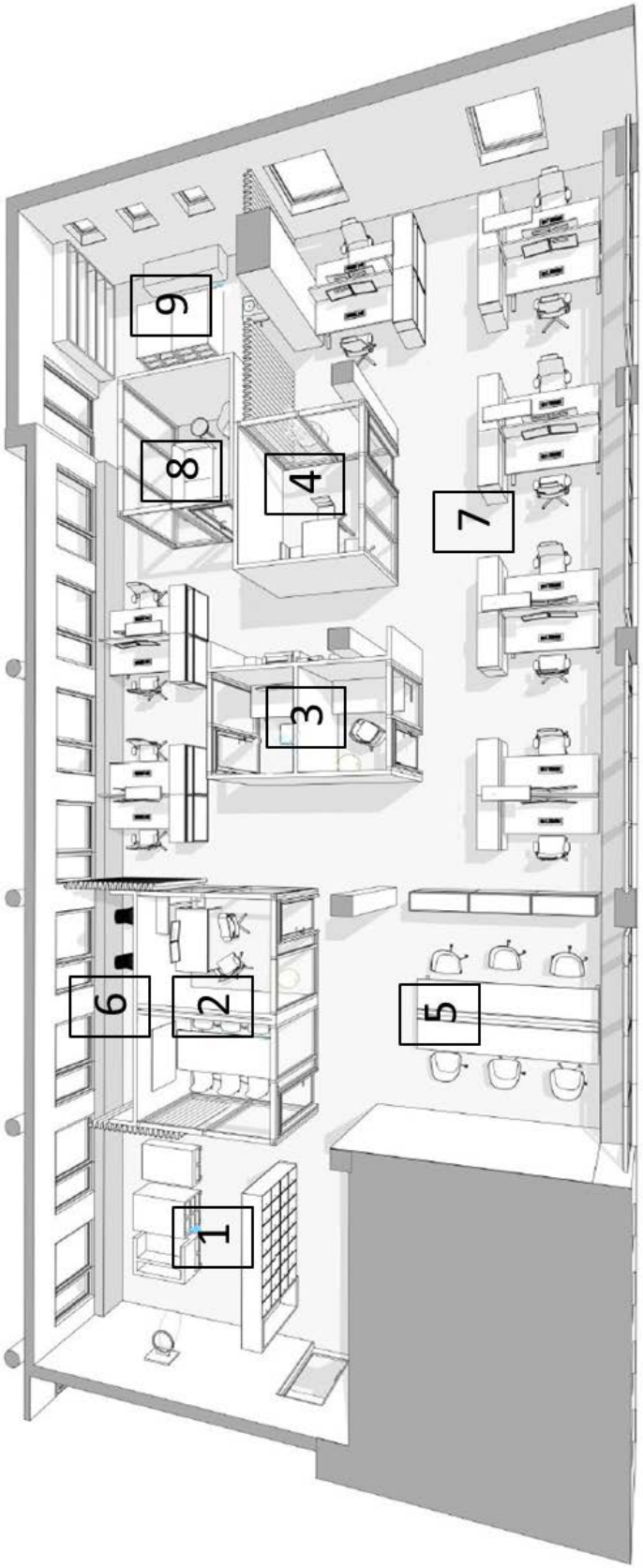
This study introduces corporate coworking spaces into the workplace literature as a new form of office environment and shows which factors affect satisfaction.

The results reveal that the physical environmental factors are most important for work satisfaction. This is in line with previous literature dealing with IEQ and shows that irrespective of whether a traditional workplace, new working environment or corporate coworking space is regarded, physical environmental factors explain the lion's variance in satisfaction (Haapakangas *et al.*, 2018). Hence, these factors can be used to predict satisfaction in coworking spaces. However, it is precisely these factors that are most difficult to configure for the individual. The second highest R^2 increase is contributed by the factor communication with a significant estimate at the 1- % level. Corporate coworking spaces thus unfold their potential through activity-based working and the various types of spaces associated with it. Since collaboration and concentration also have a significant effect, this indicates that informal meeting spaces, but also concentration spaces are valued high. Open spaces alternated with enclosed rooms dedicated to concentration work provide an appropriate mix for privacy and social interaction. As employees switch rarely between workspaces, this also implies that large open spaces should be avoided or subdivided in

smaller areas, for a low level of acoustics and higher privacy requirements. This is in accordance with extant research (Oseland, 2009; Brunia, Been, and van der Voordt, 2016). Although there are many different space configurations according to the ABW concept, we noticed that employees still prefer to use the same workplace and rarely change their workplace during the day. This is in contradiction to satisfaction, as Haapakangas *et al.*(2018) showed that a frequent change of workplace per day increases productivity and well-being. Practitioners can focus on developing strategies for motivating employees to find exactly the workplace that supports their work efficiently. Having workspaces to choose from might also give control over physical environmental factors, which enhances satisfaction. The coefficient of collaboration & social interaction has the lowest impact on work satisfaction (around a third as physical environmental factors), which was thought to be high in a coworking setting. On the one hand, this could be since the influence of collaboration in coworking spaces is overestimated by research. On the other hand, however, this influence could be rated low, as the typical collaboration characteristics, like after-work-events, collaboration apps and a community manger in this corporate coworking space are not present. It is possible that the solely spatial components may not be enough to support collaboration and might have to be accompanied by further activities. This calls for future research. Further research in the second development stage, after opening the workspace to external customers, start-ups and individuals, could capture the impact through collaboration, knowledge transfer and innovation in more detail and assess the differences in the before and after comparison, therefore additional follow-up data collection is required. An increasing share of corporates using existing coworking spaces require of the impact and benefits of these two forms of work environments.

APPENDIX

Appendix A: Exemplary Floor Plan



Nr.	Space Configuration Type
1	„Schoolyard“/Social interaction space
2,3	Meeting rooms/Think-Tanks
4	Concentration room/Phone booths
5	Work-bench
6	Bench/Short-term desks
7	Open-space flex desks
8	Lounge room
9	Creative corner and material storage

Extract from Floor Plan

Appendix B: Items of the questionnaire

Please rate on a scale of 1 to 5 the extent to which you agree with the following statements:

Item	Variable
The indoor climate is pleasant (e.g. temperature, air humidity)	Satisfaction with indoor climate
The lighting in the workplace is pleasant	Satisfaction with lighting
The working spaces are bright	Satisfaction with brightness
The work environment is well designed	Function as a feel-good atmosphere
The rooms radiate a feel-good atmosphere	Appealing space design
There are plenty of opportunities for spontaneous meetings (e.g. rooms, lounge furniture, retreat corners)	Rooms for ad-hoc meetings
Rooms are for spontaneous meetings sufficiently available	Ad-hoc meeting room availability
Rooms for spontaneous meetings are quickly accessible	Access to ad-hoc meeting rooms
There are enough rooms for scheduled meetings	Meeting room availability (for scheduled meetings)

There are enough withdrawal possibilities for spontaneous telephone calls	Possibility for withdrawal for phone calls
The working environment promotes internal communication	Satisfaction with overall communication
Concentrated work is often interrupted	Possibility for concentrated work
The background noise in the immediate working environment enables focused work	Background noises
There is a quiet work zone for concentrated work	Quiet work zones
Concentrated work is mainly interrupted through colleagues on the phone	Distraction of phoning colleagues
There are many visual distractions in the immediate working environment (e.g. through traffic)	Visual distraction
The flexible work environment ensures enough privacy	Privacy
The spatial conditions for phone calls are optimal	Spatial conditions for phone calls
The working environment supports the performance of the team	Team performance
The working environment supports a fast, professional exchange between colleagues	Collaboration supportive environment
The working environment supports cooperation and fast informal meetings	Fast, informal meetings/chats with colleagues
All necessary equipment is available (e.g. telephone, laptop, tablet, screen, printer, connections, beamer)	Work equipment
The available rooms including equipment and furniture support work optimally	Room equipment with furniture
The flexible work environment supports the teamspirit	Work satisfaction
Satisfaction with the sense of unity/belonging	
Satisfaction with the work environment	

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From Saint Jerome's study to workplace seismographs: The role of spatial layouts in decision-making speed across different industries

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ABSTRACT

Purpose: Strategy literature demonstrates the importance of fast strategic decision making to performance in dynamic industries. While some industries such as financial services operate based on decisions that take milliseconds, other industries such as academia are much slower paced and organise work within time periods of months or years. This paper investigates speed in relation to visibility arrangements in workplaces. It asks which potential for unplanned encounters arises out of spatial layouts and how those encounters in turn affect decision making speed.

Theory: Three main theory strands are brought together by this paper: firstly, the concept of industry clockspeed, which is used in management to understand the velocity of change in external business environments and how it relates to decision making speed in organisations. Secondly, space syntax theories as developed in architecture are employed to investigate visibility relationships in workplace layouts and the related affordances for encounter this creates. The concept of visibility acting as a 'seismograph' by creating awareness of what others are working on is elaborated on. Finally, theories of social networks and informal interactions are used to link management and space via a behavioural approach.

Design/methodology/approach: The conceptual ideas of the paper will be applied to a series of workplace layouts across different industries, including academia (slow paced), professional services such as law firms (medium paced) and the financial services industry (fast paced). Space syntax methods will be used to analyse the floor plans of the different organisations.

Findings: Findings suggest that floor plans generate encounter and awareness opportunities via the mechanism of visibility. Offices in high clockspeed industries were found to have significantly more integrated workplaces with higher levels of visibility. Nuances regarding required speed and the detailed role of layouts in mediating encounter opportunities are elaborated on. Spatial factors are found to be an additional and often overlooked resource when it comes to managing organisations. Spatial factors affecting strategic decision speed can be traded-off in favour of factors such as cost and privacy. Findings also show that the impact of spatial layout is particularly important in larger offices.

Originality/value: Speed of decision making is an increasing worry of companies observing how business environments become ever more fast-paced and volatile due to technological progress. Bringing this management angle together with a detailed architecturally informed analysis,

arguing that floor plans provide specific opportunities for business operations is a novel approach.

Keywords

Speed, Decision Making, Industry Clockspeed, Open-plan, Cellular Office, Informal Encounters, Space Syntax.

1 INTRODUCTION

This paper explores the possibility that office layouts might have an impact on strategic decision making speed. Office environments vary a great deal from the isolation of cellular offices typified by St Jerome's Study (see figure 1) to the frenzied, seismographic like, interaction possible on open-plan commodity trading floors (Tsen, 2001).

The competitive environments within which organisations compete are not all equally dynamic. Strategy literature identifies three ways in which industries change: rate (the frequency of changes) (Duncan, 1972; Williams, 1994), turbulence (unpredictability of industry change) (Fombrun & Ginsberg, 1990; Jurkovich, 1974), and magnitude (the size of the change) (Brown & Eisenhardt, 1997; Tushman & Anderson, 1986). This paper focuses on the rate of industry change because of its impact on the speed at which strategic decisions need to be made (Bourgeois & Eisenhardt, 1988; Fine, 1998).

Figure 1 **St Jerome's Study**, engraving by Albrecht Dürer (1514). Note the wall mounted clock in the background.

Industry clockspeed is a concept developed by Fine (1998) that measures the rate of industry change driven by external factors such as the intensity of competitive rivalry and the rate of technological developments (Porter, 1985). Fine identified three elements of industry clockspeed: product (rate of new product introductions), process (rate at which new process technologies need to be introduced) and organisation (rate of change of strategic actions) (Fine, 1998). In combination, these three elements reflect the rate of industry-level changes based on the aggregate of all the strategic decisions and actions taken across an industry, for example fast clockspeed in semiconductors and fast moving consumer goods but slow in shipbuilding and diamond mining (Nadkarni & Narayanan, 2007).

Industry clockspeed is important because organisations in high clockspeed industries need to make fast strategic decisions, which according to Eisenhardt (1989) resulted in superior performance in high clockspeed industries. By contrast, Fredrickson (1984) demonstrates that slower strategic decisions, that are analytically exhaustive, improve performance in low clockspeed industries.

These findings showed that the speed of strategic decision making needed to match the rate of change in the industry and where organisations fail to do so their performance is adversely affected (Judge & Miller, 1991; Robert Baum & Wally, 2003). This means that all organisations should be concerned with strategic decision-making speed, and with clockspeeds in all industries getting faster (Dedehayir & Mäkinen, 2011; Mendelson & Pillai, 1999) the number of organisations that need to be concerned about making fast strategic decisions grows over time.

Despite the importance of fast decision making speeds it must be noted that not all fast decisions will be good decisions. Indeed, it has been shown that fast decisions result in poor performance when relevant information gathering is sacrificed (Kahneman, 1982). This is what makes Eisenhardt's findings about the characteristics of organisations that made successful fast strategic decisions so compelling. Eisenhardt found that faster decisions resulted in organisations that considered more alternatives simultaneously and where people with industry experience were involved in the decision making process (Eisenhardt, 1989). This suggests that fast strategic decision making is done best when useful information can be processed quickly, in other words in the most successful companies, decision making is both "*fast and comprehensive*" (Robert Baum & Wally, 2003, p. 1109).

These findings have generated interest in the internal characteristics of organisations that have the capability to make successful fast strategic decisions. However, these studies tend to focus on the formal strategy-making processes of senior managers. For example, Baum and Wally show that faster strategic decisions tend to occur in organisations where strategic management is centralised and in more formalised organisational structures (Robert Baum & Wally, 2003). The underlying assumption here is that all strategy making is deliberate and carried out by senior managers. However, it is increasingly recognised in strategy literature that informal and unintentionally strategic decision making is particularly important in fast clockspeed environments (Chia & Holt, 2006; Mintzberg & Waters, 1985; Vaara & Whittington, 2012). This is because strategic decision making relies on the availability of information that is spread across an organisation, and often the most useful information exists in the periphery of an organisation (Regnér, 2003). In fast clockspeed industries strategic decisions need to be made where relevant information becomes available because it takes time for that information to travel to the centre of an organisation and be recognised as relevant in formal strategic processes. As a result, organisations making fast strategic decisions are characterised by evidence of unintentionally strategic decisions getting

made by people across an organisation in their everyday intuitive actions (Chia & Holt, 2006) in response to everyday problems (Tsoukas, 2015).

For these reasons, strategy-as-practice scholars have focussed research efforts on the everyday interactions of people across an organisation in order to understand how strategies emerge unintentionally. Each interaction may appear inconsequential (Cooren, Bencherki, Chaput, & Vasquez, 2015) but they accumulate to form strategically important patterns of action over time and this accumulation happens faster as frequency of interaction increases.

However, not any interaction is necessarily beneficial to strategic decisions, but research shows that frequent interaction across broad social networks improves the quality of ideas and real novelty in organisations (Burt, 1992; Padgett & Powell, 2012).

Research in architecture has shown that visibility in workplaces has a significant impact on who interacts with whom and how often. More integrated spaces were found to encourage greater frequency of interaction than more segregated spaces (Grajewski, 1993; Toker & Gray, 2008). This suggests that workplace design is an important factor in understanding the potential for fast strategic decision-making in organisations and we hypothesise that organisations in fast clockspeed industries will require more integrated space than those in slow clockspeed industries. However, we acknowledge that organisational workspaces are rarely (if ever) designed with strategic decision speed as the main objective. Rather, a variety of other objectives are used in designing office space such as cost (Chan, Beckman, & Lawrence, 2007) expressions of power and identity (Dale & Burrell, 2008), efficient processes (Peponis et al., 2007), and privacy (Kim & De Dear, 2013). These objectives may conflict with that of decision speed and for this reason, we look both at a large sample, but also select three organisations to understand more in-depth what compromises to strategic decision speed might have been made in pursuit of some of these other objectives.

In this paper, we test our hypothesis by comparing the office integration scores for workplaces employed by organisations in fast, medium and slow clockspeed industries.

2 METHODOLOGY

In this study, we use a large sample of 72 workplaces, all of which have been analysed in existing literature (Sailer, 2010; Sailer, Penn, & Marmot, 2012; Sailer & Pomeroy, 2016; Sailer, Pomeroy, Raheem, Budgen, & Lonsdale, 2012; Thomas, 2019) according to the degree of spatial integration of their office layouts, based on space syntax methodology. We collated information on size of the offices (number of floors, net internal area) but also the average mean depth of each workplace based on its visibility graph (Turner, Doxa, O'Sullivan, & Penn, 2001), which shows what can be seen at eye-level from every vantage point across the office (see figure 3). Mean depth (MD) is a metric describing the average number of turns (‘looking around the corner’) required to visually access all areas of a workplace from anywhere. We brought this together with an assessment of clockspeed based on the industries of the organisations, classifying them as slow (public sector organisations, universities, manufacturing, scientific organisations), medium (advertising, consumer goods organisations, law firms, consultancies, real estate companies) or fast (media, financial services and technology companies). Table 1 gives an overview of the data set. The average office in our sample is 2164 m^2 large, is spread across 2.4 floors and has an average mean depth of 4.15, which means that from any point in those offices, an average of 4.15 turns are needed to see every area. Minimum mean depth in the sample is 1.46 for a real estate

office, whereas the largest mean depth was found for a media company (MD=7.39). Differences in mean depth can be seen across the industries, however, the biggest variation in mean depth is an effect of floor area and numbers of floors, both of which increase levels of segregation naturally.

Table 1 **Overview of sample of 72 workplaces**

Industry	**# of offices**	**Clockspeed**	**Ave floor area [m²]**	**Ave # of floors**	**Min MD**	**Ave MD**	**Max MD**
Advertising	14	medium	2835	3.0	1.49	4.02	6.20
Consultancy	2	medium	2159	4.5	5.98	6.26	6.55
Consumer goods	2	medium	2307	1.5	2.15	4.24	6.32
Financial services	4	fast	1201	1.8	2.26	3.29	5.66
Law firm	2	medium	1753	4.5	4.60	5.11	5.62
Manufacturing	1	slow	2750	1.0	4.79		
Media	16	fast	2366	2.4	2.15	4.43	7.39
Public sector	21	slow	1099	1.9	1.74	3.75	7.36
Real estate	4	medium	571	1.3	1.46	2.88	4.54
Science / research	1	slow	6162	3.0	3.79		
Technology	1	fast	12600	3.0	3.97		
University	4	slow	3541	3.0	4.77	6.16	6.70
TOTAL	**72**	**---**	**2164**	**2.4**	**---**	**4.15**	**---**

In order to test the hypothesis that spatial integration of workplaces varies by clockspeed requirements of industries, we ran statistical models on the sample of 72 offices.

On the basis of this initial analysis three organisations were selected for a more detailed appraisal of the characteristics of the workplace in relation to speed of decision making and the strategic positioning of the organisation.

3 FINDINGS

3.1 Variances in workplace integration by clockspeed

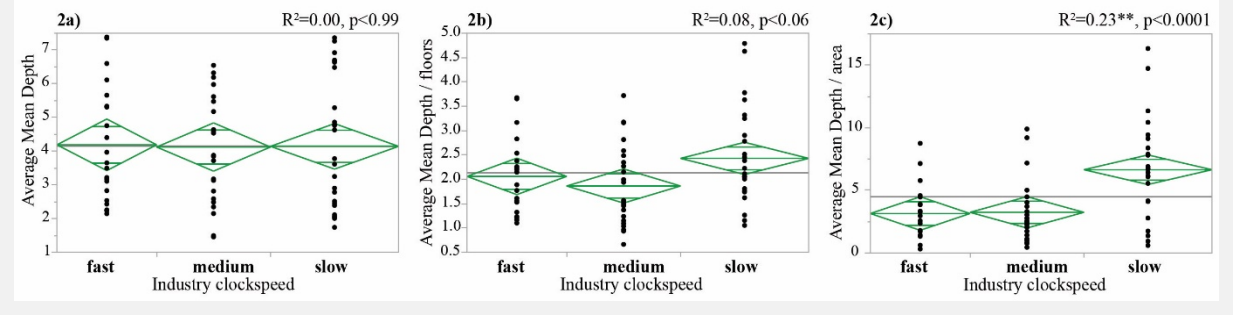
We undertook a statistical analysis of variance (ANOVA) to test for differences in average mean depth values between the three different clockspeed categories. Results (see figure 2a) show that mean depth in itself does not vary by industry.

Mean depth, however, is rather size-dependent: a least squares regression model explains 63% of the variance in mean depth by the numbers of floors, and mean depth varies by office size, too, since a linear regression predicts 16% of variance in mean depth by office area. Hence, we tested normalising mean depth for the further analysis. Dividing mean depth by numbers of floors ($MD_{N\text{-}floor}$) and using this in the ANOVA (see figure 2b) results in a clearer differentiation of mean depth by clockspeed, yet the analysis remains insignificant. Finally, we normalised mean depth by area[8] ($MD_{N\text{-}area}$) and found that clockspeed now indeed varies (see figure 2c).

[8] In order to obtain easier to handle values, we divided MD by area/1000.

As expected, fast clockspeed organisations had a lower average mean depth given their area, hence tended to occupy more relatively integrated layouts, while slow clockspeed organisations were accommodated in significantly more segregated layouts. Differences between medium and fast clockspeed were rather small.

Figure 2 **ANOVA of mean depth by clockspeed**. a) Mean depth; b) Mean depth normalised by number of floors; c) Mean depth normalised by area [in 1000m^2].



It is interesting to see that average mean depth did not show variances, yet normalised average mean depth by area did.

Because of the size dependency of mean depth, almost all large offices showed high mean depth values, no matter which industry and therefore clockspeed they were associated with. Normalising by floor was also not successful since the measure $MD_{N\text{-}floor}$ was still largely floor dependent, yet less so than the not normalised mean depth (least squares fit of $MD_{N\text{-}floor}$ against number of floors resulted in R^2=0.46**, p<0.0001). Normalising by area had an interesting effect: smaller offices now displayed a tendency towards larger normalised mean depth values. The top 15% of offices with the highest area-normalised mean depth were relatively small (mean area = 319 m^2) but showed significant amounts of partitioning, evident in relatively large mean depth values given their size (average MD = 3.19, average $MD_{N\text{-}area}$ = 10.74). Therefore, this metric of mean depth normalised by area seems to depict purposeful segregation in offices, achieved by deliberate partitioning. The floor plan of a media organisation (fast clockspeed) is shown in figure 3 below, highlighting how the workplace presents relative segregation ($MD_{N\text{-}area}$ = 8.76) in a small area (= 245 m^2) by partitioning but also to some degree by virtue of the character and shape of the floor plate.

Hence it can be summarised that the analysis confirms our hypothesis that organisations in fast[9] clockspeed industries tend to have more integrated offices than those in slow clockspeed industries.

This indicates that, on aggregate, organisations are adapting their office space to meet the strategic decision speeds demanded by their competitive environment. However, our data also shows that considerable variation exists within each clockspeed category suggesting that compromises to decision speed are also common. In the following sections we examine these possible compromises by exploring three of the organisations in our data set in more detail.

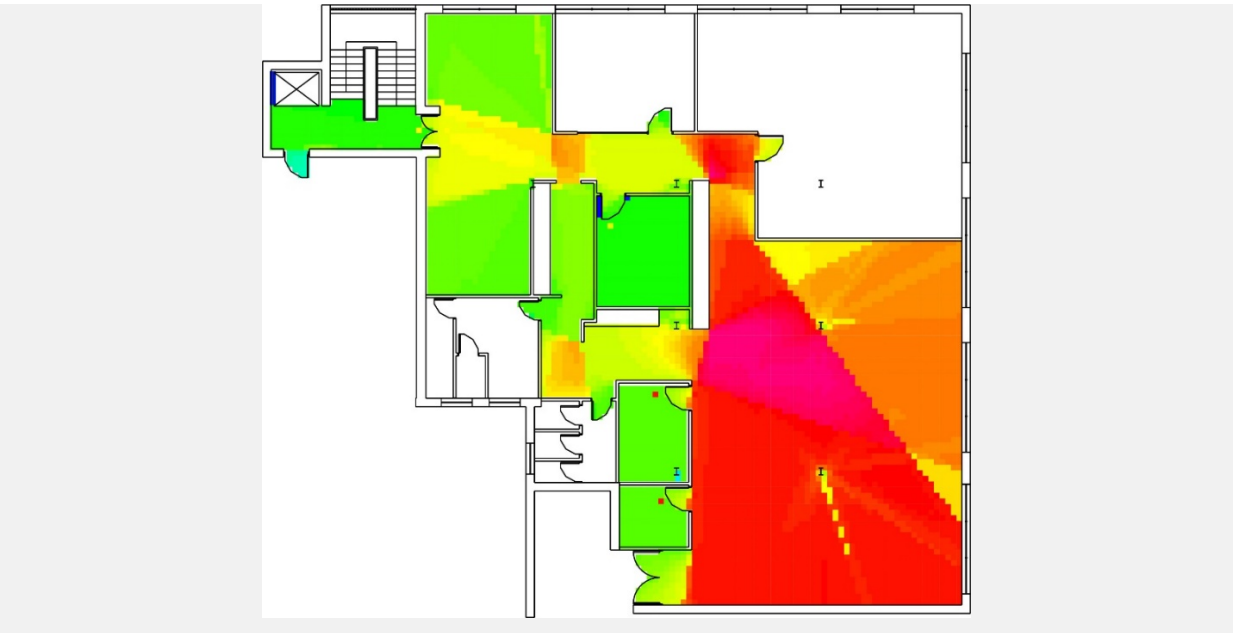
[9] Typically, the literature on clockspeed refers to fast and slow clockspeed only. As our results found no statistical difference between fast and medium clockspeed industries the remainder of the paper will refer to fast clockspeed only but our comments on fast clockspeed will also apply to the organisations we categorised as medium.

We selected three outliers for further investigation:1) an organisation with segregated offices in a fast clockspeed industry; 2) an organisation with integrated offices in a slow clockspeed industry and 3) an organisation with segregated offices in a slow clockspeed industry. The first two examples present cases where office integration and clockspeed do not match our hypothesis.

3.2 In-depth case study 1: Fast clockspeed in a segregated office

Our first case is an outlier in the above analysis. This is a small media organisation operating in a fast clockspeed industry, yet it is accommodated in a relatively segregated workplace layout. It has the highest average mean depth normalised by area in the fast clockspeed category.

Figure 3 **Visibility graph of a media organisation showing mean depth**. Areas marked in warm colours (red, orange, yellow) are integrated (low mean depth), whereas those in cool colours (green, turquoise, blue) are segregated (high mean depth).



Potentially, the relative segregation of this office makes fast decision making less likely because it would constrain frequent interaction between those developing strategic options simultaneously and hence result in slow decisions. However, this media organisation is small, with just 20 employees, all of whom are located in a single open-plan office with high levels of intervisibility (shown in red in figure 3). The relative segregation evident in the analysis occurs because the rest of the floorplan is partitioned into meeting rooms, a kitchen and a reception area. The reality is that because the organisation is so small, everyone in attendance in the office is likely to interact with everyone else, especially as all desks are arranged open-plan.

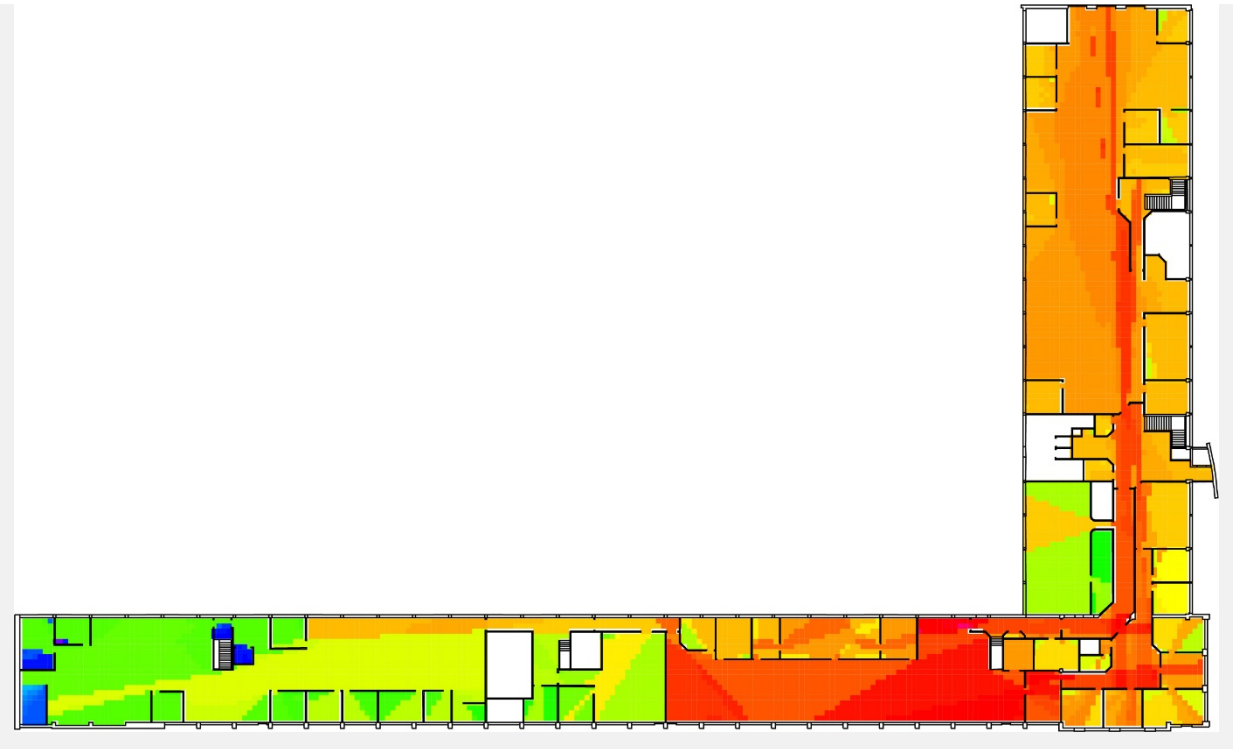
3.3 In-depth case study 2: Slow clockspeed in an integrated office

We are now considering the exact opposite case: an organisation in a slow clockspeed industry situated in a well-integrated office. As before this goes against our hypothesis.

This manufacturing business had moved from predominantly cellular offices to an open-plan design. The floorplan was arranged in an ‘L’ shape and senior managers retained cellular offices

that doubled as meeting rooms whilst the remainder of the office was open-plan where visibility was high although mean depth varied slightly depending on detailed location in the floorplan (see figure 4). The change in office layout was based on optimising space utilisation and had enabled the growing organisation to accommodate a larger number of people within the same office without the need for costly expansion of the premises. Although we do not have the data to demonstrate a performance consequence from this move, we are able to report on significant changes to working practices that resulted. The move away from cellular offices had removed a lot of potential meeting space that had not been replaced with alternatives. In the deliberate processes of comprehensive analytical decision making, many formal meetings were used to progress strategic options and to communicate the analysis. In the newer open-plan offices, existing bookable meeting space was always fully booked, and much frustration was evident that meeting space was not readily available. To replace these more formal meetings informal 'gatherings' around open-plan desk clusters started to become more frequent.

Figure 4 **Visibility graph of a manufacturing business showing mean depth**. The colour scheme is comparable to figure 3.



3.4 In-depth case study 3: Slow clockspeed in a segregated office

Our third example is of an academic institution, a slow clockspeed industry, that has segregated offices due to a cellular layout (see figure 5).

It is our experience that academics value the peace and quiet of a segregated cellular office space because it gives them the privacy for concentrated work. Our third example is segregated ($MD_{N\text{-}area}$ = 6.19), precisely because the academics have cellular offices in the floorplan studied. This is an example of a good match between the clockspeed of the industry and the impact of the

floorplan on decision making speed. However, we have selected it as an example for further investigation because we think there may be hidden trade-offs.

Figure 5 **Visibility graph of one floor of a university building showing mean depth**. The colour scheme is comparable to figure 3.

All trade-offs as well as the match between clockspeed and workplace layout will be discussed together in the following.

4 DISCUSSION

Reflecting on the overall analysis and the three in-depth case studies, two separate points are worth making in this discussion. First, we consider the fit between industry demands on fast or slow decision making with workplace layouts.

Fast clockspeed industries are where fast decision making is most critical and we have argued that integrated offices aid that fast decision making. One of the key reasons for this is that Eisenhardt (1989) showed that successful organisations in fast clockspeed industries consider more (not less) strategic options simultaneously. This, in our view, makes it essential that there is widespread and frequent interaction between those developing alternative options.

Putting our media organisation into the context of Eisenhardt's analysis, its relative segregation is no constraint on fast decision making because of the size of the organisation. In fact, all three cases shown in figure 2c that fall above the mean in the column representing fast clockspeed industries are amongst the smallest in our sample.

In contrast to these small organisations, firms with larger numbers of employees that compete in fast clockspeed industries, such as the big tech giants, cannot expect widespread and frequent interaction with no help from the office layout. In our sample, we have no examples of large organisations in fast clockspeed industries with poorly integrated offices. We think it is possible that as organisations in fast clockspeed industries grow, they have to have more integrated spaces to survive.

A second reflection we want to offer is on potential trade-offs. Workplace design might suit an organisation in some of its processes and strategies but could be detrimental to other organisational goals. Our case studies two and three offer important insights here.

The manufacturing business is operating in a slow clockspeed industry, typically gaining a performance benefit from slower strategic decision making (Fredrickson, 1984). Since they compete in an environment where speed is less of an issue competitively, these organisations can make sure decisions are made after exhaustive and inclusive strategic analysis. This means that offices do not need to be well integrated, however that was the case here. Potentially this can put the (successful) slow, considered, strategic decision making at risk, replacing it with a more intuitive decision making that the literature suggests might undermine strong long-term performance; possibly an unplanned consequence of a decision about workspace that focussed on cost rather than decision making speed.

A similar trade-off might apply to our university example. The segregated structure of cellular offices supports a wide range of activities such as marking, writing research papers, private interaction with students etc. However, the segregation would not support the sort of broad and frequent interaction necessary for innovation and real novelty (Burt, 1992; Padgett & Powell, 2012). Mintzberg argues that universities do not need to innovate strategically (Mintzberg, 2007) because they compete in very stable environments. However, we would argue that innovation and real novelty is the essence of research and think that the environment found in this university may stifle this type of innovation. It is possible that this innovative work is not actually done within the workspaces provided by the university, but rather academics leave their university to attend conferences and co-author with academics from other universities.

This raises another important question about this study, the extent to which organisation work is done outside of the physical boundaries of the organisations' buildings.

5 CONCLUSION

This research has shown that organisations in fast clockspeed industries tend to have very integrated workspaces and organisations in slow clockspeed industries have more segregated workspaces. We have suggested that this is the case because of the impact of workspace on strategic decision-making speed.

Further research is needed to investigate in more depth how organisations balance decision-making speed and strategic development with other requirements on their workplace layout such as cost, privacy, innovative capabilities, etc. and how significant layouts are to decision making speed. Studying examples of successful and struggling organisations would be insightful. Focussing on one particular industry such as technology companies would also be a worthwhile endeavour.

We suspect few organisations factor in strategic decision-making speed into their decisions about workspace layout, but we would suggest that their long-term performance may depend on this.

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Workplace design for social well-being: a conceptual model and research strategy

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ABSTRACT

Purpose: The covid-19 pandemic has increased awareness of office workers' need for real-life social interaction, connectedness and belongingness at work. The purpose of this paper is to present a way to study this important, but still under-examined, social dimension of employee well-being in relation to workplace design. A conceptual model outlines how the physical work environment might support or inhibit perception and behaviour related to social well-being of individual office workers. A research strategy is presented to develop a framework for guiding the design of workplaces.

Theory: Several well-being theories consider relatedness a basic human need. Fulfilling this need requires satisfying social interactions, leading to positive relationships and feelings of belonging. Spatial characteristics could encourage or discourage social interaction by influencing natural movement, visibility and privacy. In the workplace social interaction can be a support as well as a burden, depending on, for instance, privacy preferences and work activities. Therefore, the conceptual model presented here includes spatial characteristics encouraging or discouraging social interaction as well as the employee's perception, behaviour, personal and situational factors.

Methodology: First, workplace design and social well-being are defined and their relationship is depicted in a conceptual model. Subsequently, a mixed-methods approach is proposed to develop this model into a framework of relationships between specific workplace design elements and components of users' social well-being. The proposed research strategy starts with an exploratory phase of additional literature study, analysis of case-study data, and pilot studies to identify parameters and try out methods. The subsequent phase of main data collection and analysis includes (a) a large-scale quantitative study using statistic modeling to identify significant relationships between outcome and predictor variables, and (b) a series of field experiments applying empirical research through design for studying ways to manipulate key predictors of social well-being using design interventions. The third phase synthesises the findings and translates them into a framework to guide workplace designers and other stakeholders.

Findings: The model states that workplace design influences social well-being through actual and perceived affordances and behaviour, influenced by organizational and personal factors. Therefore it is acknowledged that measures for both the actual and the perceived work environment need to be developed. Similarly, measurement of both actual and perceived social interaction adds value to the insight in the relationship between workplace design and social well-

being. Collecting data in real-life settings in contemporary offices will enhance the internal and external validity of the framework.

Originality/value: The concept of social well-being at work has not yet been well defined and studied in a comprehensive and systematic way, nor has it entirely been connected to actual and perceived characteristics of the physical work environment. This paper makes a start with unravelling the complex relationship between workplace design, social interaction and social well-being, and offers a framework and practical suggestions for further research.

Keywords

workplace design, employee well-being, social interaction, mixed methods

1 INTRODUCTION

Health and well-being at the workplace are widely promoted (Groen, Jylhä, & Van Sprang, 2018; Schawbel, 2016; World Green Building Council, 2014), and the covid-19 pandemic has created a new momentum for this topic. Already before the pandemic healthy-building certifications were selling, unhealthy snacks were being banished from the canteen, and the "sitting is the new smoking" slogan was pressuring office workers to work standing up. However, the evidence base and effectiveness of such interventions often remains unknown (Reinders & Beckers, 2018). Meanwhile, burnout, an occupational phenomenon caused by chronic stress (WHO, 2019), is on the rise (Hooftman et al., 2019; Van der Molen et al., 2018). This situation creates a need for effective interventions decreasing stress and increasing resilience and happiness at work.

Enhancing positive social interaction and fostering connectedness could well be such an intervention. The importance to health of social interaction and relatedness has been widely recognized (Deci & Ryan, 2008; Diener & Seligman, 2004). At work, for instance, positive relationships are associated with feelings of vitality (Carmeli, 2009) and self-rated health (Oksanen et al., 2008), and social support is known to buffer job stress (Schaufeli & Bakker, 2004). On the other hand, studies show that unwanted or negative social interaction in the workplace decreases office workers' well-being (e.g. Ashkanasy et al., 2014; Kim & de Dear, 2013; Schilpzand et al., 2016). Methot, Rosado-Solomon, Downes, and Gabriel (2020) found that small talk at work was experienced as uplifting, enhancing positive emotions and sense of community, yet disrupting concentration work. This indicates that interaction time and location might play a role.

The physical work environment is crucial for the nature, quality and duration of employee social interactions at work (Ayoko & Ashkanasy, 2020). Several researchers argue that the physical work environment is capable of supporting or constraining relationship building (Khazanchi, Sprinkle, Masterson, & Tong, 2018; Wohlers & Hertel, 2017). However, in research on healthy offices social aspects of well-being tend to be underexposed (Colenberg, Jylhä, & Arkesteijn, 2020). There are several studies on social interaction related to workspace layout, but they focus on mapping and predicting location of social interaction without collecting data on the relationship with employee well-being (e.g., Appel-Meulenbroek, de Vries, & Weggeman, 2017; Sailer & McCulloh, 2012; Weijs-Perrée, Buck, Appel-Meulenbroek, & Arentze, 2019).

During the covid-19 pandemic many workers wanted to return to the office, main reasons being meetings with colleagues, socializing with people, and impromptu face-to-face interaction

(Gensler Research Institute, 2020). In recent years, organizations have become to realize that social interaction at work is important for well-being and creativity-based innovation, and that workplace design might be capable of supporting relationships (Schawbel, 2017). At the same time, open-plan offices have been getting a bad press due to distractions caused by social interaction, but if designed properly, they might have a positive influence on relationships (Morrison & Smollan, 2020). This shows the need for knowledge about the social well-being enhancing potential of workplace design to guide workplace designers and their commissioners in their decisions. Therefore, this paper presents a mixed-method research approach to find out how workplace design affects office workers' social well-being and in what ways workplace design could be used as a means to enhance social well-being.

In the next sections, first social well-being at work and its possible enablers in the physical work environment are defined, followed by a conceptual model depicting their relationship and the possible influence of other factors. Second, a research strategy is proposed to further develop and validate this model into a framework for guiding the design of office spaces that support social well-being.

2 SOCIAL WELL-BEING AT WORK

Individual subjective well-being consists of several interrelated and hierarchically structured components, one of them being the interpersonal dimension called social well-being (Gallagher, Lopez, & Preacher, 2009; Grant, Christianson, & Price, 2007; Page & Vella-Brodrick, 2009). Fisher (2014) defines social well-being at work as "feeling embedded in meaningful communities and having satisfying short-term interactions and long-term relationships with others." The first part of this definition refers to the experience of purpose and social significance (Ryff & Keyes, 1995; Turban & Yan, 2016), fulfilling human's innate need to belong (Baumeister & Leary, 1995). Feelings of belonging are created by positive relationships (McMillan & Chavis, 1986) and shared emotions (Blatt & Camden, 2007), and are influenced by personality (Malone, Pillow, & Osman, 2012) and depression symptoms (Cockshaw, Shochet, Obst, & Cockshaw, 2014). The negative opposite of belongingness is feeling detached, excluded or rejected. The second part of Fisher's social well-being definition refers to social interactions, either as incidents, or as a sequence, creating and maintaining relationships (Hinde, 1976). This means that social well-being can be considered a dimension of long-term individual well-being that originates from short-term social interactions.

Contemporary offices, applying mere open-plan, zoned open-plan, team-based, and activity-based office concepts (Pitchforth, Nelson-White, van den Helder, & Oosting, 2020), increasingly feature open workspaces and desk-sharing. These characteristics impose specific demands on their users' social well-being. Loss of ownership due to desk-sharing could lead to emotional reactions and conflicts (Ayoko and Härtel, 2003; Brown and Robinson, 2011) and limits to workspace personalization could impede feelings of belonging (Brunia & Hartjes-Gosselink, 2009; Wells, 2000). Among people working in open-plan workspaces satisfaction with regulation of social interaction is lower (Budie, Appel-Meulenbroek, Kemperman, & Weijs-Perree, 2018; Oldham, 1988). Haapakangas, Hallman, Mathiassen, & Jahncke (2019) found a decrease of belongingness and social support among office workers who moved into an activity-based office. On the positive side, spatial openness and mobility are perceived to increase opportunities for connecting with colleagues (Engelen et al., 2019; Kim & de Dear, 2013; Sailer & McCulloh, 2012). However, it is not clear yet when and how these opportunities actually lead to an increase

of desired interaction. As De Been, Beijer, and Den Hollander (2015) noted, despite the increased satisfaction with communication opportunities, occupants of activity-based offices experience a lack of communication with direct colleagues and privacy for personal conversations. Additionally, covid-19 prevention measures in the post-lockdown offices will arguably affect social interaction in different ways. All this means that a more detailed research approach to both wellbeing and workplace design is required to gain applicable insights about how to create social wellbeing supporting workplaces.

3 WORKPLACE SOCIAL AFFORDANCES

As positive social well-being results from positive social interaction, to support employees' social well-being workplace design should enable and encourage this positive social interaction – and prevent negative social interaction – as much as possible. In this paper, workplace design refers to the planning and design of interior office space, using space, furniture, finishes, lighting, accessories and technologies to realize the desired functional and aesthetic qualities (Ching & Binggeli, 2018).

The possibilities for social interaction that the workplace offers to users could be considered social affordances. The term 'affordance' was first coined by the ecological psychologist James Gibson (1979, p.127) who defined it as "what it [the environment] offers the animal, what it provides or furnishes, either for good or ill." Since popularization of the affordances concept by Norman (1988), different understandings of the concept have widely spread in the design community. In this paper an affordance is considered the utility or functional purpose (usefulness) of a design, recognizing that the degree of usability may vary depending on perceptual information and the ease to undertake the action (McGrenere & Ho, 2000).

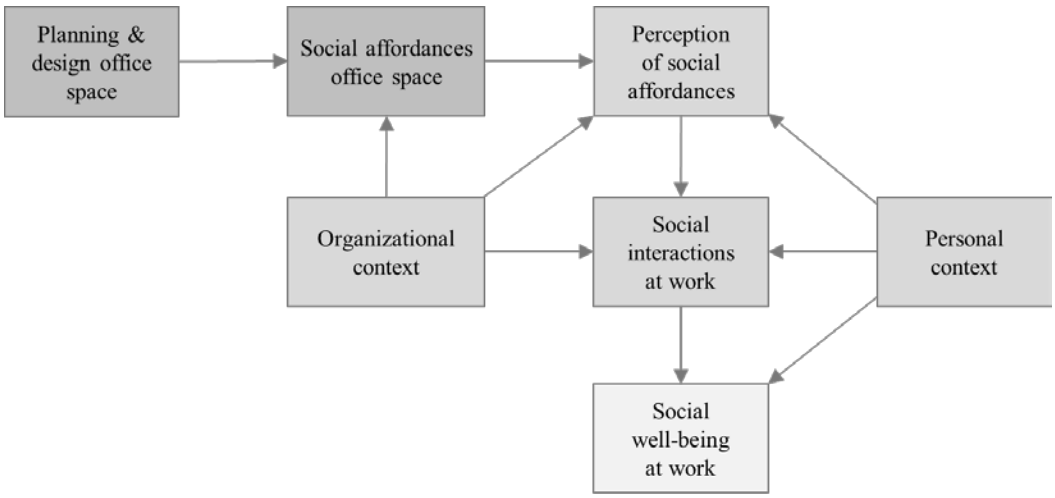
Examples of workplace social affordances include coffee bars and food spaces, and opportunities for playful engagement such as games, comics on the wall, and kitchen facilities, as well as workspace personalization and physical assimilation or segregation of teams (Spreitzer, Bacevice, & Garrett, 2020). Creating ways of , and other ways to create social distinctions and boundaries to strengthen the sense of belonging. Communicating spaces share important information about the people who use it and provide opportunities to socialize (Augustin, 2009, p.21). Fayard & Weeks (2007) showed that water-coolers could promote informal social interaction. Another source for defining social affordances is Space Syntax, a method and theory assuming that space grants or inhibits access to others and control over social interaction (Hillier, Hanson, & Peponi, 1984). This has been confirmed by Sailer, Koutsolampros, Austwick, Varoudis, and Hudson-smith (2016) showing that face-to-face interactions in the workplace are mediated by the structure of the office layout.

In summary, research on the influence of workplace design on social well-being, which is considered to result from social interactions, should focus at social affordances, that is, workplace characteristics that are known or perceived to facilitate, invite, or encourage positive social interactions in the office.

4 CONCEPTUAL MODEL

The following conceptual model outlines the main factors assumed to be in play in the relationship between workplace design elements on the one hand and social well-being at work on the other.

Figure 1. Conceptual model of the assumed relationship between workplace design and social well-being



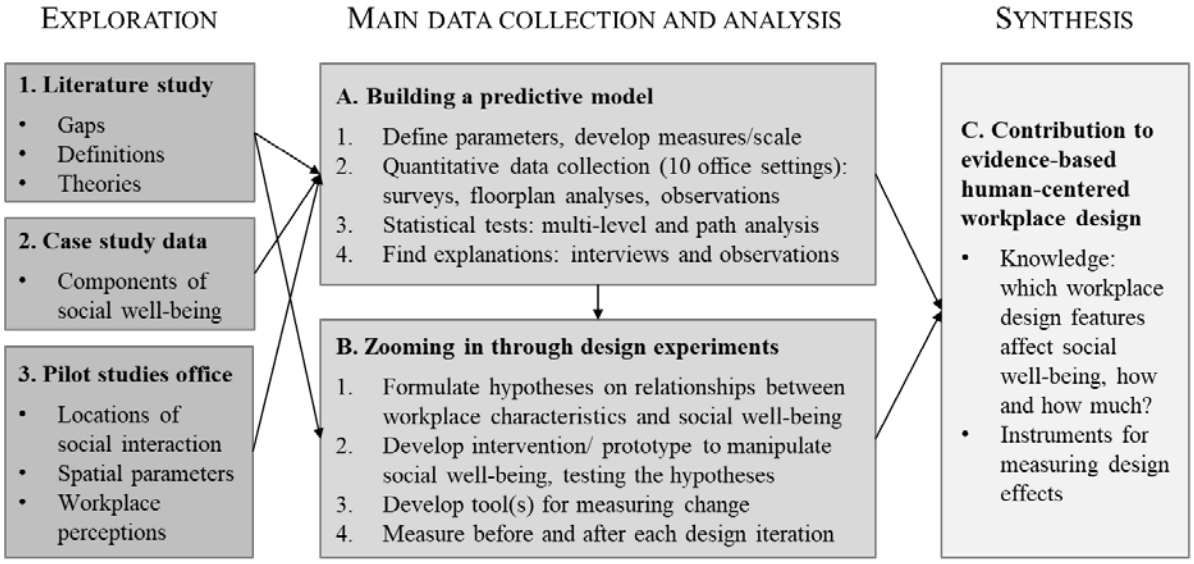
Starting with the output of the model, individual social well-being, as argued in section 2, results from social interaction and is influenced by personal context. Social interaction in the office could be 'live' interaction with others, from co-presence to conversations, or mediated through visual messages in the office space communicating values and identity. The input factor of the model, the planning and design of the interior office space, may enable or inhibit this social interaction by (1) its designed opportunities and restrictions for social interaction, called social affordances, (2) the perception of these affordances by the users, e.g. their recognition of the usability for social interaction and the easiness of use, and by (3) organizational context, such as desk-sharing, a clean-desk policy restricting possibilities for personalization, and covid-19 prevention measures regulating office space use.

In accordance with the positioning of Vischer (2008) between environmental determinism and social constructivism, the conceptual model implies that workplace design itself does not determine human behaviour, nor does social context. As depicted by Gifford (2014, p.341), perception and experience of the workplace is influenced by worker characteristics, physical work setting and work policies. This perception including psychological processes such as arousal, personal control and affect, shapes outcomes such as behaviour and well-being. For instance, the presence of other people in the workspace can be perceived as pleasant or annoying, depending on conditions such as job stress, complexity of the task, privacy preferences, previous experience and social norms. If perceived as unpleasant, the co-presence can lead to feelings of crowding, which in turn can lead to coping mechanisms such as defensive territorial behaviour (Brown & Robinson, 2011) or social withdrawal (Evans & Wener, 2007; Steg, Van den Berg, & De Groot, 2013, p.31).

5 RESEARCH STRATEGY

To further develop and validate the conceptual model and translate it into a design framework, the following approach is proposed (fig. 2). It starts with exploring the topic by (1) literature study to capture the state-of-the-art and existing measures, (2) analysis of case-study data of perceptions regarding social interaction in contemporary offices, to identify components of social well-being at work as a first step in scale development, and (3) conducting pilot studies on measuring workplace perceptions, mapping social interactions, and methods for spatial analysis.

Figure 2. Proposed research strategy for developing a design framework



Based on the exploration, the further development of instruments and the subsequent collection and analysis of data could follow two tracks:

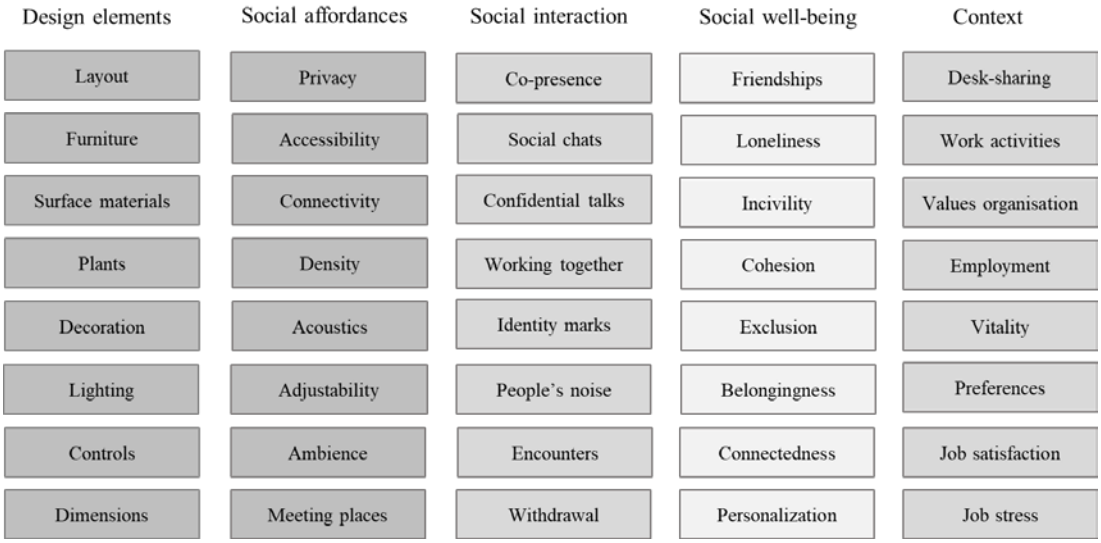
A) building a predictive model based on quantitative data collected in different office settings, to find statistical significant patterns in the relationship between workplace design and social well-being that could support design decisions;
B) field experiments using design interventions to validate key relationships between specific design elements and aspects of social well-being, while translating them into design practice.

In the next sections both tracks are further explained. Their synthesis (C) will generate evidence on how workplaces could support social well-being of its occupants, as well as examples of how to apply this knowledge.

6 PREDICTING SOCIAL WELL-BEING FROM WORKPLACE DESIGN

Construction of a predictive model first requires identification and quantification of relevant parameters. In the presented conceptual model these concern workplace characteristics, components of social well-being, possible relevant personal and job-related circumstances, and a classification of relevant social interaction and its locations. Figure 3 shows examples of parameters for each of the factors in the conceptual model as presented before.

Figure 3. Examples of parameters for constructing a predictive model



Second, instruments for collecting the quantitative data need to be developed, for instance, an online questionnaire, or tools for behavioural mapping (Fan Ng, 2016) or experience sampling (Csikszentmihalyi & Larson, 2014; Weijs-Perrée et al., 2019). A scale that captures social well-being components salient to workers in contemporary offices could be developed following the suggestions of Boateng, Neilands, Frongillo, Melgar-Quiñonez, and Young (2018), including both item deduction from existing scales addressing social aspects of well-being at work, and induction of items by exploring empirical literature and case studies. The operationalization of workplace features in recent research by Babapour Chafi, Harder, & Bodin Danielsson (2020) and Weijs-Perrée et al. (2019) on user preferences can serve as a source for operationalisation of socially relevant workplace features.

Patterns in office workers' perceptions and well-being can be identified with advanced statistical techniques such as Structural Equation Modeling (Ullman & Bentler, 2013) and developing Bayesian belief networks (Nyberg, Marcot, & Sulyma, 2006). Multilevel modelling is required to investigate the relationship between actual office setting characteristics and perceptions of workers nested in those office settings. These techniques require measurements at continuous or discrete level, such as ratings on Likert scales. To be representative of an office worker population of several million people, the sample should be based on approximately 400 respondents, given a 95% confidence interval.

7 ZOOMING IN THROUGH DESIGN EXPERIMENTS

To further strengthen the external validity of the statistical model, as well as demonstrate a way in which it can be applied, several key relations in the model could be examined via Empirical Research Through Design (ERTD) (Keyson & Bruns Alonso, 2009), testing effects of design interventions manipulating social interaction in field experiments.

The ERTD method involves the following steps (Keyson & Bruns Alonso, 2009).

1. Inducing design hypotheses on relationships between outcome and predictors from literature, available research data, and possible additional research.
2. Designing an intervention, e.g. a prototype or mock-up, to manipulate the outcome by changing the predictors.
3. Several rapid iterations of systematically testing use and effect of this intervention in pilots with a small group of users, reflecting on the design process, improving the intervention and refining the hypothesis.
4. Testing the final hypothesis in a field experiment, before and after applying the intervention or comparing the outcome variable between the user group and a control group, using quantitative measures and statistical testing.

Since relationships and feelings of belonging take time to develop and change, the field experiments focus on manipulation of short-term social interactions between people present in the office, for instance while sharing a workspace, using a facility, or when running into each other. The focus could be on enhancing face-to-face interactions, because this has a more positive influence on mood than digital interaction (Mark, Iqbal, Czerwinski, & Johns, 2014). Furthermore, in case timespan and budget of the research do not allow structural changes in the office space layout and design, such as bringing down walls or replacing furniture, the interventions could target a specific area using temporarily changes on a small scale.

Drawing upon the review of social interaction enhancing technologies of Olsson et al. (2020) the interventions' objectives could be, for instance, triggering people to interact (at the right places), facilitating ongoing social situations, supporting a sense of community, or avoiding cocooning in social silos. The Mood Squeezer of Gallacher et al. (2015), for example, was designed to open up a traditional office featuring closed rooms along a corridor. The playful intervention invited people to express their mood by squeezing a ball in a box, and aggregated the results as a colourful visualization on a public floor display, leading to a diversity of conversations throughout the office building.

Specific measures need to be developed to record the quantity and quality of social interactions before and after the intervention, and possibly at the same time in a control group, for instance occupants of two floors identical in their layout and operational function. Means of measurement could be (a combination of) users' self-reporting through short surveys or experience sampling, or manual or automated observations, e.g. by a sensor built into the prototype. Two-sided unpaired t-tests can be used to compare baseline social interaction (e.g. mean frequency, rating) between the control and intervention groups. Within-group changes can be ascertained by comparing means before and after the intervention using two-sided paired t-tests.

8 CONCLUSION

In response to current trends on healthy offices, previous research, and the current situation of the covid-19 pandemic, this paper acknowledges the need for gathering more knowledge on the potential of workplace design to enhance office workers' social well-being. It presents a conceptual model in which elements of the interior design function as social affordances, influenced by organizational policies. Office workers' recognition of these affordances and policies is assumed to influence their actual or perceived social interaction, which in turn will shape their social well-being, influenced by personal circumstances. Collecting a large amount of

data on employee perceptions, circumstances, behaviour, and well-being enables construction of a predictive model showing patterns in the relationships between workplace design elements, social well-being and mediating or moderating factors. Field experiments measuring the effect of design interventions that manipulate social interaction in the office can show in what ways workplace design be used as a means to enhance social well-being.

The research results and instruments will support evidence-based design (Hamilton & Watkins, 2008, p.29), a goal-oriented practice of predicting and systematically measuring outcomes of design decisions, based on the use of the best available knowledge. Knowledge on the relationship between specific interior design features and social aspects of employee well-being, and the factors in between, enables workplace managers, either from the perspective of facilities or human resources, to make educated decisions on modifications of the physical work environment. For example, how to balance hygiene interventions or requirements for concentration with the need for face-to-face interaction. Addition of qualitative research on the mechanisms behind the statistical pathways, explaining why employees' social well-being is affected by certain design features, could provide new directions for research and human-centered design in this area.

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SESSION 7: CREATING COLLABORATIVE SPACES

Shaping Shared Workspaces for the Creative Industries: Insights and Remarks from a Living Lab Field Research

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ABSTRACT

Based on a living lab-field research in the context of the artist settlement Halfmannshof in Gelsenkirchen, Germany, the given article is going to explore the professional needs, requirements, and preferences that should be taken into account when designing shared workspaces for artists and professional creatives. From a user-centered design approach, the given insights are intended to help practitioners to design workspaces and underlying business models that properly address the needs of creative entrepreneurs.

The article provides an overview of early-stage findings from the ongoing research project */futureWork*.

The research design follows the living lab-approach that locates applied science research close to the real-world setting of potential user groups. To do so, a living lab for digitally enhanced creative work was set up in the artist settlement Halfmannshof in Gelsenkirchen. The research activities aim to develop and test new digital tools to support creative workflows and collaboration as well as to create suitable business models to successfully run technologically enhanced, shared workspaces. The given article focuses on the latter aspect of business model development.

Guided by practice-orientated literature on business model design, qualitative data obtained by ethnographic observations and topic-centered interviews is used to draw conclusions about user needs that can be addressed by spatial or technological infrastructures. The analysis of the acquired data material allows to develop three relevant arguments from which specific design requirements can be indirectly derived.

1. Creative professionals combine different space offers in a context-specific and situational way to successfully organize their work.

2. In creative industries supplier-customer relationships can be often characterized as collaborative processes. In this context techniques of visualization and prototyping play a key role in order to enable joint efforts of different stakeholders involved.

3. The use of digital technologies is highly dependent on individual preferences and specific ways of working. Beyond that, examples show that digital and analogue media is used complementary to utilize the respective advantages of both.

The given insights can be seen as a contribution to strengthen a user-centered design approach in the field of shared workspaces. The results provided are intended to support private and/or public practitioner's activities in developing for example coworking-spaces or Creative Hubs that address the real needs of professional creatives. This does not only consider creative knowledge workers but also those who work in the fields of performing arts, visual arts, filmmaking, and others.

Keywords

Coworking, Creative Industries, Collaboration, Prototyping, Customer Needs

1 INTRODUCTION

As it turned out to be a constantly growing economic sector, the creative industries have received increasing political and scientific interest over the last decades. At the level of regional planning efforts, a vital creative industry is considered a lever for initiating positive economic development. The sector, whose economic activities are often closely intertwined with development processes of innovative products and services in traditional economic sectors, is regarded as a catalyst in the transformation towards an advanced economy of knowledge (see Arnd et al. p. 3). In this context, there is currently a growing interest on the part of public actors in how to strengthen creative economic ecosystems on a local level.

In order to gain an empirically founded understanding of the positive factors influencing the creative industries` value creation processes and to show ways of strengthening creative industries' activities, the Westphalian University of Applied Sciences, together with the Cultural Department of the City of Gelsenkirchen (a former industrial city in western Germany), has launched the research project */futureWork*.

The research activities aim to develop and test new digital tools to support creative workflows and collaboration as well as to create suitable business models to sustainably run shared workspaces for professional creatives. The research project follows the idea of a user-centered design, which puts a profound analysis of the potential user groups, their sociocultural environment and their everyday needs, requirements, and preferences as a crucial step for promising design activities (e.g. see Sanders 2002). In order to gather such insights, a so-called living lab for digitally enhanced creative work has been set up for three years in the artist settlement Halfmannshof in Gelsenkirchen.

This paper aims to provide a preliminary, highlighted overview of the results obtained in this context. It is hoped that the presented qualitative findings will provide a better understanding of contemporary organizational and working practices in the field of the creative industries, and that valuable impulses for the practical design of suitable workspaces can be derived from them.

With the focus on user needs chosen here, the intention is to show a productive intermediate path that neither succumbs to the temptation of presenting an apparent one-fits-all solution nor to the empty statement that concrete solutions must always be designed on the basis of unique local conditions.

2 CHARACTERISTICS OF CREATIVE INDUSTRIES

The concept of Creative industries (in German “Kultur- und Kreativwirtschaft”) functions as a collective term for heterogeneous economic segments. The creative industries thus cover all “[...] those companies which [...] are involved in the creation, production, distribution and/or media dissemination of cultural or creative goods and services (BMWI 2019 p. 3).”

Among the actors subsumed under this collective term - hereinafter referred to as professional creatives - are "authors, filmmakers, musicians, visual and performing artists, architects, designers, developers of computer games - and also those who can hardly be 'accommodated' with their business ideas and products in the classic sectors (BMWI 2016 p. 2)." According to the definition that was adopted by the Conference of Economic Affairs Ministers in 2009 the German approach of classifying creative industries covers the eleven sub-markets music industry, book market, art market, film industry, broadcasting industry, performing arts market, design industry, architecture market, press market, advertising market and software/games industry (see BMWI 2019, p. 3).

The creative industries are structurally characterized by a high proportion of self-employed, small and micro-enterprises. This organizational structure is accompanied by a high, situational - and often informally organized - level of cooperation and networking activity, with the help of which the various players in the creative industries acquire and fulfil customer orders (Engstler et al. 2015, p. 24). In this context, complementary know-how and competence profiles are often applied to create highly individual customer solutions.

3 CONTEXT AND METHODOLOGICAL APPROACH

The idea of living lab-research has its roots in transformatory research. This line of research is dedicated to contributing to the solution of concrete challenges which are articulated in the researched fields. To achieve this, research activities are, on the one hand, embedded as closely as possible in the real-world setting of potential user groups. On the other hand, research has an intervening role, working closely together with the stakeholders involved (see Schneidewind/ Singer-Brodowski 2014; Wagner/Grundwald 2015).

Under the benevolent support of the local administration, the Halfmannshof was founded in 1931 as an artists' colony. Since its foundation, the settlement has been primarily a venue for artistic and handicraft activities. In the 2010s, the Department of Culture of Gelsenkirchen opened up parts of the settlement for creative economic uses. Since then, these parts of the Halfmannshof have mostly functioned as a venue for various residency activities, in which artists and professional creatives lived and worked together on site for several days, weeks, or months on a rental basis or on a grant, in order to carry out artistic projects.

In this socio-geographical context the living lab has been "set up". Altogether, the research-project is carried out by one researcher from the field of innovation research (the author) and three researchers from the field of Human-Computer-Interaction (HCI). While the HCI-research team pursues the question of how workspaces can be enhanced technologically in a way that strengthens the output of creative cooperation or collaboration, the line of innovation research pursuits the question how underlying business models can be shaped in order to successfully run technologically enhanced, shared workspaces comparable to the one in the living lab.

Although business model related issues have received a great deal of attention in academic literature in recent years (see Schallmo 2014; Zott et. al. 2011), there is yet no reliable methodological procedure to guide applied research when it comes to the systematic investigation and analysis of business model opportunities (see Halecker 2016, p. 119). For this reason, the approach that is proposed and pursued here connects practice-orientated business model design techniques with mixed-methods from qualitative social research.

Following the practice-orientated literature, a business model "describes the rationale of how an organization creates, delivers, and captures value (Osterwalder/Pigneur 2010, p. 14)." There, as in the scientific literature it has been stated that the central basis for any business model is a functioning nexus between the value proposition a respective organization provides and the needs of the customer it addresses (see Osterwalder et al. 2014, p. 43; Teeth 2010, p. 176). Following this perspective, an organizations' value proposition is related to customer needs in the sense that it provides "gain creators" or "pain relievers" according to actual customer problems (Osterwalder et. al. 2014, p. 8). (In the following, the potential customers of shared workspaces will be referred as "users". By doing so, it is hoped to avoid any possible confusion between professional creatives and their respective clients)

According to this conception, understanding the needs of potential users-groups is a first crucial step that allows practitioners to develop a promising value proposition on which to base advanced activities of business model development.

To investigate the relevant user group's needs, requirements, and preferences a mixed-methods-approach is applied that make use of the opportunities of the living lab-environment. Observations of, as well as numerous informal conversations (see Sway, J./Spire 2020**)** with (temporal) residents are enabled by the researcher's regular presence in the living lab. All observation activities are carried out with the voluntary agreement of the respective residents. Additionally, in-depth topic-centered interviews are conducted with residents who agree to do so.

The preliminary findings that are presented in the following are mainly based on a first sample of data that was raised by semi-structured interviews with professional creatives from the sections of filmmaking (N=2) and performing arts (N=2), each interview having a duration of one and a half hour. All interviewees in this sample are of about 30 years old and have started their freelance activities as professional creatives within the last 4 years. They are equal parts male and female.

To unfold relevant functions, qualities or characteristics shared workspace offers could provide to professional users, the interviews were structured by three main questions: 1. What constellations of cooperative or collaborative workflows are relevant for the interviewees' professional activities? 2. What kind of tools and/or methods are used by the interviewees to acquire/manage/fulfill customer orders? And 3. What general challenges do the interviewees have to overcome in order to be professionally successful?

The findings below are further informed by additional perspectives gained from another, one and a half hour in-depth interview with a coworking-operator in the region as well as from several informal conversations with professional creatives from the fields of graphic design, illustration, media arts, and theatre - all of different age, gender and professional experience. Observations and informal conversation were captured as field notes by the researcher.

The overall data was then analyzed by affinity diagramming (see Holzblatt/Beyer 2015). To do so, the recorded interviews were disassembled into single statements and, together with the field notes, transferred into a software that allowed to visually cluster the data. This procedure made it possible to inductively generate and refine higher categories from the data through several iterative passes. For the purpose of this paper, the resulting categories of work-related issues were finally selected according to whether they a) are directly or indirectly related to spatial and technological resources and b) proved to be relevant for at least more than one creative sector.

4 FINDINGS

As result of this analytic process, three arguments could be developed that help to define the requirements that spatial infrastructure will have to address, in order to support local professional creatives' activities. These arguments will be illustrated with the help of empirical examples. Finally, the given insights are synthesized into a common perspective by giving recommendations for actions in the concluding remarks.

4.1 Motivation and criteria for the use of coworking offers

In the interviews, the primary motivation for using coworking services is the desire to move one's work from the home office. The general experience of isolation, an uneven work-life balance and difficulties in finding the necessary self-discipline in the home office to carry out administrative tasks or maintain professional contacts are challenges that are met by using coworking services.

Nevertheless, the interviews show that the choice between using coworking space and home office is rarely an absolute choice. Some of our interview partners reported that, parallel to renting a desk in a coworking space, they continued to optimize their own home office to meet specific work requirements resulting, for example, from craft activities. In addition, further spatial infrastructures are intensively used in order to meet the needs that result from project-dependent workflows or specific professions. Examples are publicly and non-publicly accessible workrooms of universities for arts and sciences (which provide access to different sets of tools), training facilities for physical arts as well as general venues such as cafés and private apartments.

These examples show that the interviewed creative workers systematically make use of spatial infrastructures within their catchment area, which are frequented situatively depending on temporary work situations (such as concentrated individual work, administrative individual work, coordination rounds, customer and partner discussions, creative meetings, manual work, training) and the associated requirements. The need to switch between different working environments flexibly and without major frictional losses, is thus one of the central challenges against the background of which these creative professionals have to successfully organize their work. As a result, geographical position (together with the price structure) is one of the most important criteria for evaluating a suitable coworking offer. As an impressive example for this, it happens that users move from one coworking service to another if there is a change in daily travel routines due to e.g. childcare requirements.

All in all, it can be stated that professional creatives have considerable assets at their disposal to avoid unnecessary cost factors for the use of premises by making use of alternative possibilities through contact networks and local knowledge. Consequently, the greatest willingness to use premises against payment exists where it is difficult to substitute them by improvised arrangements. According to our current assessment, this applies in particular to workspaces that are used for intensive content-related work in larger groups, as well as for those that are used for direct customer contact and thus have to meet representative requirements.

As it will be shown in the following paragraph, these working spaces have in common that they are dedicated to collaborative work practices in a narrower sense.

4.2 The role of collaborative work practices

It has become a well-accepted fact, that the particular added value of using coworking spaces lies in increasing the chances of cooperation for the users involved (see Ries et al. 2014, p. 45). Past studies have further highlighted the importance of cooperative work processes in creative

industries. In corresponding surveys, more than half of professional creatives stated that they work with their customers in “cooperative work situations” (Engstler et al. 2015, p. 34). In a subsequent study, more than four-fifths of respondents also stated that “cooperative work situations” with customer involvement occur “frequently” or “very frequently” (Engstler et al. 2018, p. 50).

When taken together with the former paragraph's conclusions, it can be concluded that a promising approach on supporting creative industries activities lies in providing infrastructure that takes into account the requirements resulting from the particular significance of supplier-customer relationships in the field. In order to expand on the above mentioned, existing findings, it can be assumed that in most cases the supplier-customer-relationship in creative industries can be understood as *collaborative* workflows.

The terms of cooperation and collaboration are often confused (see Carmarinha-Matos/Afsarmenesh 2008, p. 311). Referring to the examinations of Camarinha-Mathos and Afsarmenesh, collaboration must be seen as a certain and namely the most intense form of joint endeavor. While processes of cooperation solemnly presuppose a compatibility of the objectives that are pursued by the actors involved, collaboration processes require the existence of joint goals, joint identities and joint responsibilities. In its narrow sense, collaboration describes a process in which the participants “integrate their results and [strive for] joint problem solving (ibid. p. 312).”

Based on this understanding, two empirical examples can help to illustrate that the interplay between professional creatives and their customers can be understood as *collaborative* workflows.

An interviewee working in a young advertising film company stated that typically, processing a customer order involves three to four physical meetings with the customer. In these meetings, both the professional creatives and the clients bring in ideas and visions which are then worked out in joint interaction, first to form a basic idea, then eventually a final script. In contrast to the characteristics of a cooperative relationship, the creatives do not merely take on the role of a passive supplier/service provider who simply realizes the wishes and ideas of the customer based on a division of labor. Rather, the creative product is developed in several cycles together *with* the customer. The fact that filmmakers intensively evaluate a customer enquiry to determine whether the objectives expressed in it are compatible with their own is expressed *ex negativo* in the following quote:

> *We make videos that we would watch ourselves. And if the customer has a wish, where we say “Boy, we can do that, but we really don't feel like it, then it just won't be good.” Then we'd rather say, "No, we won't do that [kind of films – authors note] at all." [...], because they just want to have a few pans and zooms and interviews, just like on TV. And that's not our field, we work scenically and staged and less documentary, because that's just not the art of filmmaking.*

In the course of the participatory observation of a logo design process, it was also possible to observe how several optional design versions were adapted to the situation in the dialogue between customer and designer. This dialogue resulted in co-creating a new, common version of the logo that emerged by isolating and transferring single design elements from one of the former sketches to another. Also, in this example it was found that the designer felt a high degree of personal responsibility for the final co-created product. Apparently, in some situations the professional creatives even feel the need to refuse customer wishes which in their view would deteriorate the joint result.

In these collaborative contexts the accompanying visual or experiential documentation of the generated impulses, ideas and intermediate states is of high importance. In early phases of work, this usually takes the form of mind maps, timelines and the attachment of sticky notes on flipcharts and whiteboards. These methods seem to be quite common, regardless of the specific professions of certain users. Subsequently, context-specific procedures of prototyping are applied in which the preliminary results are increasingly concretized and thus made available for joint processing of the actors involved.

The previously mentioned film team, for example, uses special software to virtually walk through the planned film sets in advance and illuminate them with the help of digitally available light resources. On the basis of these virtual twins of the (not yet existing) set, the editing sequences of the planned shooting were prepared in detail. The results obtained in this way were then discussed in a joint meeting with the customers and partly modified. By working together on a common visual model, the customer was able to get a realistic feeling for individual shots and form his own mind about it. Furthermore, using a digital prototype enabled the filmmakers to immediately evaluate the technical and personal resources that resulted from the commonly developed script which allowed the customer to make decisions, and if necessary, to reject single shots from the script.

Another example is the case of a theatre collective that lived and worked for several days in the living lab to prepare a new play. In order to simulate spatial settings for an upcoming play, the group used about twenty cardboard boxes they had brought with them, which, if necessary, delimited or represented individual segments of the later stage set. The *imaginable* stage sets, which are brought into being this way, were subsequently used for joint improvisation and discussion about a scenic setup.

As such specialized techniques of prototyping seem crucial in managing advanced creative collaboration, one goal of our further research is to find out if canonical sets of prototyping practices can be identified and therefore taken into account when it comes to the design of shared workspaces for particular audiences.

4.3 The usage of digital technology

Notwithstanding the fact that some of the interviewees described themselves as not particularly digital-affine, all of the actors observed or interviewed use digital technologies and especially communication channels to varying degrees in their everyday work. The interviewees particularly emphasize the importance of applications that allow two-way interaction between different participants. In this respect, shared online documents (e.g. Google Docs) or remote desktop applications (e.g. TeamViewer) are used to work on more complex content issues synchronously, spontaneously, and across spatial distances.

Regarding the working tools and the equipment used, the dividing line between digital and analogue methods forms a perceptible boundary, which sides are associated with different qualities that are deliberately used, due to their effects on one's own work.

A freelance illustrator, for example, reported that when making early sketches, she consistently avoids the use of devices or software. The possibility of continuous (re-)processing of digital drafts always leads to the correction of details and, as a result, to a distraction from the essential challenge of the early design stage, which consists in the identification and selection of the most suitable basic ideas. In turn, she often uses specialized digital devices hereafter to finalize her work, as this allows to save time and material when adjusting or reworking single details.

A young scenographer in turn organizes her knowledge and self-management along the boundary between analogue-digital media:

> *For creative people - I now simply claim - it is indeed the case that in conversation - and I believe that this can hardly be replaced - we must write. And I have the habit of actually digitizing it again afterwards. Well, you go through your notes anyway, and I sort it into "Thoughts", "Future", "Actions Tabs" and whatever you need from it... [Interviewer: So you do that in a software that you sort or you do that in a text document?] E1: I do that in a software. I am still very much in favor of booklets - I have fifty different ones. This one [picks up the booklet in front of her] is the [name of her current project] booklet. And I still take it with me everywhere I go, because sometimes - like now in the conversation - it's somehow nicer to write and look at my booklet than to slam me in the front of a laptop. And there are things and thoughts that are in the limbo - they always stay in this booklet, but thoughts that are concrete and dates are immediately inserted somewhere.*

Those both examples show that digital and analogue media is used complementary to utilize the respective advantages of both.

The scenographer's statement also mentions that working with analogue notebooks has a less isolating effect in discussions with other persons than using a laptop. It becomes apparent that the usefulness of technological artefacts is not only assessed in terms of their specific functionalities, but also in terms of their social implications in situations of dialogue and collaboration.

This aspect also becomes apparent, albeit exactly the other way around in the interview with the commercial filmmakers. The filmmakers make intensive use of the digital whiteboards in the living lab, which they use for presentation and documentation in collaborative customer interaction. Especially in the field of documentation, the available digital methods offer comparatively few advantages over analogue alternatives. Nevertheless, the interviewees preferred the digital variants especially because they consider the confident use of technological artefacts to be an effective means of communicating their own professionalism to their customers. Beyond functionality, the value of digital infrastructure in this case therefore lies not least in the effective presentation of one's own competencies and thus underpinning one's own claim to be a professional service provider.

5 CONCLUDING REMARKS

As outlined in the third chapter, the findings presented here were gathered with the aim of drawing conclusions for the design of business models for shared workspaces. The underlying idea is that tapping into the needs, requirements and preferences of potential user groups can provide orientation for the practical design of promising value propositions, which forms the very basis of any advanced business model development.

By its very nature, this approach does not directly lead to compelling conclusions. The given findings can be considered and adapted in multiple ways, which remains a task to be accomplished by practical efforts. Nevertheless, the following conclusions are proposed here: As users will see certain workspace-offers as piece of a puzzle in a comprehensive landscape of different work-possibilities, new offers should be carefully embedded into the existing local creative ecosystems. In this regard, I suppose that competition advantage can be claimed by geographically combining at least two modules of complementary work modes (such as concentrate office work, team collaboration, customer collaboration, craft activities, theatre/stage work).

A promising approach can be seen in focusing on shaping workspaces that enable the users to collaboratively work with partners and customers in particular. While desk-based coworking offers are easy to be bypassed by alternative and private solutions, adequately equipped and representative spaces for collaboration can provide spaces of evident value for the users. In this context, advanced presentation technology is seen as a useful resource that enables professional creatives to make use of digital prototyping methods and to showcase their professionalism. As the preference to use such technology highly depends on individual work steps and is often supplemented complementarily with analogue media, both – analogue as well as digital methods – should be always accessible at the same time.

As research activities at */futureWork* are still ongoing, the next step is to validate the previous findings for other freelance-based sections in creative industries, such as the fields of motion design/animation, sound design/music, professional writing, software and game development, 3D/Virtual Reality-modelling and others. Another focus lies on further investigating identifying typical techniques of prototyping in the context of creative collaboration. By doing so, it could be possible to formulate concrete instructions for actions that take into account the specialized methods of different target groups within the cultural industries.

If you have any further, supplementary or contradicting observations and examples related to the field of research, please feel heartily invited to contact the author.

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A Flexible Office Business Case – the investor's, operator's, and user's perspective on the COWORKSTATT

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ABSTRACT

Purpose: Predictions estimate that 30% of office inventory will be flexible by 2030. Who is providing such flexible spaces, and for whom will this generate value? What are the parameters that influence this value-generation? This paper outlines the financial aspects of business models for those involved in the venture: the landlord/owner of the property, the provider/operator of the space, and its tenants/users. Their assessments and calculations as well as interdependencies to be considered are discussed in order to draw a holistic picture of the provision of flexible office space (FOS) and support decision-making.

Theory: Foundations of the paper are the Real Estate Perspectives Model (Kämpf-Dern/Pfnür), which is adapted for FOS, as well as basics of business modelling.

Design/methodology/approach: The provision of FOS directly involves three real estate actor groups – investors, operators, and users. For each of them, the paper summarizes their relevant business model dimensions and financials. The approach is an inductive case study based on the flexible office space 'COWORKSTATT', an averaged-sized FOS in a major German city. The case example is substantiated by transdisciplinary research results on FOS/coworking spaces and market data in order to draw inductive conclusions.

Findings: Landlords, FOS providers, and tenants need to take a multitude of data into account when considering provision and usage of FOS. These data are put into relation, visualizing and operationalizing the business models of all actors. Since typical data is used, the set of levers become apparent that sustainably enable the provision, operation, and usage of FOS,. With the case being representative for many of today's FOS, the assumption that usually tenants have the greatest benefit while operators bear the major risk, gets a first confirmation.

Originality/value: Flexible offices are a new type of operator-run property with yet very limited information and even less recommendations on how to evaluate them financially. The paper suggests the parameters, benefits, costs, risks and interdependencies to be considered. It thus, for the first time, draws a holistic picture of flexible office business models and the dependencies of the actors and their relevant parameters. Hence, it can serve as guidance for comparable decision-making situations.

Keywords

Flexible office; business model; financial model; real estate perspectives; coworking; hybrid;

1 INTRODUCTION

Megatrends such as digitalization, individualization, mobility and globalization have been changing the way we work, especially within the last decade. Different ways of working require substantial changes in workplaces and workspaces. These changes, particularly the increasing demand for flexibility regarding office space and office work, already started in the 1990s, together with the 'new economy' (e.g. van Meel & Vos, 2001). They are characterized by higher flexibility of rental contracts, e.g. shorter leases, greater diversity and wider flexibility of terms of occupation (e.g. O'Roarty, 2000), choice and sharing of work settings (e.g. Worthington, 1997; Veldhoen, 2004; Appel-Meulenbroek et al., 2011), and individualized working hours and places of work, e.g. flexible time, home office, third places (e.g. Oldenburg, 1989; Avery & Zabel, 2001; Haun, 2018; DB, 2020).

Accordingly, the term 'flexible office space' (FOS) associates a broad field of partly overlapping, partly distinctive meanings. In this paper, the JLL definition for FOS is utilized: "Office space offered by an operator at flexible conditions in terms of lease terms, number or workstations and pricing. Flexible office space users also benefit from the operator′s existing office infrastructure and other services." (JLL, 2018).

Flexible office supply has considerably grown worldwide (estimate by deskmag, 2019: 24% p.a. between 2015-2020). Extraordinary growth also applies to Germany's major cities (Zahrnt, 2017; Zahrnt & Barthauer, 2018). This is the case even in secondary markets, with hybrid models showing the strongest growth (Zahrnt, 2019). While the percentage of FOS of the office inventory is only at 1-2% on average and 2-4% in FOS hotspots, predictions estimate that by 2030, 30% of office space will be used flexibly (JLL, 2018). The reason is that the FOS concepts provide conditions that very well address changing work environment needs: increased flexibility regarding market, business, and staff volatility, facilitated market entries & exits, reduced occupancy costs, enhanced collaboration, and better sustainability. (JLL, 2018; Van Meel & Brinkø, 2014) FOS "refer to the idea of a sharing economy in two dimensions providing the access to shared physical assets (office, infrastructure, cafeteria etc.) and the sharing of intangible assets (information, knowledge etc.)" (Bouncken et al., 2018a)

Profound research on design options, user preferences, or impacts of flexible office space (FOS) on satisfaction and productivity has increased considerably (only see these proceedings). However, despite the high interest of commercial real estate market participants, solid information on financial value generation through FOS is largely missing. Zahrnt (2019) states that the low level of transparency and the very short track record of operators lets owners take a cautious approach. The few numbers being available are also not too promising: Globally, only 42% of coworking spaces have been profitable in 2018, and only 31% in Germany (deskmag, 2018).

Knowing the characteristics of FOS, this is not particularly surprising. FOS is an 'operator property', rather to be compared to the hotel or health care industry than to traditional office investment and leasing. Traditional office investment and leasing regularly only involves the investor on the one side and the user on the other, having a long term contract with the majority of specific needs' oriented operation being the user's responsibility. In the case of FOS, the situation is much more complex: An additional actor needs to be involved, namely the operator, providing major services for heterogeneous tenants and end-users, with quicker changing needs and requirements than in a traditional space renting model.

Therefore, running a flex-space operation is a complex business. And it can be a big disappointment for investors, if not carefully planned and executed. “Understanding the many moving components of the business model is critical to success, along with attracting and retaining customers, running an efficient and scalable operation, and meeting the varying demands of today’s occupiers. Landlords must get the operation right from day one and decide how to position themselves in a new market.” (Essensys, 2020)

The financial considerations of this triangular situation need to include many more parameters than landlords are used to. The business case – overall as well as for each of the involved parties – is accordingly more interdependent and complex than ‘just’ looking at the base rent plus ancillary costs on the one site, and building operating expenses and capital cost on the other side.

Based on a real case of an averaged sized FOS in a major German city, the paper discloses and discusses the considerations and calculations of the owner/investor of the property, the operator of the COWORKSTATT, and potential users (combining tenants and end-users). These are, according to the real estate perspectives model (Kämpf-Dern & Pfnür, 2009; Kämpf-Dern, Roulac & Pfnür, 2013; Kämpf-Dern & Pfnür, 2014) the three groups directly related to the FOS. The paper looks at the dimensions, parameters and financial models relevant for these groups, and sketches – exemplarily – their business cases.

The paper is structured as follows: In chapter 2, the case example is classified within the FOS segments. After the application of the real estate perspectives model to FOS actor groups in chapter 3, the financial model and business case for each of them is explained in chapter 4. Then the benefits, chances and risks, and their interrelations are discussed in chapter 5, followed by the conclusions and an outlook in chapter 6.

2 HYBRID MODELS AS FASTEST GROWING SEGMENT OF FOS

There are various ways to classify FOS. CW (2018) describe a whole range between the traditional, fully dedicated office and the virtual office, that does not even physically occupy a desk but only uses services (e.g. address, business services). Mostly depicted (e.g. Van Meel & Brinkø. 2014; CW, 2018; Zahrnt & Barthauer, 2018) are the ‘Serviced Office’ (also called ‘Business Center’) and the ‘Coworking Space’.

The ‘Serviced Office’ targets conventional office users like employees of larger corporates, and thus focuses on the provision of private offices, a serious business environment, high level of professional service, and security. In contrast to this, ‘Coworking’ offers predominantly open plan, community and meeting areas, has a more relaxed and often industrial design. It offers even more flexible options regarding usage, and puts communication and collaboration benefits in the center. Here the target groups are freelancers and start-ups. The ‘hybrid model’ is a blended version of serviced office and coworking space. It thus accommodates diverse target groups, with ‘normal’ corporates rather working in private rooms, while the ‘coworkers’ use community spaces for work and networking at the same time. (Zahrnt & Barthauer, 2018)

According to Zahrnt (2019), hybrid FOS in the Big 7 cities in Germany overtook the long established business centers in 2017 (based on sqm). They are estimated to provide 160% more space than the business centers in 2019.

The ‘COWORKSTATT’ belongs to the hybrids, as can be seen below in chapter 4.1. Moreover, it is an independent coworking space, using the type classification of Bouncken et al. (2018b),

not a corporate, an open corporate, or a consultancy space. Characteristics of the independent type are the establishment and provision of space – office, infrastructure and social space through membership to the public, the provision of additional services, and revenues through membership fees, catering, and/or rents.

3 REAL ESTATE PERSPECTIVES MODEL APPLIED TO FOS

3.1 Essentials of the real estate perspectives model

From an economic point of view, real estate as a good and service is unique being an essential part in not only two but three vastly differing transformation processes (Kämpf-Dern/Pfnür, 2009). Real estate (services) is/are at the same time and with the same property

i. an input factor / a resource in the transformation processes of users
ii. an output factor / product (goods and services) in the transformation processes of producers (e.g. planners, construction companies, facilities operators, etc.),
iii. the underlying asset in the transformation processes of investors, and also
iv. the environmental context for many people, not only those using or operating the estate, summarized under ‘the society’.

Thus, the objectives of these actor groups for their real estate activities are considerably different, partly in alignment, partly in concurrence with the other groups’:

- Users want to maximize the benefit-cost-ratio of their occupied real estate (resources), meaning minimizing the total cost and effort of ready-to-use (warm, fully-equipped, functional) spaces and space-related services while maximizing the performance (e.g. productivity) of their personnel and their activities, working on and in the space, with the goal to maximize corporate profit.
- Producers’ benefit-cost-ratio consists of their revenues from planning, building, marketing, operating, and servicing properties as their core business, and the directly associated costs with these activities (mainly personnel cost). So their revenues to be maximized are part of the users’ costs to be minimized.

The concurring relationship between users (customers) and producers/service providers is nothing specific. Yet, real estate as an especially capital intensive good and service requires a third, equally important group with yet another objective:

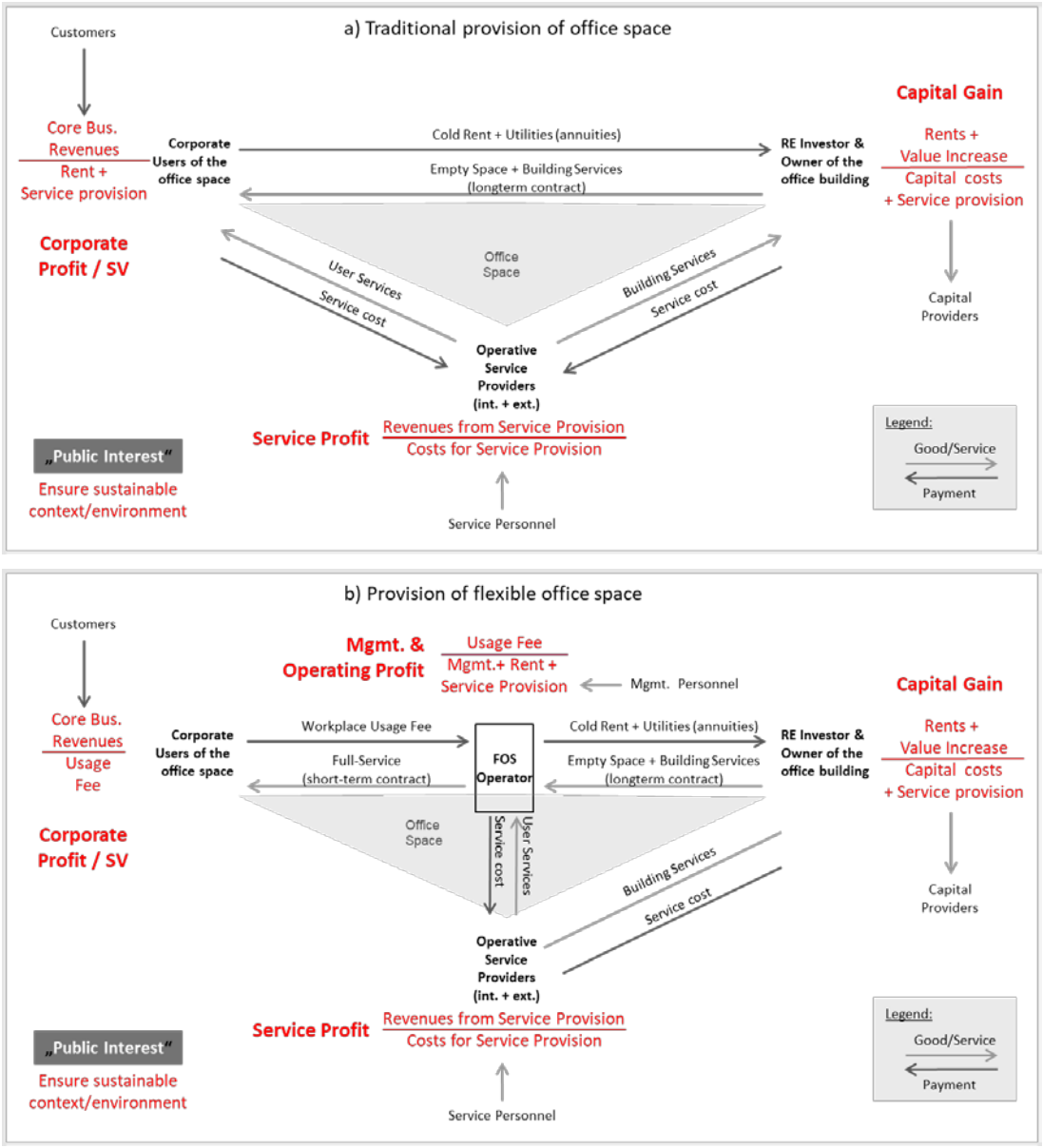
- Investors strive to maximize the benefit-cost ratio from their capital investment in real property (capital gain), with benefits coming from users’ payments (directly as rents and indirectly from rent-dependent appreciation) and costs as the sum of payments to producers (for their goods and services) and to other investors (capital costs).

Last, but not least, public interests in individual real estate activities of i. to iii. need to be considered, which also includes mediating between their concurring objectives:

- Society’s (public interest’s) benefit-cost-ratio is sustainability, trying to balance economic, ecological, and social interests of all stakeholders of an estate in a way that "meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland et al., 1987). Real estate ventures should therefore always consider and fulfill the requirements for sustainable developments.

Figure 1 shows these mutual interdependencies, 1a) as traditional provision of office space, and 1b) applied to a FOS:

Figure 1: RE Perspectives model applied to Flexible Office Space



3.2 Investor's perspective on FOS

The investor owns the estate that houses the (potential) FOS. In the traditional RE office situation, they have made an investment (capital expenditures = CAPEX) into the ground and the building, including building equipment and technology. They also organize and pay for the building's operating expenses (OPEX), e.g. maintenance, building tax, heating/electricity/water, common areas' cleaning and other building services. In Germany, most of the OPEX of commercial buildings ('ancillary costs') are then charged to and paid by the users, based on square footage and/or consumption, in addition to the base rent. These regulations are part of the

leasing contracts that are usually signed for 3-10 years. The CAPEX including a (small) risk premium is covered by the base rent; major parts of the OPEX are transitory for the investor.

In the case of FOS, if investors choose to lease to an operating company instead of user companies, there are no structural changes to the traditional model. Even potential built-out investments together with an accordingly higher rent, or a higher rent because of a higher risk premium if the operator is deemed risky than comparable user companies, are nothing special.

Things would only change in case of the investor choosing another FOS provision model (e.g. a joint venture with an operator, outsourcing management to an operator, or operating by himself). Yet, the dominant model – accounting for 70% of spaces globally and for 89% of spaces in Germany – is the standard lease to a FOS provider. (deskmag, 2018)

What changes significantly in the case of FOS are the roles and responsibilities of operators and users, and thus their chances and risks.

3.3 Operator's perspective on FOS

In the traditional model, only general property operations are performed by the owner (for the hallways and few common spaces), while the user organizations take care of their own facilities (their respective office spaces including any additional facility services). In case of owner-occupiers (corporate real estate investment), necessary services are either provided by own personnel or outsourced (service by service) to companies providing facility services. Most outsourcing is related to 'mass services', e.g. cleaning, catering, maintenance. The management of facility services providers is mostly conducted by the user companies' own personnel, at least on the strategic management level.

With FOS not just being an empty space to be equipped with furniture, office technology, and services by the user, but being provided as a package to a larger variety of users and much shorter leasing time, the role and function of space operators changes significantly. Not only are they now managing a much more complex service package; they also provide this service package to a more heterogeneous, often unknown group of users, at a higher pace, and with users that can easily choose another alternative. (Van Meel & Brinkø, 2014) Additionally, they are bearing a much higher risk because of renting long-term and investing themselves upfront in the fit-outs, while leasing out short-term to a variety of users.

The operator's business model – reliable and attractive in their services, profitable themselves, but also affordable for the users – thus is key for both, the property owner / investor of the building, and the user companies, who are outsourcing an essential input factor of their core business.

3.4 User's perspective on FOS

As described above, in the traditional model, user organizations manage most of their real estate operations themselves. This is often considered a rather side activity in which the (property) cost side of the benefit-cost-ratio is more important than the needs of and benefits for the occupiers. Additional management costs are often not considered, and neither are the risks, e.g. from a lack of flexibility in an increasingly faster changing business environment. But most importantly, more and more heterogeneous and faster changing needs of their personnel can hardly be considered and taken care of in traditional CREM structures and processes. A well-functioning FOS can thus add considerably to the maximization of users' benefit-cost ratio, even though the

cost might seem higher in the case of 'renting' compared to 'providing' corporate office space, especially when considering smaller entities.

In the next chapter, we will take a closer look at typical users' real estate financials, not even considering the potential positive productivity effects that are difficult to quantify.

3.5 Society's perspective on FOS

Generally, FOS can be beneficial for society, e.g. with regard to climate balances. FOS make better use of physical resources through higher utilization of existing or new buildings. When spreading to smaller towns and being closer to more residential areas, they open up time and emissions savings, improving health and climate, as commuting to work is no longer necessary or significantly reduced. Yet, these public management issues will not be further investigated in this paper that concentrates on business plans for individual FOS.

4 BUSINESS CASE / FINANCIAL MODEL

4.1 Flexible office space case data

The FOS example looked at in this case is called COWORKSTATT and can roughly be compared to a well-designed 3* hotel: not being in a CBD (Central Business District) location or offering luxury or prime quality, but well accessible by public transport and car, surrounded by shops and restaurants, and offering a functional office environment that is better than state-of-the-art of average small and medium sized companies, which are the target group of the COWORKSTATT. (COWORKSTATT is a word creation that merges 'coworking' with the German word 'Werkstatt' meaning workbench, studio, garage.)

Table 1: Key data of the COWORKSTATT

Attribute	**Description and level**		
# Private Offices	6 (24 – 50 sqm each)	1 – 4 desks / office	20 desks
# Co-Working Offices	4 (20 – 45 sqm each)	16 mobile desks	16 desks
		4 fixed desks	4 desks
# Community Conference Rooms	2 (13 – 18 sqm each)	12 seats	4 workplaces
Community incl. phone booths		24 seats	8 workplaces
Total Hybrid Office	**530 sqm**	**76 seats**	**52 workplaces**
Meeting Large	(dividable)	20 seats	
Meeting Small	(design thinking)	6 seats	
Lounge		3 seats	
Meeting Area	**110 sqm**	**26 – 60 seats**	**10 workplaces**
TOTAL COWORKSTATT	**640 sqm** (ca. 10.3 / 14,7 sqm / person at 100% / 70% occupancy)	**15 separable rooms** (1 – 30 people per room, average 4 people per room)	**62 workplaces**

The space is part of an existing commercial building complex, about 5 km away from the central station of a major German city. The overall letting space of the complex, being built between 1970-1985 and since then constantly maintained and refurbished, is about 6,500 sqm (including storage), with smallest unit sizes ranging from 125 sqm to 410 sqm, resulting in 15-20 different

tenants. The COWORKSTATT occupies 530 sqm of hybrid office / community space and a separately bookable meeting/conference/design thinking area of 110 sqm. The concept and design were done by workspace experts after the former long term tenant had terminated its lease.

The FOS offers a combination of half-transparent cell offices for private usage as well as co-working, community space and meeting rooms thus providing space for communication as well as concentration. In total, depending on usage, 100-160 seats are available in 15 separable rooms / 640 sqm of letting space, with ca. 60 people being able to use workstations at 100% occupancy. Further relevant space data can be taken from Table 1.

4.2 Investor's data and business case

The average letting price (base rent, net) of the building complex, being aged and in a non-sophisticated area of the city, has been € 6-7/sqm/month in the past years and risen to € 7-8/sqm/month, despite its very good connection to public transport, central station, airport, and highways. Utilities (incl. heating) are on average at about € 2,50/sqm/month. But even at this relatively low price, a space with roughly 640 sqm, resulting in a warm rent of more than € 6.000,- (net) per month, was not easy to let, compared to units of e.g. 125-150 sqm. The reason is that the clientele, looking for this kind of space, has 4-10 employees rather than 30+ that it would take when dividing the space's size by approximately 20 sqm/person, a number that is regarded as efficient. Consequently, the vacancy risk is high and vacancy periods can be long.

Considering the shape and the already existing transparency of the space, the investors decided to not only refurbish it in a traditional way (new flooring, new lights, and paint), resulting in ca. € 100-150,-/sqm and no competitive advantage against other low standard, low price offices. This would only permit re-letting the space at a price of € 7-8/sqm/month plus parking (€ 45,-/per parking/month). With operative management fees (ca. 3-5%) and marketing/provision fees (ca. 7-8%), this would result at a raw profit of € 6,10-7,20/sqm/month.

Instead, the investors hired an experienced interior designer and developed a concept that would attract and allow a FOS usage, with about 60% of the space for furnished private office leasing (minimum lease length 3 months) and 40% for coworking (minimum lease length 1 month). The reasoning for this was less to increase nominal income per month, but rather to diversify the risk of longer vacancy periods of this large space.

The time and cost for developing such a concept should not be underestimated. Despite the personal and uncharged time commitment of the investors, the external cost for the planners, including implementation advice (but without construction management) came to about € 70-80 / sqm. Additional investments for technology improvements, additional installations/walls, furniture, design/decoration, and other equipment (though partly acquired used) sum up to another € 120-150 € / sqm (€ 90-100 / sqm for mobile furniture/equipment, € 30-50 / sqm for fixtures/technology). The additional investment for the FOS on a standard, non-sophisticated level thus arrives at € 190-250 / sqm. When amortizing this straight over a 10 year period (not even considering time value of money nor vacancy nor other risks) this results in € 1,60 - € 2,10 / sqm additional rent needed, coming to € 8,60 – 10,10 (base, net, including equipment) or € 7,85-9,10 /sqm (base, net, only including the concept and some fixtures).

While this seems to be reasonable, in the respective market it would hardly be feasible without further operations provided, as first test advertising had shown.

4.3 Operator's data and business case

To market and operate the space as flexible office to individuals and smaller sized companies, additional efforts need to be taken that cause not only additional costs, but also additional income as can be seen in the following.

Market research for coworking places as well as private offices in the area showed (e.g. Zahrnt, 2019) that for the COWORKSTATT it is reasonable to price a desk between € 225,-/month (mobile coworking) and € 450,-/month (private office) according to Table 2:

Table 2: Pricing COWORKSTATT

Offer	#	Persons max	Room size	Add. space	Rental space	Price/ month [€] (plus IVA)	Price/ work-space [€]
Private Office 1	1	2,0	24 m²	16 m²	40 m²	760,00	**380**
Private Office 2	1	4,0	31 m²	20 m²	51 m²	1.380,00	**345**
Private Office 3	1	4,0	35 m²	23 m²	58 m²	1.470,00	**368**
Private Office 4	1	4,0	50 m²	33 m²	83 m²	1.750,00	**438**
Private Office 5	1	3,0	28 m²	18 m²	46 m²	1.120,00	**373**
Private Office 6	1	3,0	28 m²	18 m²	46 m²	1.120,00	**373**
Coworking Fixed	4	1	6 m²	4 m²	10 m²	275,00	**275**
Coworking Mobile	16	1	6 m²	4 m²	10 m²	225,00	**225**
							Leases: from 3 months

At 70% average occupancy (higher with the private offices, lower with the coworking), which is expected to be reached in year 3 (after 60% in year 1 and 65% in year 2), and including meeting room bookings as well as additional revenues from coffee/printer as well as parking, total revenues are expected to be € 192.000,- (net, year 3), equaling € 25,-/sqm/month. This sounds incredible compared to a base rent of € 7,85-10,10 / sqm from chapter 3.3. Yet, considering the costs (see Table 3) and risks, the excitement diminishes quickly. In Year 4 and following, when average occupancy reaches 75%, NOI goes to 5-6% of revenues (€ 11.000-13.000 per year, € 1,50/sqm/month).

This means that after firstly becoming profitable in year 3, the profit margin is about 5-6% in year 4 and then slowly rising when gaining scale.

Table 3: Revenues and costs of the COWORKSTATT operations (Year 3)

Position	**% of**	**€ (per year)**	**€/sqm/month**
Revenues (total)	**100**	**192.100**	**25,10**
Rooms	86	165.200	21,50
Parking	7	13.450	(65,-/PP x 17) 1,75
Coffee/Printer	7	13.450	1,75
Fixed and direct operating expenses	**56**	**107.450**	**14,00**
Lease[10]	30	57.600	7,50
Utilities, electricity, IT	14	27.000	3,50
Parking	5	9.500	(47,-/PP x 17) 1,25
Furniture Lease, Repairs & Maintenance	5	9.500	1,25
FF&E Reserve	2	3.850	0,50
Service expenses	**26,5**	**51.000**	**6,65**
Cleaning	13 (of room revenues)	21.500	2,80
Reception	12 (of room revenues)	20.000	2,60
Coffee, printer	5	9.500	1,25
Overhead	**15**	**28.850**	**3,75**
Admin & General	5	9.500	1,25
Sales & Marketing[11] (incl. Management Fees)	8	15.500	2,00
Operator Insurances	2	3.850	0,50
NOI Operator (Net Operating Income)	**2,5**	**4.800**	**0,70**

4.4 User's data and business case

Assuming that the user company has 3-5 employees, including the owner, with 1-2 people working part-time respectively partly out of the office (at home / at the client / travelling), the minimum office size for this user would be a 100 sqm unit, with the following room sizes:

- 2 offices, each with 2 desks, together 44 sqm
- 1 meeting/telephone/recreation room/additional workplace, 16 sqm
- Toilet(s), coffee kitchen, storage room: 21 sqm
- Entrance, walkways: 16 sqm
- Light walls: 3 sqm

The cost of a standard office in a comparable building (location, quality) with 4 working desks and little flexibility regarding privacy, communication/meetings, etc, are about € 2.030,-/month respectively € 507,50 per person/month (see Table 4).

[10] Investor's income
[11] Investor's cost in traditional model

In the FOS the comparable cost per month are between € 1.380,- (Private Office 2) and € 1.880,- (Private Offices 1 and 5 combined). Therefore, costs are lower (because of shared resources) while attractiveness and quality, flexibility and organizational efforts (especially no / little set-up) are better.

In both cases, parking and coffee/printer costs (apart from depreciation) are not considered as they are comparable.

Table 4: User's office rental, ancillary, own operations cost

Position	**Amount**	**€ (cost per unit, per month)**	**Total costs (per month)**
Rental costs	**100**	**11,50**	**1.150,00**
Base rent	100	9,00	900,00
Utilities	100	2,50	250,00
Further operating expenses			**340,00**
Electricity			120,00
IT (usage)			70,00
Furniture Lease, Repairs & Maintenance (Investment depreciated over 10 years)	€ 12.000,00	1,00	100,00
FF&E Reserve	100	0,50	50,00
Service expenses			**410,00**
Cleaning	16 h	25,00	400,00
Printer (depreciation 4 years)	€ 500,00	2%	10,00
Overhead			**130,00**
Admin & General Organization	4 h	50,00	200,00
Office Insurance			30,00
Total / Total per person			**2.030,00 / 507,50**

5 RESULTS AND DISCUSSION

5.1 Benefits and Chances

The financial models and considerations show that investors with spaces that are generally suitable for FOS or can be transformed with little effort can diminish their vacancy risks compared to letting larger spaces to one individual company. When finding a professional and thus efficient operator, they can even increase their revenues as the operator is able to increase asset quality as well as utilization, compared to standard office use of individual companies.

This also benefits users, especially if they are individuals or small and cost sensitive companies. The possibility to share resources lowers their cost while at the same time they benefit from higher quality and flexibility. This spread alternatively offers potential for operators and/or investors to increase their margin.

5.2 Risks

In the situation shown, users benefit the most while the entrepreneurial risks are higher with the operator respectively operating owner. Yet, in the long run, when the FOS has established itself, this can be a very stable enterprise

6. CONCLUSION

Flexible offices are a new type of operator-run properties with yet very limited information and even less recommendations on how to evaluate them financially. The paper suggests what needs to be considered and how the various aspects relate to each other for all relevant actors. It thus, for the first time, draws a holistic picture of flexible office business cases and can serve as guidance for comparable decision-making situations.

Like any entrepreneurial venture, a business model for the FOS needs to be established that specifies the customer target group(s), the respective value proposition, the market situation including competitors and other stakeholders, services and processes, investments and staffing, branding and marketing, revenues and costs, and expected market developments. Planning for and establishing a FOS resembles more a hotel opening and management than the traditional activities of commercial real estate letting and management. It is a complex business that should not be taken lightly as disappointment can be huge with the average probability of making a profit is currently less than 33%. The space provider thus is in a challenging and risky position.

This can also negatively impact the owner. Therefore, the operator needs to be chosen carefully, similar to the terms and conditions regarding the fit-out. A partnership approach might be more advantageous than a pure landlord-tenant-relation.

The user can be the lucky third in this deal: He can get it all: flexibility and risk-reduction as well as better quality, often at reduced cost, compared to own office provision, and better sustainability. Therefore the positive development of FOS demand side will likely continue.

Yet, without competent and profit-making space providers, the development cannot continue. Therefore, further research is needed to find out more about how to make FOS a sustainably profitable venture – for all parties involved.

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Russian governmental bodies meeting an open plan office: intended and unintended effects

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ABSTRACT

The research presents an ethnographic snapshot of a large-scale process that implies a significant change of working space for Russian civil service employees. Theoretic framework applies the concepts of organizational culture, organizational change and public interaction. Findings show that such core categories of bureaucrats' identity as security are being reconsidered in the new physical environments, which leads to a weakening of formal norms, but a limited range of public places for non-targeted interactions (third places) decline the potential for a substantial organizational change within the civil service. Socialization in a classic bureaucratic culture also presents barriers and obstacles for a successful relocation of civil servants to open office environment.

Keywords

Open office, civil servants, ethnography, communication, documents

1 INTRODUCTION

In 2019, a number of Russian governmental bodies relocated to one of the Moscow International Business Center towers, a "Canary Wharf of Moscow". This relocation includes about 5.000 people, which are to occupy approximately 70.000m^2 instead of 170.000m^2 in the previously inhabited discrete buildings. Since April 2019, governmental bodies (several ministries and affiliated organizations) occupy a whole tower called "United Governmental Office" (UGO); none of the relocated entities had previously an experience of working in an open plan office. New workspace is an open space office involving a number of meeting and focus rooms, kitchens and supportive facilities like printer areas, and implying that most of the employees, including executives, are to be located in the open plan office.

Apart from optimization of maintenance costs and improvement of the civil service's public image, the relocation's initiators proclaimed as the intended tasks the following:

- intensification of electronic document management;
- acceleration of knowledge dissemination among civil employees;
- establishment of informal communication within the state agencies;
- recruitment of young professionals to the civil service.

Those who were relocated to new spaces in 2019 are regarded as pilot cases for Russian civil servants working conditions change. Our team is responsible for investigating the subsequent effects and providing consultancy for the upcoming relocations. Our research aims to:

1. Define the suitable theoretical approaches, concepts and ideas in order to interpret the relocation's effects on social patterns in the UGO (section 2);
2. Develop an efficient methodology for detecting the phenomena described in the theoretic framework (section 3);
3. Depict and interpret the findings of the data collected during the fieldwork (section 4).

2 THEORY

Listed below are some theoretical approaches which provided the most illustrative research conclusions. First, we describe a number of concepts, research and ideas related to the effect of physical change on the organizational culture within civil service, and the induced organizational change. Due to reasonable limitations, here we focus on the most prominent instances of organizational changes that we had the chance to observe in UGO, and depict theoretical frameworks for their interpretation. Second, we investigate the possible contribution of public places inside UGO for the distribution of knowledge and intensification of informal communication between agencies, as one of the most significant intention of the relocation project.

2.1 Various aspects of organizational change

Following Hofstede and Minkov (1991) we conceptualise organizational culture as "the collective programming of the mind which distinguishes the members of one organization from another". In defining organizational change, we adhere to the process-oriented approach and assume that organizational change "is the reweaving of actors' webs of beliefs and habits of action to accommodate new experiences obtained through interactions. Insofar as this is an ongoing process, that is to the extent actors try to make sense of and act coherently in the world, change is inherent in human action, and organizations are sites of continuously evolving human action" (Tsoukas & Chia, 2002).

Recent research provides numerous examples of how organizational changes are linked to workplace conditions (see, for example, Mitev & De Vaujany, 2013, for the concept of 'architextures').

In particular, the interconnection between organizational and physical change can be found in structural forms of a space and its components, and workplace's users' experience-based habits and practices (Mitev & De Vaujany, 2013, p. 81). Below are listed theoretic foundations for prominent examples of changes in organizational culture that we observed.

Employees' perception of security as part of their identity that undergoes changes

Space and workplace constitute social identities of employees, as well as they present the identity of the place with which employees associate their professional role in an organization (Rooney et al., 2010). Thus, a change in working environments may be followed by modifications in the identities of workers, the perception of their professional images, and the identity of an organization.

One of the valuable categories that civil employees operate with when talking about their work is such of security, related whether to the need to consider and protect national interests while performing their job, or to the importance of maintaining a high level of privacy of the documents that they deal with. Giddens defined ontological security as the "confidence or trust that the natural and social worlds are as they appear to be, including the basic existential parameters of self and social identity" (Giddens, 1984, p. 375). Material, i.e. physical, changes may induce organizational change (Dale, 2005), and its effect on the employees' perception of security would be an indicator of this process.

Documents as a core basis for civil service

In most cases, paper documents continue to play an important symbolic role within the civil service, which is often explained by the fact that a paper document serves as a materialized normative basis for the communication between different elements of the organization and a legitimizing form of expert knowledge in the organization (Hull, 2012).

Reinforcing any type of messaging or interaction by documents is seen as an element of vertically-oriented organizational control and a way of establishing privacy boundaries (McEvily et al, 2014). Documents' role in an organization is providing basic and most obvious form of communication between different parts of enterprise (Hull, 2012). Furthermore, documents are seen as a way to create meaning for or defining vague situations (Weick, 1995).

Physical change may induce alternation of the organization's symbolic meaning

Theories of organizational change show that people who differ by their positions tend to evaluate changes in their workspaces differently (Paulsen et al., 2005). For example, Martin et al. (2006) found that many lower-level employees experience a fear that their identities may become under threat in new buildings or workplaces. Emotional responses to a change in physical working environments include feelings of alienation, nostalgia, and disorientation (Spellet et al., 2002).

Organization relocation is considered not only spatial, but also a temporary transition in the life of the organization (Ybema, 2014). Relocation plays a role of rite of passage, bringing organization to a new state. New experience is taken into account as a part of organizational memory, and spatial configurations of working places contribute a major part of collective practices and perception of organization and its development phases (Decker, 2014).

2.2 Work of transparency: coworking, publicity and community

Transparency and departments copresence is seen as one of the most significant changes in public service workplace design. In this part we aim to analyze UGO environment for encounters and public interaction, which may result in knowledge, experience and values transfer. We test three concepts referring to space or social behaviour: coworking, public space (and public interaction) and community building (and strengthening) in the third places.

Untargeted and indirect communication is often considered as a desirable feature of a modern working space. Research shows that valuable informal education is closely connected to spontaneous and non-work related talks (see e.g. Elsbach & Bechky, 2007). New combinations of knowledge and experience, emerging from meetings of people which are not working on the same tasks, lead to innovation activity growth (Derksen, de Caluwé & Simons, 2011) and an effective experience transfer (Dale, 2005). Coworking spaces provide physical basis for valuable co-presence (Parrino, 2012): space users observe others in a state of effective work; socialize with non-colleague teams in buffer and recreation spaces; coworking spaces typically eliminate hierarchy. Moreover, coworking work style is usually associated with playful younger employees (Schuermann, 2014).

Open plan provides means to experience publicity which can be provided by different forms of public interaction. Public space, according to Goffman (2008), is seen as a place for "multiple spontaneous interactions" and serves for anonymous yet considerate observation of others and a demonstration of self. Actors in the public space may seem passive (e.g. silent), but involved in a communication – in an unfocused interaction regime. Collaboration with shared focus of attention – talking would be the simplest example – is considered a focused interaction. Both forms of interaction are possible due to openness and availability of actors for each other, which are provided by public places. In our research we aim to investigate whether the new office, designed as an open plan working space work as a public space in that sense and how it is perceived by space users.

We also use the urban planning paradigm to assess the new office. According to some research, city public places characterized by significant flow of people and an established behaviour pattern can play a significant role in community regeneration (MacDonald, 2011). The role of third places – which are neither home nor work and where people gather and hang out following the same scenario – in urban environment is highlighted by numerous scholars (see, for example, Mehta & Bosson, 2010; Wexler & Oberlander, 2017). A third place's function is seen in maintaining civic society and a community's social vitality (Oldenburg, 1999). Although ideologically questioned, third places usage in corporate environments is becoming a part of a design strategy and a prominent trend for office and coworking projects. It could be realized in a game or cafe zone, library, bar etc. - main feature is it's nudging for public interaction within a community, which is neither a family nor a direct colleagues group. Thus, we apply the notion of local community, its' regeneration and maintaining from urban planning concepts in our analysis.

The effects of office design go beyond intensifying communication and knowledge transfer: a new framework to represent and interpret all processes within organization is established by modern researches (see Peponis et al, 2007).

3 METHODOLOGY

We operate with 94 semi-structured interviews of 3 governmental bodies employees, 6 of which are top managers. All interviews have been collected during 3 months of the fieldwork. In order to reduce the impact of various biases that could have occured in interviews, the research team conducted 2 weeks of non-participant observation in various agencies. Observation consisted of a full day presence at one of a workplace inside an agency and informal communication with its employees about the new open space and their experience with it. Physical presence in the studied work space enabled us not only to depict various social patterns, modes of

communication, and multiple ways of human interaction with the elements of open space, but also to establish trust relationship with employees. In order to get access, we had to inform the ministries about the aims of our research, but all of our informants were not formally obliged to participate in the study, and vast majority of our informants were invited to the research on a voluntary basis. Such a semi-formalized approach to recruitment allowed us to gather a representative and reliable data.

Interviews were conducted following a semi-structured questionnaire that covered biographical information of a respondent, an informant's experience with the relocation process and the new workplace, and discussion of his/her tasks, professional role, relationships with colleagues, participation in formal and informal practices, and other issues of everyday social routine related to the job and the new building.

All interviews were anonymized and transcribed. For the analysis of text transcripts, a rubricator was developed that allows classifying respondents' opinions on various topics relevant to the research tasks. A catalog (codifier) is a set of tags that can be used to identify certain fragments of an interview. Interviews were analyzed within Atlas.TI 8 software by the three researchers in the mode of constant comparison and revision of results.

In addition to encoding, the text transcripts of all interviews were subjected to a meaningful analysis: interviews were compared with each other, with common topics and trends of descriptions highlighted. The resulting narratives allow us to capture changes observed in the workspace, in the organization of the process, and in the organizational practices of agencies' employees.

4 FINDINGS

4.1 Various aspects of organizational change

The need to maintain security is being questioned due to the transparency of the openspace

Open space office triggers a conflict between working requirements imposed on the confidential or, most often, semi-confidential documents and the norms of the open plan workspace, where almost no secrecy can be maintained.

> *«An employee can't leave his workplace. What if he wanted to go to the bathroom? What should he do? His colleagues can come up to his desk, looked at the documents, and leave».*

As it can be seen from the quote, the lack of privacy is considered as a threat to the security, and even colleagues are perceived 'unsafe' in that case. Aside the physical transparency, the new office impose the easy availability of computer screens, on which an employee can also perform a 'secret' work. The new extremely transparent and open environments lead civil workers to revise their category of security and establish new, collective and informal, rules of the document work.

> *«We agreed that papers [talking about any documents on paper] are not distributed, except in cases when a document must be printed and not scanned into the system [which contains e-copies of documents] — otherwise we operate with electronic copies of any documents».*

Moreover, as the trust level between employees rises in a new office, the formal rules of maintaining a high level of security are weakening, giving way to face-to-face communication.

> *«Some day I couldn't find a document by the close line [a part of documents' base which one needs a special access to], so I just went down to their 'secret room' and asked who they had addressed it to [who was the person in charge]. I mean, I should not have got in that room, but any system is imperfect».*

Documents persist to be a mean of communicating and reducing the uncertainty

Before moving to the UGO, civil servants must have been operated only with printed version of documents. However, shortly before the relocation, the top executives of the studied organizations began to implement an electronic system of document management. They even promoted a paperless environment as one of the new office's promoted benefits. However, paper document still play its role in the civil service's organizational culture.

As shown below, there exist a high level of uncertainty concerning the task distribution among the agencies and their employees, which contributes to the reproduction of practices inherent in hierarchies with high level of working communications formalization. Thus, employees of the researched organizations, even after moving into an open plan office, have not refused to use formal paper notices and documentation of correspondence in the daily working interactions.

> *«— Electronic document management has been around for a long time.*
>
> *— Why then everyone is sitting in piles of papers?*
>
> *— Not all documents can be loaded into the electronic document flow, there are secret documents, first of all. Well, secondly, not all organizations are 'immersed' in it [the electronic system]. Documents can circulate [by e-system] among ministries, but there are still agencies that are not connected [to the e-system]. And we don't share the document flow with other civil organizations».*

All in all, even though structural forms of the new physical space (open and transparent workplace, the united building and the common electronic system of document management) have had a certain effect on the employees practices, in particular, their perception of security, document flow still performs its role in ensuring communication and maintaining the hierarchy between the civil organizations and their workers.

The organization's symbolic meaning is being changed in the new physical environments

Even though low-level employees tend to evaluate changes in workplace negatively, this theoretic assumption has not been relevant for the UGO case. In fact, those respondents who occupy the lowest positions – employees who have worked in the civil service for less than three years and do not have subordinates – expressed the most positive appraisals of the new place.

For such employees, the design of the UGO is not inferior to the offices of alternative employers, such as large consulting companies. The location of the office in the Moscow city district, on a high floor with panoramic city views, is often noted as an important component of a business style office. What is more, the symbolic meaning has been drifting towards a more western paradigm.

> *«That classic institutional spirit – it has disappeared here a little. Visually it all corresponds more to a pro-western company».*

The workplace's effect on the symbolic meaning of the civil work has been directly addressed by some informants.

> *«[There is] such a visual positivity. It's not like the old walls of an old building. Everything is in bright colors and in lighting. That is such an airy feel. And this adds a kind of ease in making some work decisions. If you compare it with a surfer – he slides the wave, he jumps. So easily. He is not floundering in the waves, struggling with something, but it [the environment] pushes him in the direction of an easy perception».*

However, those civil servants who occupy middle-level positions, express feelings of resentment and loss associated with the relocation. Those who have been working in the state employment system for some years, display strong resistance to the new environments and even consider the new office inappropriate for the civil service.

> *«— Do you think that the design corresponds to the corporate culture of the ministry?*
>
> *— Absolutely not. It is clear that people and all employees associate the ministry with a more cabinet-oriented system, and not with a modern open space».*

All the demonstrated examples prove the idea that arrangements in symbolic meaning follow changes in physical space, which is distinctly tangible for the employees, whether they find the new place attractive or not.

4.2 Work of transparency: coworking, publicity and community

Half of the relocation goals (i.e. acceleration of knowledge dissemination and informal communication) are closely related to public interaction and community building. The aim to recruit young professionals to the civil service is pursued by providing a presumably attractive design, part of which is openness and intentional dissimilarity to the usual public service image. Coworking networking in UGO, however, is limited.

Emerging practices and limitations

On the organizational level, concentration of several institutions in one building provides typical advantages of coworking spaces. Employees from different organizational bodies get chances to meet and exchange knowledge in numerous combinations. For example, department A arranged a blood donation event, which attracted people from other organizations, including B. Several weeks later, division B was hosting a lecture on time-management and invited their colleagues from A to join.

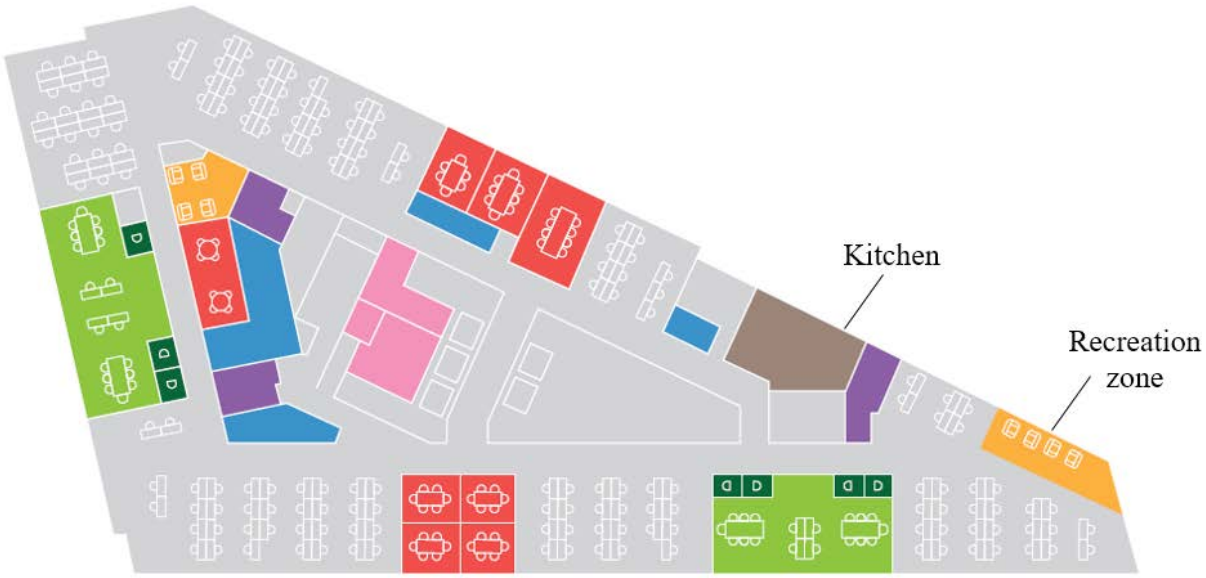
Smoking area of UGO functions as a public place where an unfocused interaction can easily turn into a focused one by starting a conversation. For example, employees of several ministries, meeting regularly in the smoking area, heard about open positions with better working conditions in one of the agencies occupying the UGO, and offered their candidacies This case could be described as an example of spontaneous interaction. Thus, smoking area acts as a public space, where small talk in a group of people triggered a reaction.

On an employee level, respondents often praise classical effects of coworking spaces – useful meeting with diversity – in a general way: *«... many ministries are concentrated here at once, which means that it will be possible for me to meet new people, enlarge my network of acquaintances and use it for personal purposes».* However, certain examples of fruitful or peculiar encounters causing public interaction, as mentioned above, are quite rare.

For some informants openness to unknown observers does not seem to be safe enough: *«...people no longer have parties celebrate special occasions. We have cameras everywhere…»*. In this case CCTV is perceived as a burden for informal communication, which is mutually desired both by managers (and the goals of relocation) and employees.

Rules of space usage, especially noise reduction (loud talking, phone sound etc) are often mentioned throughout the interviews. These rules could be formulated orally within a conflict or a priori by administrative staff or other employees. Obviously, perceived (by informants) goal of these rules is to increase the comfort of space users. However, the rules also regulate the natural transparency of space, limiting some actions demonstration, as in above example with uncomfortable partying. Effects of this kind of controlled transparency may be seen in a longer distance and need to be checked.

Figure 1. Floor plan of UGO.



The range of places that may provide its users with a noticeable flow of people and an opportunity to promote person-to-person interaction and observation of each other is limited. The smoking area is applicable for smokers only. Kitchens are equipped with an always-on TV; ⅓ of kitchen sitting areas are window-facing, turning a visitor's back to others. Recreational sofa areas on each floor do not succeed in gathering employees due to insufficient visitor traffic.

Apart from furniture, these areas lack triggers for possible activities or invitation to play. Moreover, sofas are considered to belong to the nearest departments (their proximity to working desks is also a burden), even though formally serving the whole floor.

> *«...the recreation area that's in that wing [of the floor] is not for us. Only those [employees] who sit there use it».*

The limit of public spaces is amplified by the fact that UGO users experience a loss in terms of social areas variety, compared to their previous workplaces. There is no sports space, while in some of the old buildings, according to informants, it served as a rallying point and a meeting

place. Nostalgia for previously used type of public or third places may become a barrier for new type of publicity in UGO providing more chances for unfocused interaction.

Space openness and visibility of direct colleagues lead to intensified practices of mutual assistance, and an improved sense of shared responsibility for the work results.

> *«I felt how great it is when there is a feeling of a team. Other departments sent us [the necessary] information almost at the last second, and many of my colleagues stayed here with me until 11 PM. That is, no one left me – [not like] we dropped you the task, you figure it out yourself. They stayed with me to help me do everything correctly. They helped me and sat with me. The crowd was at one computer, I sit at the keyboard, they told me what to write, how to do it faster».*

Employees of different groups and departments, however, experience rather low "comprehensibility" of work activities of other working units. Open plan alone does not improve employees' understanding of the tactical and strategic objectives of the department and agency they work for. Though employees see others more frequently, observation doesn't help to grow knowledge.

> *«...you are an expert in some narrow field, and, to a large extent, you don't know what other people do in the Ministry, you don't know any details, well, you know what a department's main activity is, but you do not know [any specific information] for sure...».*

In an open plan office the idea of equal use of resources dominates, which, in practice, challenges those who occupy leadership positions in civil service. Public service executives strive to use spatial advantages to ensure their superiority in the hierarchical structure of the organization by occupying meeting rooms solely, taking the most 'prestigious places' (most often located by the windows or behind a pillar that can hide a person), or exhibiting their personal belongings as decorations, which is officially prohibited for ordinary employees. However, in some observed groups a rather original form of decision-making concerning the resource allocation could be found (e.g. drawing lots).

> *«...someone says: "Well, we will pull lottery tickets out of the hat." Someone begins to calculate the processes: who has more paper which should be carried to the elevator [to carry it on another floor], who has less of it [meaning that those who possess more paperwork should be allowed to sit closer to the floor exit]. And so on».*

Attitude towards publicity

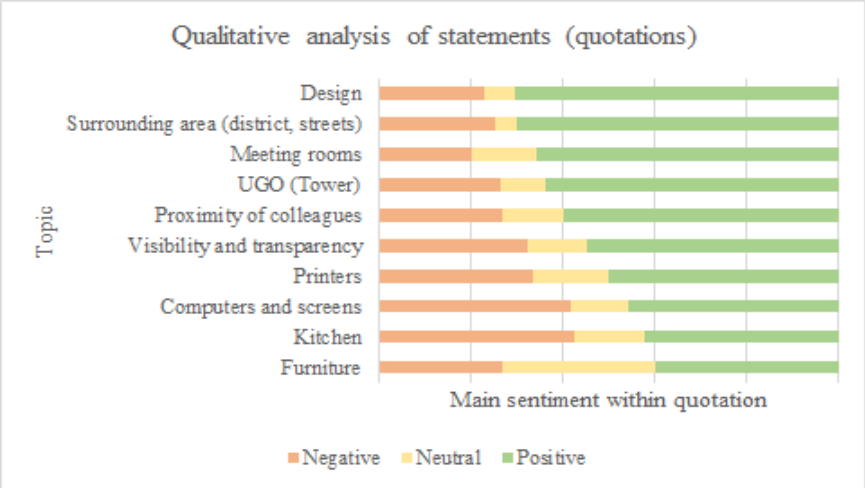
Positive attitude towards openness prevails now: proximity to colleagues and transparency of common places are assessed quite high compared to other features of the new working environment. They occupy top-5th and 6th positions accordingly in a ranking of space features derived from interview narratives (space features and the attitude towards them were used in the coding list) -more than half of statements on these topics are positive in our interviews.

However, a considerable number of our informants described the relocation and the new building using militarized speech, typical rather for martial environment than to creative industry, which civil service aspires to resemble.

> *«Technically, my position is equivalent to a General. If we consider the class ranks, then my position is equal to the major General's class rank. And there are soldiers [subordinate colleagues]. In the army, a soldier does not sit in the same room with a*

General. Not because a General likes it, or a soldier likes it. There are simply questions that a soldier should not hear».

Figure 2. Statements sentiment analysis.



5 CONCLUSION

Multiple interviews, combined with ethnographic fieldwork, enable to observe and fix the effects brought to the rigid social structure of civil service in Russia by the massive relocation of governmental bodies to the new building with innovative open plan offices. We observe changes in perceptions of formal practices of paperwork due to the exposed conflict of organizational norms (total openness and transparency opposed to required secrecy), informal communication patterns change and barriers for its' development. Actors of a rather conservative organizational culture are reacting to an open office plan and new design: whether narratives on transparency per se are positive, there is still evidence allowing us to see numerous zones of conflict between bureaucratic culture and open-plan office.

Obstacles and challenges arise when public servants socialised in bureaucratic culture are moved to open office environment. These include:

- orientation towards high level of secrecy and privacy;
- reliance on documents as a secure mean of communication;
- perception of civil service as close to the military duty;
- high level of uncertainty in task distribution;
- pursuit of hierarchy;
- nostalgia for old types of public spaces;
- adapting to increased volume of unfocused interaction in transparent spaces.

As to the intended results of the relocation project, only the aspiration to attract more young employees have been fully addressed by the new work space. Documents are still circulating in paper, and civil servants prefer to ignore the electronic system of document management. The lack of public places for non-targeted interaction with a sufficient flow of visitors does not permit

free knowledge dissemination and community building. Transparent space, although usually described positively, is sometimes perceived as an unsafe environment due to emerging peer and management control practices and probably needs special assistance for adaptation.

However, there are some unintended effects of the agencies' relocation to the UGO. This include the persistent weakening of the security requirements, a change in the civil service's symbolic meaning, and development of collective forms of cooperation[12].

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SESSION 8: PERSONALITY AND WORKPLACES

Workplace curiosity as a factor of success for driving innovation

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ABSTRACT

If a company wants to be successful and grow, innovation is essential. This exploratory pilot study has examined the efficacy of a team training program, targeting workplace curiosity and innovative work behavior. We designed an online video tutorial-based team training, the ACTIVATE CURIOSITY program. The content was tied to four curiosity dimensions and offered two techniques per dimension. We conducted program evaluation with comparisons between pre- and post-intervention survey results and with analyzing interviews with the team leads. Results show that teams benefitted from the techniques in two ways: First, the intervention altered team routines such that creative ideation become commonplace. Second, the techniques had a visible social impact. Reserved members contributed more often, and group confidence increased. The qualitative data analysis shows evidence of these behavioral changes. The data show that a training intervention to increase workplace curiosity can improve the innovation potential of teams. Since the intervention was designed as a team-online training, evidence suggests that training teams, even virtual teams, is a promising approach for increasing innovative work behavior.

Keywords

Curiosity, innovation, curiosity dimensions, multidimensional workplace curiosity scale, Merck KGaA, Darmstadt, Germany

1 PREMISE

The world is growing more volatile, uncertain, complex, and ambiguous. The pace of change, from technology to the environment, is increasing in speed. Global market forces follow these trends as competitive pressures are pushing organizations to alter their practices and consider innovations that did not exist five years ago. To some degree, an organization is an aggregation of the attitudes, actions, behaviors and decisions of the people in it. To understand how an organization considers and adopts innovative practices, there is utility in beginning with teams and individuals within those teams.

Innovation can be understood as a problem-solving strategy for dealing effectively with work related problems (Bunce & West, 1994). Researchers have been trying to uncover the workplace behaviors that increase the probability of approaching rather than avoiding the innovation that will improve the opportunities of an organization (e.g., Anderson, De Dreu & Nijstad, 2004; Janssen, 2000; Kleysen & Street 2001; Meißner, 1999; Scott & Bruce, 1994). To extend this work, researchers must explore the antecedents of workplace innovation, and whether and how these antecedents can be modified in teams and individuals (Kleysen & Street, 2001).

With regards to characteristics theorized to increase the probability of innovation (Janssen, Vliert & West, 2004), we focused on a construct which has only recently received attention. A small body of research has found that individual differences in curiosity are an important unique predictor of idea generation (Hardy, Ness & Mecca, 2017) and work curiosity (e.g., Celik, Storme, Davila, & Myszkowski, 2016; Chang & Shih, 2019; Hagtvedt, Dossinger, Harrison, & Huang, 2019).

Based on previous research on the measurement of workplace curiosity and associations with innovative work behavior (Kashdan et al., 2019), we employed a four-dimensional construct of workplace curiosity. The framework includes four dimensions of workplace curiosity: Joyous Exploration, Deprivation Sensitivity, Distress Tolerance, and Openness for Other People´s Ideas. Initial data provides evidence of satisfactory psychometric properties in both United States and German samples. We used this multidimensional model to measure baseline and post intervention levels of team curiosity as well as a guideline for designing the intervention.

Workplace Curiosity

The conceptual model developed by Kashdan et al. (2019) is based on prior findings from Mussel (2013), who developed a one-dimensional, domain-specific curiosity scale. Evidence supported the strongest linkages between workplace curiosity and intellectual engagement and openness to ideas, along with individual job performance (e.g., Mussel, 2013; Mussel, Spengler, Litman & Schuler, 2012). Additional studies (Reio & Callahan, 2004; Mussel & Spengler, 2015; Harrison & Dossinger, 2017) reinforce the possibility that curiosity has considerable benefits in workplace engagement, productivity, creativity, and innovation. However, these findings are limited to empirical research on curiosity and innovative work behavior at an individual level. In the workplace, individuals work together in teams within an organization. Our aim was to extend this body of work by exploring these additional levels of functioning in the workplace.

Innovative Work Behavior

Conceptual models distinguish creativity as focusing on the generation of novel and useful ideas and innovation as the implementation of these ideas into processes and products (e.g., Anderson, Potočnik und Zhou, 2014). Innovative work behaviors are best described as a broad range of behaviors that span idea generation, idea championing, and idea implementation (De Jong & Den Hartog, 2010; Janssen, 2000; Naughton & Zander-Schellenberg, 2019; Sameer 2018; Scott & Bruce, 1998). Our initial work suggests that workplace curiosity is more strongly linked to innovative work behaviors than more widely studied individual differences such as mindfulness (Kashdan et al., 2019). What remains to be seen is how this relationship changes over the course of time, especially with the onset of targeted interventions to increase both curiosity and innovation.

2 GUIDING QUESTION

We wondered if a training intervention could increase workplace curiosity levels that in turn would serve to increase innovative workplace behavior. This exploratory pilot study examined the efficacy of a team training program targeting workplace curiosity and innovative work behavior.

3 METHODOLOGY

3.1 Sample

We recruited 133 adult workers from 10 teams within Merck KGaA, Darmstadt, Germany, a science and technology company that has a strong focus on R&D. Team size ranged from four to 26. In terms of sample demographics, 51.1% of the workers were women, with ages ranging from 25 to 52.

Teams were non-randomly selected to ensure representation from each of the three business sectors of Merck KGaA, Darmstadt, Germany (Performance Materials, Life Science and Healthcare) and corporate functions, different world regions, and both remote and in-person presence.

Team 1: 10 members from the Life Science business unit working together remotely in different geographical locations.

Team 2: 13 members from the Life Science business unit working together in person in the United States.

Team 3: 12 members from the Performance Materials business unit working together in person in Germany.

Team 4: 19 members in the Performance Materials Business Development sector working remotely. This team dropped out at mid-point due to a restructuring measure within the business unit.

Team 5: 14 members from the Healthcare R&D sector working together in person in Germany.

Team 6: 20 team members from the Healthcare Research Analysis team in two locations (Germany and the USA), working together remotely.

Team 7: 26 team members from the Healthcare R&D/innovation sector in different geographical locations, working together remotely.

Team 8: 17 team members in Corporate Affairs, working together in China.

Team 9: 9 team members from Site Management working in Germany.

Team 10: 12 team members from an innovation group in South America working together remotely.

Program participants, including the Curiosity Activators, completed a survey at the beginning and end of the program. Activators and team members also provided feedback during the duration of the program via:

- Month 1 check-in calls (Curiosity Activators)
- Monthly feedback diaries (Curiosity Activators)
- Midpoint e-poll (Curiosity Activators and team members)
- Final check-in calls (Curiosity Activators)

At the beginning, a total of 133 respondents completed the pre-program Curiosity survey, and nine out of the ten Curiosity Activators participated in the Month 1 check-in calls. At program mid-point, there was a decline in response rates, with only 45 Curiosity Activators and team members completing the midpoint e-poll. The decrease in responses compared to the pre-program Curiosity survey can be attributed to team attrition, changes in team composition, and lastly, failure to complete the midpoint e-poll within the allotted time frame until November 15th, 2019. To capture results, we conducted final check-in calls with eight of the nine remaining participating Curiosity Activators.

Post-intervention survey participants per team:

Team 1: n=4 (4 same as pre-program = 40%)

Team 2: n=9 (5 same as pre-program = 38%)

Team 3: n=7 (5 same as pre-program = 42%)

Team 5: n=8 (7 same as pre-program = 42%)

Team 6: n=1 (1 same as pre-program = 5%)

Team 7: n=14 (12 same as pre-program = 46%)

Team 8: n=0

Team 9: n=0

Team 10: n=5 (5 same as pre-program = 42%)

3.2 Video tutorial-based team training program

We designed an online video tutorial-based team training program, the ACTIVATE CURIOSITY program. Each tutorial consisted of a video introduction to the intervention, incorporated an explanation for choosing said intervention, its scientific background and application examples in a business context. This was followed by a step by step explanation of the intervention procedure

itself. Participants were invited to stop after each of the steps to complete exercises that apply the principles to their day-to-day work life. Each intervention element was tied to one of the four curiosity dimensions.

Joyous Exploration is the pleasure of recognizing and seeking out new knowledge and information at work, and the subsequent joy of learning and growing. The two tactics designed for this dimension are the Intelligent Question Model (IQM) and Mirror Thinking.

- **IQM** is a structured way to explore an issue by asking questions. When people care about a problem and then systematically start thinking about questions and putting them down on paper, patterns begin to emerge about the kinds of questions being asked, and the kinds of answers being sought. These patterns can help to narrow the field of questions, which helps to target the right answers.
- **Mirror Thinking** is an approach to conceive and engage with two or more opposite or contradictory ideas, concepts, or images, simultaneously. This kind of paradoxical thinking ignores the rules of common logic, which is precisely why it supports cognitive flexibility and innovative thinking. The tactic Mirror Thinking turns this approach into a process.

Openness to people's ideas means valuing people with diverse perspectives and ideas and intentionally seeking out different approaches at work. The two tactics designed for this dimension are Parallel Thinking and Plussing.

- **Parallel Thinking** uses the power of immersion and metaphors to free people from their routines. In addition, it introduces a parallel development process with participants developing several solution approaches. These will then subsequently receive feedback from mentors, allowing participants to narrow down their approaches until they have one final solution approach left. It prevents early lock-in toward one way of thinking or behaving by developing and working on multiple ideas.
- **Plussing** is a structured way to give constructive feedback on ideas within a team. It keeps people motivated by ensuring ideas are heard and taken seriously. Pure criticism may not be expressed; instead, every criticism must immediately include a constructive suggestion how to improve an idea.

Deprivation Sensitivity means recognizing a gap in knowledge and pondering abstract or complex ideas to try to solve the problem and reduce the gap. (It offers a sense of relief when the problem has been solved.) The two tactics designed for this dimension are Hypothesis Testing and the Unfixing Technique.

- **Hypothesis Testing** supports empirical creativity by transforming assumptions into hypotheses that can be tested. Testing is based on a measurable number that can be tracked, for example a certain number of people interested in a new offer. Structured feedback loops help to define the next steps. The idea that any additional work beyond what is required is a waste is central to the tactic's principle.
- The **Unfixing Technique** helps people to reduce fixed mindsets. It centers on the ability to relentlessly drill down beyond what is normally assumed. In order to change the way a problem or creative task can be approached, it must be considered what they consist of. Each aspect is broken down into its basic ingredients. This is the way lose fixedness. It

helps to change the way an object is described, which allows avoiding unintentionally narrowing its conception, and ultimately leads to more ideas for its potential use.

Distress tolerance is the willingness to embrace doubt, confusion, anxiety, and other forms of distress that arise from exploring the new and uncertain at work. The two tactics designed for this dimension are Cognitive Reappraisal and Attentional Intelligence.

- **Cognitive Reappraisal** is a way of regulating emotions which is helpful when dealing with the new, the complex or the unexpected and the negative feelings that can follow this. Changing the course of people's thoughts can change the course of their emotions. By reinterpreting a situation and taking another perspective, it is possible to either reduce the severity of the negative response or replace the negative attitude with a more positive one.
- **Attentional Intelligence** is not about distracting users from their stressors but about refocusing their attention by helping them to reconnect with their surroundings and their desired qualities. It is about making room for other perspectives, which will help to lessen the power of these stressors.

3.3 Pilot Program Set-up

In September 2019, a six-month pilot program commenced. Voluntary selected teams of different business areas, approached via our personal network within the company, completed a pre-intervention curiosity survey (see State of Curiosity report 2018, curiosity.merckgroup.com). In addition, the teams answered questions regarding what worked well with them and responded to an open-ended question about the innovation challenge they wanted to solve using the program. The survey results and the additional questions were evaluated by the company's Curiosity Council members (CCM), Dr. Carl Naughton and Andreas Steinle; individual tactic recommendations (4 tactics each) were provided for each team.

The program started with a video conference with "team leads", also known as "Curiosity Activators". (Please note that not all of them were team managers within the organization; in five teams the activators were team members who volunteered to lead the team through this program.) In addition to the program explanation, all Curiosity Activators received a recommendation of four tactics based on their team's survey results. The activators were asked to organize their team's approach to the program with setting up respective meetings, providing material for exercises if required and tracking their team's progress.

Team progress was evaluated through monthly check-in calls or e-mails from the Curiosity Activators and a mid-point poll sent to all team members. A mid-point meeting was undertaken to enable the Activators to discuss implementation issues, obtain expert CCM support and exchange ideas and methods. Six activators took part in this meeting, three of them via video conference.

The mid-point poll did not include a measure to track the number of occasions the tactics were actually employed on.

At the end of the program each team took the curiosity survey again and each of the activators had a telephone interview to discuss their outcomes. These interviews were introduced as an opportunity to discuss experiences, successes and changes activators witnessed on their teams, as well as challenges that activators faced with implementing the program. Participants started off with a question about whether the team achieved their business innovation goal followed by

questions about the top three successes of implementing the program. Subsequent questions asked for the hypothesized reasons for success.

The activators were asked what, if any, behavioral shifts they experienced within their team.

The next question focused on the message the activator would convey to senior leadership teams about the program and its potential value to the business.

The last three questions elaborated on the support that was available, additional material that would help future activators, and suggestions for refining the program.

Program evaluation centered on comparisons between pre- and post-intervention survey results. In addition, we coded the audiotaped post-intervention interviews with Curiosity Activators in order to obtain qualitative data. Eight of the nine Activators took part in post-intervention interviews.

4 RESULTS

4.1 Curiosity Scores

In the pre-intervention survey, participants (n=133) obtained an overall average workplace curiosity score (across the four dimensions) of 80.5/100. This average score is higher than the average score of participants from the 2018 State of Curiosity Report (70.3/100). Employees scored highest in the Openness to People's Ideas Dimension (86.8/100) and lowest in the Stress Tolerance Dimension (74.0/100). Averaging the scores of each team member for each of the teams, all ten endorsed workplace curiosity scores were above the average Curiosity score from the 2018 State of Curiosity Report. The lowest team scored 77.3/100 and the highest team scored 84.5/100. In the post-intervention survey, participants obtained an overall average score of 83.66/100. The scores for Openness to People's Ideas increased from 86.8/100 to 88.2/100, for Joyous Exploration from 82.2/100 to 84.5/100, for Deprivation Sensitivity from 76.8/100 to 80.0 and for Stress Tolerance from 74.0/100 to 82.0/100. Although the raw scores increased from pre-intervention, we failed to find statistically significant difference from pre- to post-intervention. Due to low numbers of participants in the post-program survey, we added a qualitative data analysis for the final interviews with the Activators.

4.2 Views on Curiosity in the workplace

At the beginning of the program, 80.4% of respondents agreed or strongly agreed that investing in curiosity-enhancing tactics to drive innovation is a sound investment. However, 51.1% of respondents reported that a barrier to curiosity in the workplace is that most new initiatives or projects arrive from upper administrators (i.e., top down), leaving them unable to act on new ideas. This leads us to believe that there is a need for increased employee participation in initiatives. The ACTIVATE Curiosity program could help overcome this barrier by encouraging employees to take full ownership of the program and its implementation. At the end of the pilot program the number of respondents who strongly agreed that investing in curiosity-enhancing tactics to drive innovation is a sound investment increased by 5.53% to 55.3%.

4.3 Qualitative Data on Team Progress and Program Impact

The post-intervention interviews from eight team leaders were analyzed and evaluated according to the textual structured qualitative content analysis by Kuckartz (2018) with the software

MAXQDA. The analysis aims to structure the data by forming main and subcategories, which help to evaluate and interpret the data.

The final interviews were conducted by phone at the end of the intervention between February 11th and February 19th, 2020 with the respective program lead of each participating team. A team member of the Curiosity initiative from Merck KGaA, Darmstadt, Germany and an employee of the supporting agency were present, and the sessions were recorded and sent to a third party for transcription. These transcripted documents were used for data evaluation. Statements concerning the induction were marked and memos created to summarize the findings, which could be relevant for the evaluation. Based on the first collection of statements, the following four main categories were created deductively:

- “Behavioral changes”
    - "I think we’re more accepting of each other’s ideas and sharing ideas. Group confidence has gotten better. Ultimately also sparking some creativity in how we talk with each other and try to solve problems.”
- “Refreshed way of thinking”
    - "People have their own attitude, their own thinking; they are sometimes quite fixed in the way they’re thinking. The mirror thinking was definitely something to actually go out of your own perspective, pick something else, and consider reflecting on a specific aspect from a different perspective."
- “Roll-out of the initiative pilot”
    - "Yes, we tried to keep it really more casual like, 'Hey, let’s try this out,' rather than, 'There’s a new initiative and we have to do this'. The nature of the program itself is a little bit fun and a little bit playful and it didn’t come across so much like more work."
- “Suggestions for improvements”
    - "The training videos were considered quite long. If you have a busy schedule and you want to watch a video, it would be nice to shorten them, eventually, a little bit."

The first two categories are especially interesting as they describe the impact the program had on the teams. The amount of statements (44 in total) confirms the personal perception of the activators that there was a cultural shift in the team. The third category reverses the perspective and identifies how the working environment effects implementation in the workspace. The fourth category is valuable for the further development of the intervention but will not be discussed in the present paper. Overall, 106 text segments were coded in the interviews.

The software MAXQDA compiled the coded segments automatically for each category. In the second reading of these segments, similar tendencies became obvious, hence subcategories were formed inductively within each main category. The interviews were coded again following the specified coding system. Within this process the same texts segments can be assigned to different categories. The coding guideline (see Appendix A) defines how the text segments were assigned to the respective category.

The category “Behavioral changes” implies that the intervention on one hand improved the collaboration within the team. One Activator reported they became “more accepting of each other’s ideas and sharing ideas. Group confidence has gotten better.” Another noticed “they started to be much more productive in the process to producing ideas and coming up with conclusions and recommendations around those ideas” and it helped to reduce “hierarchical thinking a little bit”.

The team showed a difference in their behavior and, additionally, participants experienced personal changes, compiled in the subcategory “Personal Growth”. The team lead witnessed changes in the quieter members — “a big development, in terms of how much they discussed, how much they say in such a meeting and what they were at the end.” As implemented tactics increased team member participation, it is possible that confidence increased along with the feeling that it “was very much appreciated if they said something, and that it had a certain impact.”

During the final check-in calls, Activators highlighted that the program also supported teams in progressing towards their innovation goals, and in the case of two teams, to achieve them. In addition to progressing towards their innovation goal itself, one Activator also reported that “working on the goal in the context of the Curiosity initiative helped to refresh team goals, objectives, mission”. Teams that have not achieved their goals believe that they made “really strong steps” towards them and that “projects have been significantly aided by the program”.

To achieve a certain goal, it helps to look at an objective from different perspectives, and the category “Refreshed Way of Thinking” underlines how the intervention supported this. One Activator explained that the team was “fixed in the way they’re thinking”, however, the intervention pushed them to “pick something else, and consider reflecting on a specific aspect from a different perspective.” In the end this resulted in the team to come up with “solutions, and most important, the business understood, accepted them and is working to implement them”. Other statements in the subcategory “Development of new ideas” validate these observations.

Finally, mid-point e-poll scores revealed that teams with initially lower pre-intervention scores obtained higher midpoint scores. On the other hand, teams with high pre-intervention scores obtained the lowest scores in the midpoint e-poll (not statistically proven). Members from the lower scoring teams at mid-point commented that their lower scores were attributed to their curiosity and motivation being high prior to the intervention with little room for change. This suggests that the program might have a greater impact on teams that have low Curiosity scores at the beginning of the program.

The success of the intervention depends on the working environment in which it is implemented. The category “Roll-out of the initiative pilot” shows that the working space has either a positive or a negative effect on the outcome of the intervention. When the pilot was kicked-off and organized in a rather “light and playful manner” or “casual way”, the outcomes improved. One activator mentioned that it shouldn’t feel “like more work”. When the intervention was overrun by other priorities and everyday work overwhelmed the teams, they had difficulties in engaging with the program. One activator observed “people were quite reserved and critical about the program because we have so many appointments. We have so many appointments and it was just an extra hour that they had to spend.” Those teams struggled to stick with the program. While curiosity might be malleable and trainable, the working environment has a crucial effect on results. This confirms the findings of the Curiosity Report (Merck, 2019) already conducted in

2018, which showed that only a quarter of employees (28%) say they are provided time to explore new ideas at work.

According to monthly check-ins, while watching tutorial videos and implementing tactics over the first few weeks, two Curiosity Activators reported that curiosity and creativity had not yet been sparked within their teams. One team reported that some team members were skeptical of the program's value because they branded themselves as being very curious scientists. Two teams reported the implementation of tactics within the first two months with the use of special meetings (e.g. team 3, two 4-hour meetings and 5 1,5-hour meetings). Three teams met bi-weekly and implemented two of their four recommended tactics after only two months; three teams met monthly and reported that team members watched the video tutorials individually. These teams used their team meetings for the recommended exercises and to work on their business innovation goals. Comparing these different approaches to implementing tactics, it becomes clear that greater guidance for how the program will be implemented and what barriers and enablers exist might improve the process and outcomes. Nevertheless, the midpoint e-poll scores suggested that participants believed that the program would help them to improve teamwork, contribution and engagement. More importantly, Curiosity Activators reported in the feedback diaries and the final check-ins that they witnessed positive culture shifts and behavioral changes in their teams as a result of the program.

5 CONCLUSION

Innovation is thought to be one of the key drivers for developing and maintaining a competitive edge in organizational settings (Baer & Frese, 2003). Innovative behaviors are the contributions by individuals or teams, including the "generation, introduction and application of beneficial novelty at any organizational level" (Kleysen & Street, 2001, p 285). We explored the potential impact of workplace curiosity on innovative behavior. We tested whether a 6-month online curiosity training program enhances curious and innovative behaviors. Intervention techniques were tied to each of the four dimensions of workplace curiosity: Joyous Exploration, Deprivation Sensitivity, Stress Tolerance, and Openness to People's Ideas. Intervention techniques were matched to nine international teams from different departments of Merck KGaA, Darmstadt, Germany, based on respective team curiosity baseline scores — lower scores on a dimension led to an intervention with tactics on that dimension.

As the Covid-19 crisis reached a first peak in China in February, the Chinese team and its Activator were not available for the post-program survey and for the final interview. In the post-program Curiosity survey conducted in February/March 2020 the responses dropped to 48 participants. We assume a negative influence of the Covid-19 pandemic here as well.

Survey results showed that each team had a strong curiosity baseline and benefitted from the techniques in two ways: First, the intervention altered team routines such that creative ideation became commonplace. Second, the techniques had a visible social impact. Reserved members contributed more often, and group confidence increased. The qualitative data analysis showed these behavioral changes and the "refreshed ways of thinking".

Attrition in longitudinal studies is a well-documented phenomenon in naturalistic work environments (for an overview see Cotter et al., 2005; Gustavson et al., 2012). Since the data collection based on the results from the four-dimensional workplace curiosity inventory (MWCI) did not yield to statistical analysis, we had to focus on the qualitative data obtained during the

pilot study with semi-structured interviews. This presents a challenge in evaluating intervention efficacy. Possible reasons for the lack of data could be that the study collided with the Covid-19 pandemic, thus disrupting not only work routines but also commitments like those connected with the ACTIVATE program. Furthermore, organizational reality is such that teams change, team set-ups are adapted to evolving organizational needs, and the workforce is constantly changing with lateral and horizontal moves along with organizational firings and retention problems.

Evaluating the qualitative data, we observed several categories which help understand the impact of the pilot program. Participants pointed out a detection of behavioral change that resulted in an increased awareness of other participants´ thought processes and ideas. This reflection can be associated with one of the dimensions of the multi-dimensional mode, openness to other people´s ideas. Furthermore, participants reported a "refreshed way of thinking" which they attributed directly to tactics targeting cognitive flexibility (e.g. mirror thinking). More work is needed on the importance of psychological flexibility in workplace settings (Kashdan & Rottenberg, 2010)

On a more general level, 44 statements reflected that the interventions enabled a cultural shift with the teams. This is in accordance with qualitative data from a prior pilot program that focused on a face-to-face training of curiosity enhancing interventions (Naughton et al., 2018), where participants noted that using the interventions led to a different mindset.

Practice Implications

To our knowledge the research program presented is the first attempt to use an online training program to increase workplace curiosity. The data show that workplace curiosity can be measured with acceptable psychometric properties and is malleable, suggesting usefulness in program evaluation efforts. The reports show that specific techniques helping induce a curious mindset creativity (Mumford, Martin, Elliott & McIntosh, 2018) can alter the innovation potential of teams. Since the intervention was designed as a team-online training, evidence suggests that training teams, even training virtual teams, is a promising approach for increasing innovative work behavior (Widmann, Messmann & Mulder, 2016). Process loss in groups due to a fear of unjust criticism, a fear of getting insufficient credit for work conducted, a fear of being neglected and underappreciated, and a fear of sharing ideas can be counteracted (e.g., Paulus, Larey & Dzindolet, 2001). Finally, the generation of techniques based on initial workplace curiosity scores offers a counter to "one-size-fits-all" team trainings. Different teams have different qualities that might require different nutriments.

As the results give an indication that teams and the whole organization can benefit from trainings enhancing workplace curiosity, a company-wide roll-out of the program is planned for this year. A baseline research on employees' curiosity scores will take place in August. The invitation to take part will go out to all employees in Germany, China, the USA, and the Latin America and Europe Middle East Asia regions.

The Activate Curiosity training program will be established on LinkedIn Learning in nine language versions, allowing employees not fluent in English to participate. The program will be voluntary and self-guided. Internal communication on the benefits of this program will be commenced in the second half of 2020 and will be ongoing.

Strengths and Limitations

Participating teams reported above average baseline curiosity scores. To date, we do not have any data on whether teams that score below average benefit from online trainings. Our findings on innovation are limited by a reliance on self-reports, and future work would benefit from supplemental behavioral assessments. Despite these limitations, our work offers insights into the nature and malleability of curiosity in workplace teams, and the downstream influences on innovative behavior.

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APPENDIX

A. Coding Guideline

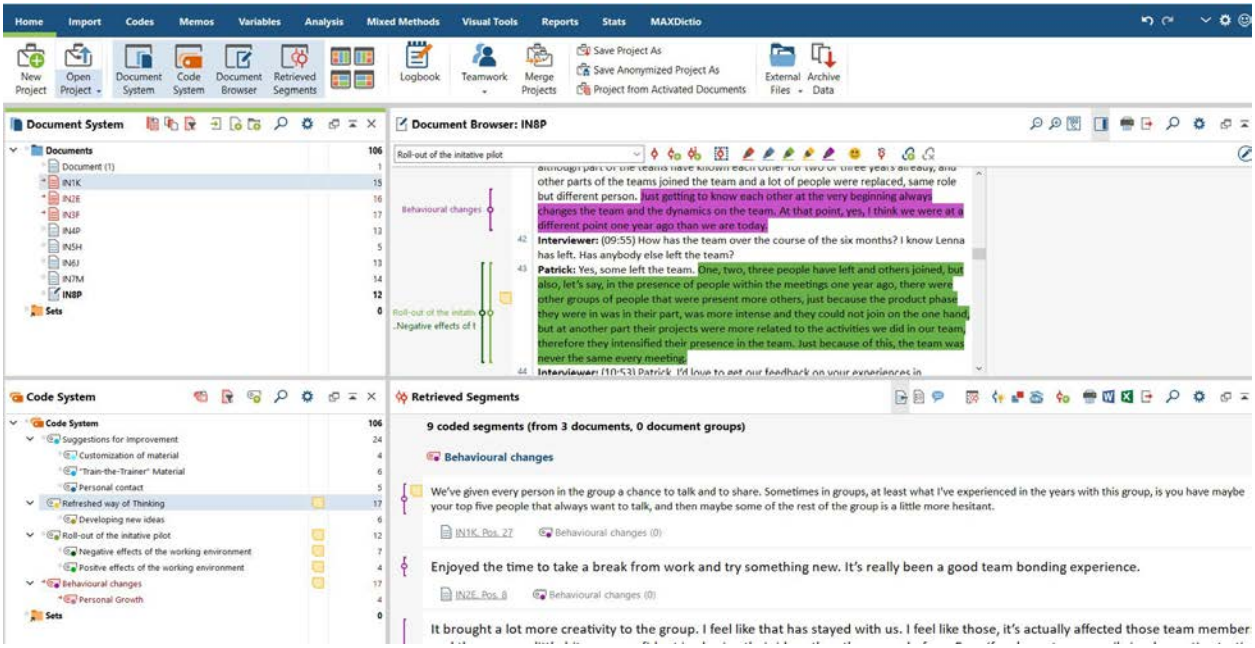
Category Type	Category Name	Definition	Coding Rule	Coding Sample
Main category 1	Behavioral changes	Includes the effect of the intervention on the behavior of the team	Collects all statements regarding behavioral changes in the team	IN2E: t"I think we're more accepting of each other's ideas and sharing ideas. Group confidence

			collaboration	has gotten better. Ultimately also sparking some creativity in how we talk with each other and try to solve problems." #00:06:17-2#
Subcategory 1 Level 1	Personal growth	Includes the effect of the intervention on single members of the team	Collects all statements regarding a change in the attitude of team members	IN7M: "I really saw for certain people a big development, in terms of how much they discussed, how much they say in such a meeting and what they were at the end." #00:06:42-7#
Main category 2	Refreshed way of thinking	Includes how the implemented tactics helped to approach a business goal	Collects all statements regarding how the implemented tactics helped the team to manage their tasks and changed their way of thinking	IN3F: "One thing that I also thought was quite helpful and people have their own attitude, their own thinking; they are sometimes quite fixed in the way they're thinking. The mirror thinking was definitely something to actually go out of your own perspective, pick something else, and consider reflecting on a specific aspect from a different perspective." #00:14:22-3#
Subcategory 1 First Level	Developing new ideas	Includes how the implemented tactics helped to generate new ideas	Collects all statements which explicitly mention that the tactics helped the teams to develop new ideas	IN1K: "I think the top three successes have been we've generated some really good fresh, new ideas." # 00:03:28-1#
Main category 3	Roll-out of the initiative pilot	Includes the overall framework in which the intervention was rolled out	Collects all statements referring to the working environment and the approach on how the intervention was implemented	IN1K: "Yes, we tried to keep it really more casual like, 'Hey, let's try this out,' rather than, 'There's a new initiative and we have to do this'. The

				nature of the program itself is a little bit fun and a little bit playful and it didn't come across so much like more work." #00:05:28-1#
Subcategory 1 Level 1	Positive effect from the working environment	Includes how the working environment influenced the intervention in a positive way	Collects all statements which show how the intervention was implemented and how it affected the outcome in a positive way	IN1K: "How our team engaged it is a kind of fun and additional layer onto our everyday life, rather than something that we have to work and put a lot, a lot of time. If we can get folks to receive it in a very light and playful manner, the outcomes, even in our team, has been great." #00:07:18-1#
Subcategory 2 Level 1	Negative effect from the working environment	Includes how the working environment influenced the intervention in a negative way	Collects all statements referring to barriers which blocked the success of the intervention	IN5H: "I think that people were quite reserved and critical about the program because we have so many appointments. We have so many appointments and it was just an extra hour that they had to spend. They were not really happy. Also, I got the task of my bosses to do this program, but also to look at the resources. To do it but with minimal effort, let's say." #00:02:56-5#
Main category 4	Suggestions for improvements	Includes suggestions by the participants on how to improve the intervention	Collects all statements which include suggestions for the intervention	IN3F: "The training videos were considered quite long. If you have a busy schedule and you want to watch a video, it would be nice to shorten them, eventually, a

				little bit." #00:13:20-3#
Subcategory 1 Level 1	Customization of material	Includes suggestions regarding the customization of the material	Collects all statements which suggest that customizing the material could lead to a higher engagement during the intervention	IN8P: "But this is an important thing to be sustainably successful as an initiative within Merck, on the one hand, and on the other hand, try not to be one size fits all when you explain the value of a program like this, but try to break down to users. We're not talking about every single person with their very individual framework, but at least start to think about user groups." #00:21:44-8#
Subcategory 2 Level 1	"Train-the-Trainer" material	Includes suggestions which refer to train-the-trainer material	Collects all statements referring to material which could assist the person leading the intervention in the respective team to engage the team members better	IN2E: "I think maybe having, for each video or each training module, some kind of heads up for the person leading it. Written out what the activity is, just to prepare beforehand." #00:09:04-2#
Sub category 3 Level 1	Personal contact	Includes suggestion which refer to more personal contact during the intervention	Collects all statements which explicitly mention the need of personal meetings	IN8P: "I think what could have helped was, maybe, a personal catch up, like the call we're having right now, and maybe an on-topic discussion regarding the tactics." #00:12:05-8#

B. INTERFACE AND CODING METHOD WITHIN THE QUALITATIVE DATA ANALYSIS SOFTWARE MAXQDA



SESSION 9: WORKPLACE PERFORMANCE MANAGEMENT

Contextual user research methods for eliciting user experience insights in workplace studies

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ABSTRACT

Purpose: The purpose of this paper is to contribute with experiences and reflections on user research methods that we have tested in our studies of users' experiences in office environments.

Theory: Previous workplace studies with qualitative data approaches mainly rely on traditional methods such as interviews and observations. Based on user-centered design research, we outline methods that can be used to facilitate understanding the interrelations between users and their surrounding environment.

Design: Three methods and their variations were applied in different case studies to facilitate understanding of user experiences in office environments: (i) spatial walkthroughs, (ii) card sorting, and (iii) experience curve mapping.

Findings: Spatial walkthroughs were more immersive and provided most insights on the actual context with respect to spatial design qualities. The card sorting enabled exploring user experiences with respect to predetermined aspects. The experience curve mapping enabled understanding the temporal aspects of the user experience. The latter two methods were less immersive and less disruptive in the organisational context than the spatial walkthroughs. The flexibility of these methods allows for tailoring the application depending on the purpose of the workplace studies. We recommend using a combination of these methods to capture a more holistic understanding of user experiences and improving the workspace design to better fit the users.

Originality: The outlined methods required user involvement and participation and provided insights for making evidence-based recommendations for designing or redesigning office environments that fit users' needs and preferences.

Keywords

User research; Qualitative methods; Workspace design; Office evaluations; User involvement

1 INTRODUCTION

New ways of organising work and using resources in office environments such as implementation of Flexible Offices are being increasingly implemented in organisations worldwide. These implementations take place amidst larger societal transitions such as the need to mitigate negative

environmental impacts coupled with consumption of goods and energy, as well as technological changes such as the prevalence of portable computing devices and cloud services in people's everyday life. However, research results on the outcomes and implications of relocating to flexible offices show challenges in terms of satisfaction with workspaces and perceived performance (see the literature review by Engelen et al., 2019). This is reported to be due to unassigned workstations and lack of privacy (Morrison and Macky, 2017), and poor ergonomics and mismatches with employees' needs and preferences (e.g. Babapour, 2019a). This highlights that design of such new and flexible offices is often inadequate due to a limited understanding and anticipation of needs and preferences of employees as users of these workplaces.

While there are many works in the workplace research field that address how office environments impact employees (de Croon et al., 2005), there is a wider gap in aiding workplace designers when exploring, creating, evaluating or further developing office solutions from a user-centred design perspective. The study of user experience requires a more holistic approach to gain a more in-depth understanding of users' complex and multidimensional experiences (Desmet, 2003; Law, 2011). In the context of offices, user satisfaction have been addressed with respect to a set of factors such as thermal comfort, air quality, or noise control (Minyoung et al., 2019). However, focusing on general satisfaction with these factors does not suffice for understanding users' experiences in flexible offices since use preferences and actual usage patterns vary considerably among office users (Babapour 2019a; Cobaleda-Cordero, 2019). In contexts other than office environments, qualitative contextual inquiries are recommended to elicit rich user experience data and understand conditions of users' activities in actual real-world situations e.g. with regards consumer products or interaction design (Forlizzi, 2008; Nardi, 1996). However, use of qualitative methods for the study of user experiences in office environments is limited. Therefore, we focus on providing an overview of methods that can lead to a better understanding of users and their use situations, and finding more fitting workplace designs.

The aim of this paper is to contribute with experiences and reflections on user research methods that we have tested in our studies of users' experiences in flexible offices. Specifically, three methods are outlined in the next section. For each of the methods, a theoretical background is provided, followed by the application of the method and its variations in our studies, as well as a reflection on insights that we acquired by using the method. In the discussions, we compare the methods in order to help workplace researchers and designers in choosing between the methods.

2 USER RESEARCH METHODS APPLIED IN WORKPLACE STUDIES

We have applied a variety of qualitative and ethnographic methods for conducting contextual inquiries motivated by the user-centred design perspective. These methods were all used in the context of flexible offices, and in different case studies, each of which with unique research designs. Therefore, each method is outlined with a background, followed by the specificities of its application in our studies, and reflections on the method application.

2.1 Spatial walkthroughs and annotations on architectural drawings

Background – This method is inspired by "cognitive walkthrough" which is used to evaluate whether a system is aligned with how users process tasks (cf. Martin et al. 2012; Polson et al. 1992). Similar to cognitive walkthroughs, a spatial walkthrough evaluates how users understand spatial characteristics of the environments, whether the environment is easy to use, and whether the environment helps employees to achieve their goals. This method has advantages over

occupancy studies that mainly show usage of spaces, rather than allowing for understanding users' motives and reasons behind their workspace preferences. An alternative walkthrough is using architectural drawings as a mediating tool in interviews, encouraging the participants to mark their workspace preferences and comment on the drawings. What follows is the application of variations of spatial walkthroughs in studies on office environments.

Application – We have used three variations of the spatial walkthroughs in our case studies of Flexible Offices to understand users' needs and preferences, and analyse the design of the physical work environment:

- In-situ walkthroughs with post-it notes (Figure 1A) – The participants marked their usage preferences and non-preferences and their motives on post-it notes during the walkthroughs around their flexible office. This application was conducted with pairs of participants in a series of workshops to identify areas of improvement.
- In-situ walkthroughs with architectural drawings (Figure 1B) – An architectural drawing was provided for each participant for marking and motivating their preferences during a walkthrough around the offices. This application was conducted with 3-7 participants prior to a focus group interview, and was analysed as a complementary data to the interviews.
- "Offline" walkthroughs (Figure 1C) – This involved going through an architectural drawing during individual interviews with employees who were asked to mark their preferences and elaborate of their experiences.

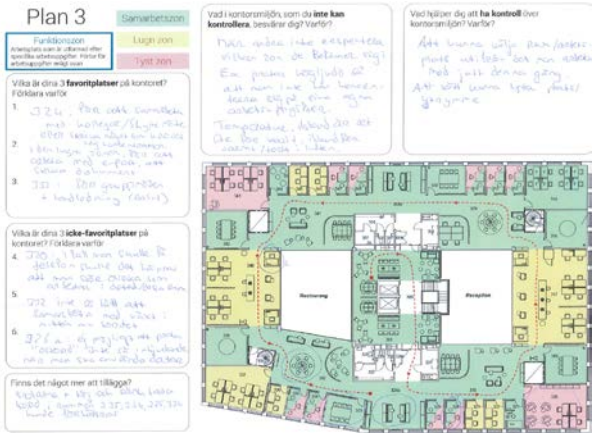
Insights – Application of these methods allowed for understanding users' (non-)preferences (Figure 1D), and identifying successful and sub-optimal features in the design of the studied offices. This covered both architectural aspects and design of furniture and office products. Putting the results together allowed for capturing similar and/or dissimilar preferences among employees, identifying conflicting needs of some employees, and generally underused spaces.

The findings facilitated formulating evidence-based recommendations for re-design of the studied cases. In addition, the methods were appreciated among the participants as it triggered reflections on their workspace choices: "*It was very interesting to take the drawing and reflect; do I feel well and thrive here or not? And why? I haven't actually thought about this before. I have only gone around and wondered why I don't like it here. I have just taken or disregarded the different spots without stopping and thinking why*".

Figure 1. A: In-situ walkthroughs with post-it notes; B: In-situ walkthroughs with architectural drawings; C: “Offline” walkthroughs with annotations on architectural drawings; D: Synthesis of walkthroughs in one of the case studies showing preferences and non-preferences, as well as overlapping and at times conflicting preferences among the different participants.

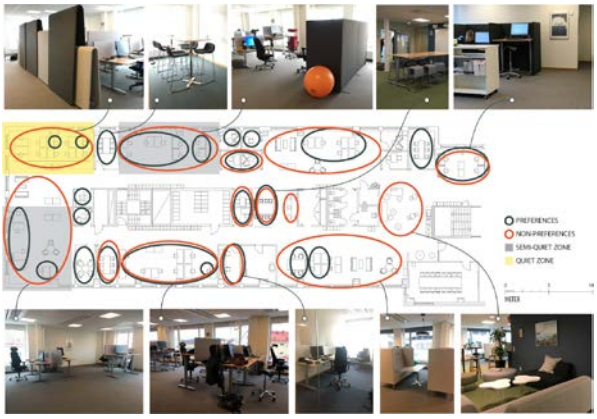
A

B



C

DD

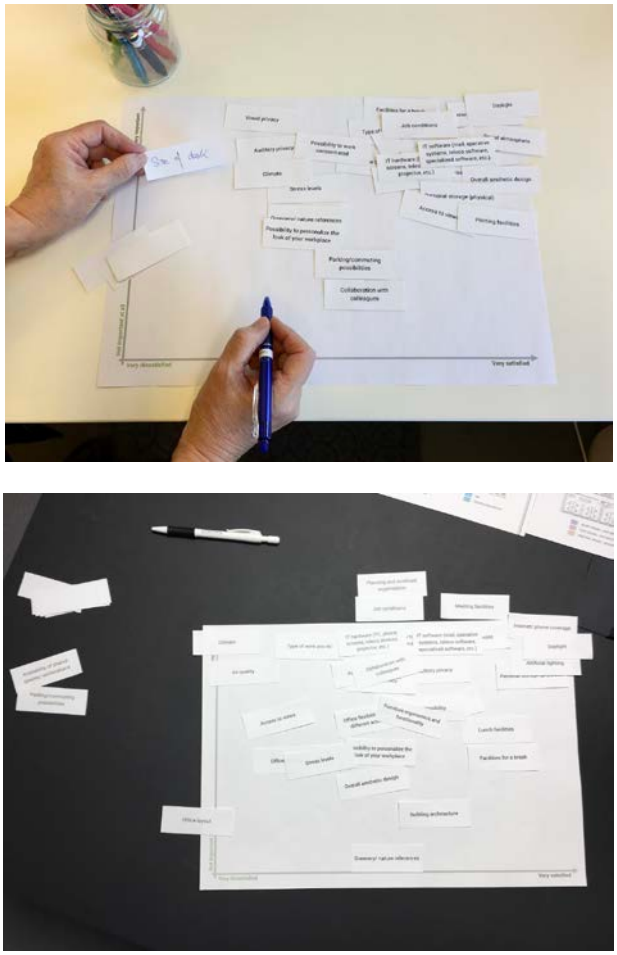


2.2 Card sorting

Background – The Card sorting method is used to understand users' mental models about the information architecture of a product, software or website, and gather their feedback (Spencer, 2009). Users are requested to organise cards with a piece of content or functionalities into groups. Patterns on how the information is expected to be found can be identified and used later for usability improvements (Nurmuliani et al. 2004). There are two modalities of card sorting: 'open card sorting' and 'closed card sorting', that differ in the ability that the user has (or not) to define the content of the cards and the categories for clustering them (Paul, 2008). Traditionally, the outcome of card-sorting method is a representation of how users expect to find the information architecture of a product, software or website. The method presented here shares the focus on user experience and adopts the fundamental principle of sorting cards, but with the aim of understanding users' preferences and workplace ideals rather than usability issues. In the context of office environments, card sorting can be used to elicit insights on how close the office environment is to users' ideal, as well as the circumstances that motivate such perceptions.

Application – Card sorting was used as mediation tool in interviews (Cobaleda-Cordero et al., 2020). The participants were introduced to a biaxial chart; visualising levels of satisfaction and importance (Figure 2). Next, the participants were provided with a series of cards predefined themes one by one. The predefined themes covered the spatial qualities of the office environment such as daylight, thermal comfort or visual privacy, and contextual variables such as job conditions, social environment, etc. The participants were then was asked to sort the cards on the chart while motivating their decisions. Once all the pre-set cards were sorted, the participants were given the opportunity to add extra themes on blank cards to the chart in order to bring up themes that were deemed important but were not addressed. Our application of the card-sorting method can be seen both as a 'closed card sorting' with predefined themes, and a semi-open card sorting' where participants being able to add their own cards.

Figure 2. Examples of how the participants sorted the cards with respect to satisfaction and importance.



Insights – This method enabled mapping how and why diverse variables in the work environment are considered satisfactory and important from the users' viewpoints. In addition, comparisons between participants allowed for distinguishing general patterns. Other insights about the use of this method were: (i) the data collection benefits from opening a dialogue space where participants can provide rich insights even on themes that were not considered a priori, but surface as relevant and worth to be proposed to following participants; (ii) handing-in the cards one by one to the participants proved to be an effective manner to help them focus on concrete

themes, while allowing them to freely reflect and elaborate on how each of those themes related to their daily office experiences, (iii) the biaxial chart used for sorting was more efficient in our pilot tests than a four-quadrant chart, since the latter chart took longer for the participants to familiarise with it and sort each card, and (iv) the exact placement of the cards on the chart is not crucial in the card-sorting method, since demanding high accuracy in sorting would shift the focus from sharing insights to making the precise placement and would be more time-consuming. In summary, the main benefit of using this method is that it triggers discussions on a diversity of themes and facilitates eliciting user experience data in workplace studies.

2.3 Experience curve

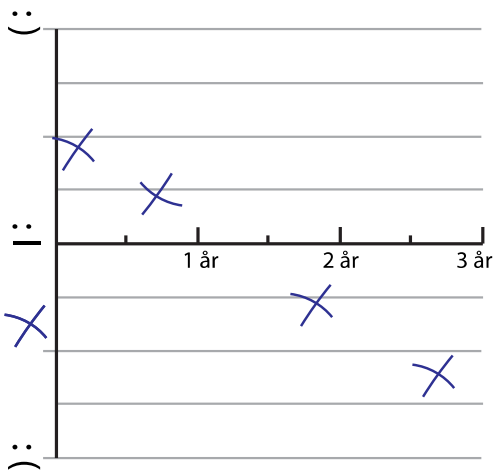
Background – Experience curves are commonly used in the field of interaction design to understand temporal changes in users' experiences of interacting with computers (Kujala et al., 2011). The method aims at "*assisting users in retrospectively reporting how and why their experience with a product has changed over time*" (ibid.). This method enables determining the quality of long-term user experience and the influences that improve user experience over time or cause it to deteriorate. In the context of flexible of offices, this method can be used in two ways: (i) to understand the office users' experience over a pre-determined and relatively short duration e.g. a day or a week, and (ii) to explore the employees' long-term experience post-relocation.

Application – The two variations of the Experience curve mapping were used in our case studies of Flexible Offices to capture temporal changes in employees' experiences (Figure 3):

- Daily experiences – The participants were asked to map their activities in a typical workday, and mark their experience with respect to pleasurability in the workspaces. They were then asked to explain reasons behind "peaks and valleys" of their experience curves, and suggest improvements that could potentially resolve the negative experiences. This method was used during focus group interviews with 3-7 participants.
- Long-term experiences – In individual interviews, the participants were asked to mark changes in their experience in a Flexible Office over a 3-year period post-relocation. They were then encouraged to reflect on the "peaks and valleys" of their experience curves and highlight the events that were the tuning points in their experiences.

Insights – The experience mapping encouraged the participants to elaborate on personal experiences related to specific time frames. In both versions, the participants had to take some minutes to recall and reflect on their activities and experience. The first variation was used in interviews with two participants where they had to explain to each other what they did and how they experienced the workspaces. This interaction facilitated more discussions and allowed the participants to build on each other's reflections. The long-term version of the method helped capturing hedonic adaptations and the adoption processes over time (Babapour, 2019b).

Figure 3. Left: Experience curve, mapping a typical day's activities and the users' experience coupled with the specific activity in relation to the office; Right: an example of the user experience mapping over a longer timeframe post-relocation.



3 DISCUSSIONS AND CONCLUDING REMARKS

To facilitate the understanding of office users' experiences in relation to the design of workplaces, we outlined three types of user-centred research methods that we have applied in case studies on Flexible Offices. It is important to highlight the extensive research on methods and tools for user studies within the fields of Product Design and Human-Computer-Interaction (for further reading, see Interaction Design Foundation, 2020). This paper exemplifies the application of such methods in workplace studies for the first time, and provides insights on methodological implications for eliciting rich data on users' experiences of their workplaces. The following discussion addresses the relevance of these methods to practice, and provides a comparison of the methods.

The outlined methods provided rich qualitative data in all of the applications, and guidance for re-design of the studied offices. Previous research on flexible offices emphasise on making incremental improvements post-relation (Babapour, 2019b), and that a lack of improvements can lead to prolonged dissatisfaction, frustrations and a feeling of resignation among employees (Babapour, Karlsson & Osvalder, 2018). The outlined methods can support organisations in finding ways to mitigate the unintended mismatches and problems that surface after relocation to Flexible Offices. We argue that these methods can also be used before relocation to facilitate needs and activity analysis, and enable an evidence-based and participative design process.

To inform choice of methods when studying users' experiences in office environments, it is important to consider the different characteristics of the outlined methods. It is important to note that these methods complement each other in understanding users' situations, eliciting users' needs, and exploring potential future solutions, and therefore should be used together. The major differences between the outlined methods are in terms of:

- the extent to which the actual context is brought up in the elicited insights,

- the extent to which the participants are immersed in the actual context,
- the temporality that the method covers: whether it relates to anticipated experiences in future, ongoing momentary ones, episodic everyday experiences or cumulative experiences over time (cf. Roto et al., 2011),
- the extent to which the participants are guided or encouraged to be spontaneous, and
- how disruptive the application of the method is with respect to the surrounding activities in the organisation.

Spatial walkthroughs provide concrete, direct, and open feedback about the studied office environment, encouraging the participants to elaborate on their preferences and daily experiences. The method allows for spontaneity and a complete immersion in the workspaces. It triggers recollection of emotional reactions and reflections related to their momentary experience of walking through the office and the episodic experiences of having recently used the workspaces. The variation with blueprint annotations is however less immersive, relying on the ability of the participant to interpret the floor plan and recall experiences without the sensorial stimuli of the actual context. This entails a more filtered impression of the office context. Therefore, it is more likely to elicit information on cumulative experiences. The immersive walkthrough is however to some extent disruptive, as it can distract other employees, while the non-immersive version can avoid disruptions. Nonetheless, the method allows for eliciting user experience data and provides insights for further improvement of office environments.

Card sorting is less explorative than the walk-throughs as it departs from a set cards with predefined themes to reflect and discuss. As a result, the actual context of the office somehow shifts to the background, with less immersion and disruption than the walkthroughs. Thus, the temporal aspect is mostly focused on the cumulative experience of the participants as longer-term users of the studied offices. We recommend card sorting for studies aiming to collect rich user experience data on predetermined aspects of the office environment known to influence users' experience. This method can also be used to understand users' preferences in terms of these predetermined aspects in the design process as it is not dependant on the actual context.

Experience mapping can be labelled as a temporal walk-through during which the participants are encouraged to elaborate on personal experiences related to specific time frames. The method is explorative with direct and open feedback from the participants. Revisiting a time frame instead of a physical setting involves less immersion in the actual context. It is important to highlight that this method captures what remains important from the users' viewpoint about their experiences. If the purpose of a study is to ensure in-situ accuracy of experiences and avoid retrieval failure, we recommend using diary methods instead, for example the quantitative application of the diary method by Gerdenitsch and colleagues (2018). Nonetheless, the experience mapping method provided insights on what users found important about their office environments. The choice of the timeframe for application of the method should be tailored based on the purpose of studies

The main essence of the outlined methods is ***Participation*** and a high degree of user involvement, as they mainly rely on personal experiences, perceptions, affective states, needs, etc. Previous studies on Flexible Offices emphasise on the role of employee participation during the design process (Babapour, 2019a; Rolfö, 2018), but studies on how to ensure and facilitate this process are limited. The methods outlined in this paper facilitate employee involvement both during the design process and for incremental adjustments post-relocation.

To conclude, three user research methods and their variations were outlined in this paper that enable capturing different aspects of user experience with respect to their office environments. Therefore, a multi-method approach for triangulation of data is recommended to capture a holistic and thorough understanding of the office user experience. The outlined methods facilitate employee involvement and participation, and provide opportunities for making experience- and evidence-based recommendations for (re-)design of workplaces.

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Flexible Workspace – Hype or sustainable investment product?

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ABSTRACT

Flexible workspace is a fast-growing phenomenon. As a real estate developer and investor, the aim of our survey was to analyse the opportunities and risks for landlords and investors resulting from the rise in the importance of flexible workspace, commonly better known as coworking spaces. To appreciate the magnitude of recent shifts in office market behaviour, we first mapped the history of the shared office industry. Our research showcases the evolution of flexible workspace, starting from a global perspective, with examples of flexible workspace markets in different phases of development, to focus later on the German market in particular. We go on to highlight characteristics of the flexible workspace industry from both a customer and a business perspective.

Based on our assumption, "Flexible workspace is here to stay", the paper deals with the following topics: "How does flexible workspace influence supply and demand in office leasing markets?", "What impact can a flexible workspace operator in a building have on rental and capital values?" and "Does the proportion of space in a building leased to a flexible workspace operator have an impact on its valuation?"

The analysis is based upon twelve semi-structured interviews with space managers of different operators or with their expansion managers (e.g. WeWork, Regus, Design Offices, Spaces, rent24, Mindspace, Tribes) in Germany and the United Kingdom, each of about one hour. In the same context some spaces of these operators were visited. In addition, a detailed analysis of literature on the subject was carried out, in order to identify the relevant data to explain the flexible workspace market. Finally, we held conversations with members of the research departments of some of the leading international real estate agents (e.g. Cushman & Wakefield, JLL, Savills, CBRE).

Findings

Flexible workspace is not only here to stay, it is an integral part of the ongoing structural change in global office leasing markets. Not only will flexible workspace operators be more apparent in the coming years, there will also be an increasing number of landlords who will launch their own operators. After a decade of dynamic growth, the first signs of consolidation in the more mature markets are becoming visible. In general, strong operators will lead to a better positioning and branding of properties and therefore generate higher values. Nevertheless, investors are still risk averse regarding flexible workspace due to the risks inherent in the business model of the operators and the absence of a longer track record in respect of the majority of the major players.

Keywords

Flexible Workspace, Coworking, Business Centres, Valuation, Rental Value, Space as a Service

1 INTRODUCTION

According to the legend, the term “coworking” first appeared in a blog post in 2005. A good decade later, coworking is capturing the zeitgeist, reflecting the preferred working and lifestyle habits of Millennials, the first generation of digital natives. This generation has changed the face of work like no other, having moved away from time- and place-bound employment, and experienced work-life blending as a reality for some time. In less than 15 years, Millennials will make up the largest single group in the labour market. The dynamic growth in the last few years of external operators offering flexible workplace solutions has accommodated this new lifestyle and way of working.

Given the highly dynamic nature of this segment within the global office leasing market in recent years, investors are increasingly faced with the question of how to respond to this phenomenon. Is it simply a short-term hype or are flexible workspaces a sign of structural change in the labour market?

2 CHARACTERISTICS OF THE FLEXIBLE WORKSPACE MARKET

2.1 Business Model and Specifications

In this paper we use the terms flexible workspace or flexible office space for all kind of operated coworking spaces regardless of whether the spaces are operated by the operator on a profitable or non-commercial basis. The business model of professional flexible workspace operators is based on their long-term leasing of office space, which they make available on a flexible and scalable short-term basis by subletting individual furnished workstations at a higher price. The operator’s success then depends on the level of arbitrage achieved.

In general, the term flexible workspace or flexible office is used for different specifications. Serviced office concepts have existed since the 1960s, when the first **business centres** were opened in exhibition centres, conference centres, and at major train stations and airports. They made their global break-through with professional operators such as the International Workplace Group IWG (Regus, Spaces), a business centre operator founded in Belgium (1989). Generally, business centres host typical office users to whom they offer regular office services and the required office infrastructure (e.g. telephone, printer). The typical service office client appreciates a professional environment and prefers private and closed offices during his stay.

Initially, the familiar **coworking spaces** that have emerged since 2005 mainly served as incubators for the fast-growing start-up scene. As a result, this concept focuses on the classic coworking values of community, openness, collaboration, sustainability and accessibility. Most of them focus on start-ups, freelancers and small businesses with fewer than 10 employees. Consequently, coworking spaces are characterised by open spaces with hot desks and a trendy design.

In particular, the success of **hybrid spaces** is due to their ability to harness the connections between a business centre and positive traits of coworking spaces, for example, a dynamic community, events and practical collaboration. These clearly profit- and expansion-oriented

operator concepts are primarily focused on larger corporates that have adopted flexible workplace concepts like coworking as part of their work design – especially when it comes to recruiting young, well-educated professionals who will form their future talent pool. As a result, they can usually facilitate both longer lease terms (resulting in higher occupation) and a more stable cash flow than their trendy predecessors. As a matter of fact, the split of private offices and shared space (hot and dedicated desks) is clearly in favour of private offices.

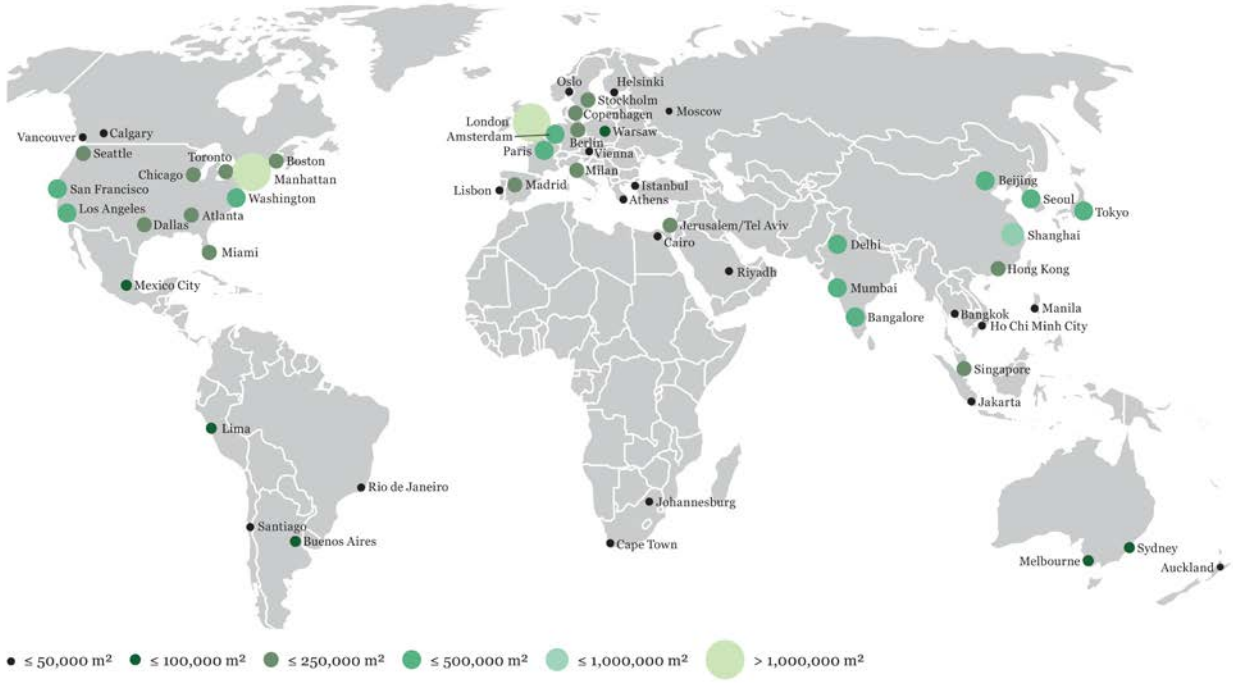
Figure 1: Comparison of Flexible Workspace Concepts

Source: Art-Invest

2.2 Market Dynamics

No matter where in the world, all flexible office markets show the same patterns: until 2013, flexible workspace was responsible for less than 1% of the global office take-up. First attempts were made at the beginning of the new Millennium due to the new economy boom, but they came to an early end with the bursting of the dotcom bubble. After that, the business centre stock has grown steadily over the past two decades and is still expanding now.

Figure 2: Global Hotspots for Flexible Workspace

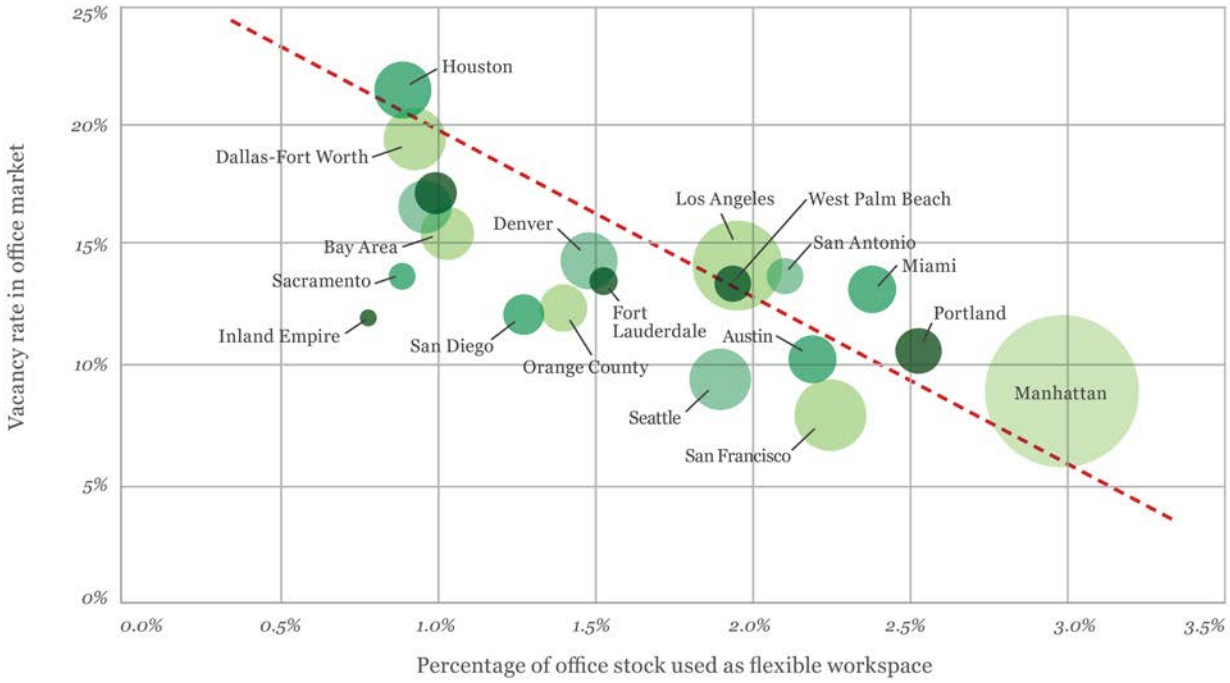


Source: Art-Invest biased on data from CBRE, Colliers, Cushman & Wakefield, Jones Lang LaSalle, Savills etc.

The game-changing factors were the rise of the gig economy and employment growth in the technology sector, combined with the introduction of mobile technologies and cloud computing which has made agile working cheap, easy and popular. At the same time, since 2010, some of the most successful operators have been established. In pioneering markets like New York and London the breakthrough started in 2013. Since then, the take-up of hybrid space has grown more than ten-fold and supply has overtaken the business centre segment. Today, flexible offices have a share of approximately 10% of total demand and up to 25% in downtown locations.

Yardi Matrix has shown for the top 50 US office markets that there is a strong correlation between markets with low vacancy rates and a high penetration of coworking. An above-average concentration of flexible offices can be found in cities with large technology sectors and/or a large knowledge-based workforce.

Figure 3: Correlation between Office Vacancy and Size of Market



Source: Yardi Matrix, 2019

Recently, shared and flexible offices are popping up in properties such as malls, college campuses and hotels. Last but not least, airports and train stations are incorporating coworking for commuters with long stopovers.

Globally, London (1.2 m sq m) and New York (1.6 m sq m) are the markets with the highest maturity. As a percentage of total office stock, Amsterdam is the leading coworking market with a share of 6.0%, followed by London (4.8%), Brooklyn (3.9%) and Manhattan (3.7%).

According to Savills, 2019 has been another successful year for flexible workspace across Europe. At Q3 2019, 687,000 sq m of space has been signed for by flexible office operators, 15% above the equivalent level one year earlier. As new operators enter the market, the operating profit margins become smaller for the established players. As a result, flexible office space has increased its market share from 10% in 2018 to 12% of total take-up in the first three quarters of 2019.

Although traditional leases remain most prevalent, partnership and operating agreements between landlords and third-party “flex” operators are growing in popularity. Real Estate fundamentals in the most concentrated flexible office markets are shifting and the volume of small traditional leases in these markets is falling as flexible space operators gain market share.

2.3 Key Players

As seen above and not withstanding their rising share of total office take-up, flexible offices still have a very small relevance for the global office markets. In the United Kingdom and the United States alone, their share of the total national office stock barely exceeds 1-2%.

The same can be seen in relation to the dominant key players locally in the different countries. There are still only two significant global players: The We Group (WeWork) and the International Workplace Group (e.g. Regus, Spaces). At the national level, in addition to these two global operators, every country has its own set of local players who figure among the "Top 5" operators:

Table 1: Top 5 Flexible Office Operators by Country

USA	UK	Germany	France	The Netherlands
WeWork	WeWork	Design Offices	WeWork	Spaces
Regus	Regus	Regus	WoJo (ex nextdoor)	KleinKantoor/Mindspace
Spaces	TOG The Office Group	WeWork	Regus/Spaces	WeWork
Knotel	i2	Spaces	bap/morning coworking	Tribes
Industrious	Spaces	Mindspace	Kwerk	HNK

WeWork and IWG continue to top the list of the most active operators in Europe and hold a 45% market share of activity based on the 33 markets covered by the Colliers EMEA survey. Yet they are not the only players, with a further 98 operators accounting for a further 42% of the market. US coworking company Knotel continues its European expansion with locations in London, Berlin and Paris. UK's The Office Group is moving into Germany, whilst the German coworking operator rent24 continues its expansion in London, the US and Eastern Europe. And it is only a matter of time before other operators start to comb the German flexible office market for opportunities.

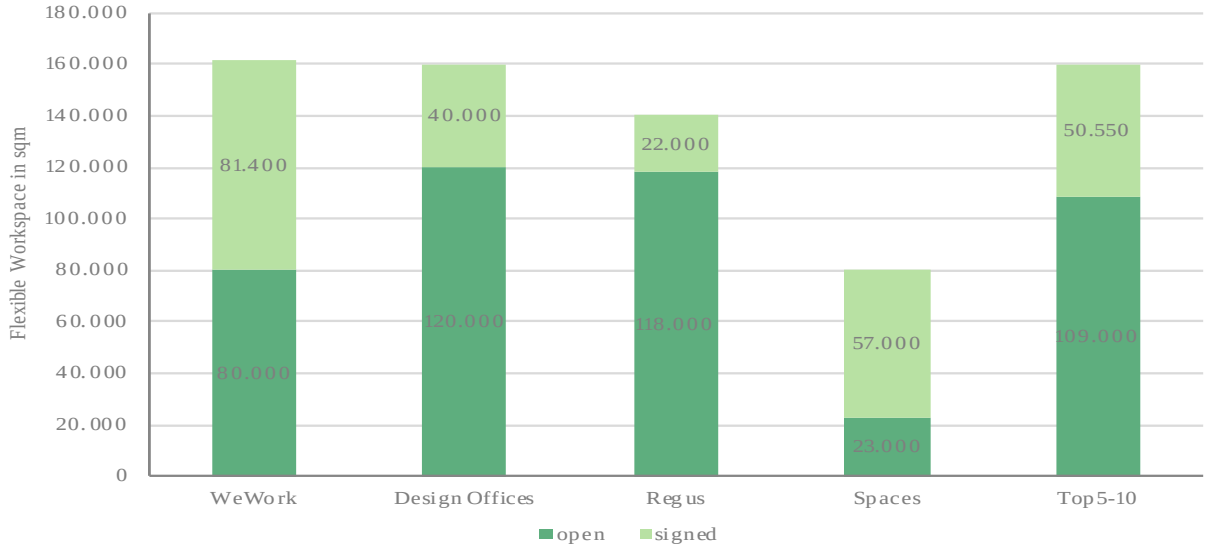
3 THE GERMAN FLEXIBLE OFFICE MARKET

Compared to the British, French and Dutch office markets, Germany offers a far more polycentric market structure with seven leading office markets (Berlin, Dusseldorf, Frankfurt, Hamburg, Cologne, Munich, Stuttgart) and twelve secondary cities.

It was only five years ago, that flexible offices began to conquer the prime locations of the "Top 7" cities. Since then, several international players have entered the German market. Despite the rising competition, Design Offices, Germany's market leader for hybrid spaces, has managed to defend its pole position in the flexible office market followed by Regus, WeWork and Spaces.

Most of the 1 m sq m of flexible office stock in operation is allocated in the Top 7 cities. Secondary cities only account for 15.5% of the total national inventory. In just five years, the stock of flexible office has more than tripled. In total, more than 700,000 sq m have been added. Leases on a further 408,000 sq m of flexible workspace have been signed already and will be delivered by 2025. Nevertheless, flexible offices still only have a share of 1% of total office stock of the Top 7 cities. In the secondary cities, the share (0.4%) is even lower.

Figure 4: Operator Ranking Germany



Source: Art-Invest based on data from Jones Lang LaSalle, H1 2019

4 PROS AND CONS OF FLEXIBLE OFFICES

From the point of view of the end user, especially for start-ups who cannot predict precisely their business success and consequently the space required for their staff, the use of a flexible workspace represents a financial relief, since high start-up costs for equipment, IT support, etc. are involved and long-term obligations to the bank or landlord are eliminated. An additional benefit consists in access to top office locations with exclusive addresses and excellent accessibility, which many freelancers could otherwise not afford.

In addition, there are advantages for end users such as proximity to customers and potential business partners as well as the classic values of coworking (openness, collaboration, sustainability, community, free access to the community and its network). For users who previously operated from their home office (e.g. during the Covid-19 confinement), the risk of isolation is also reduced by sharing coworking spaces with other members and participating in various community events.

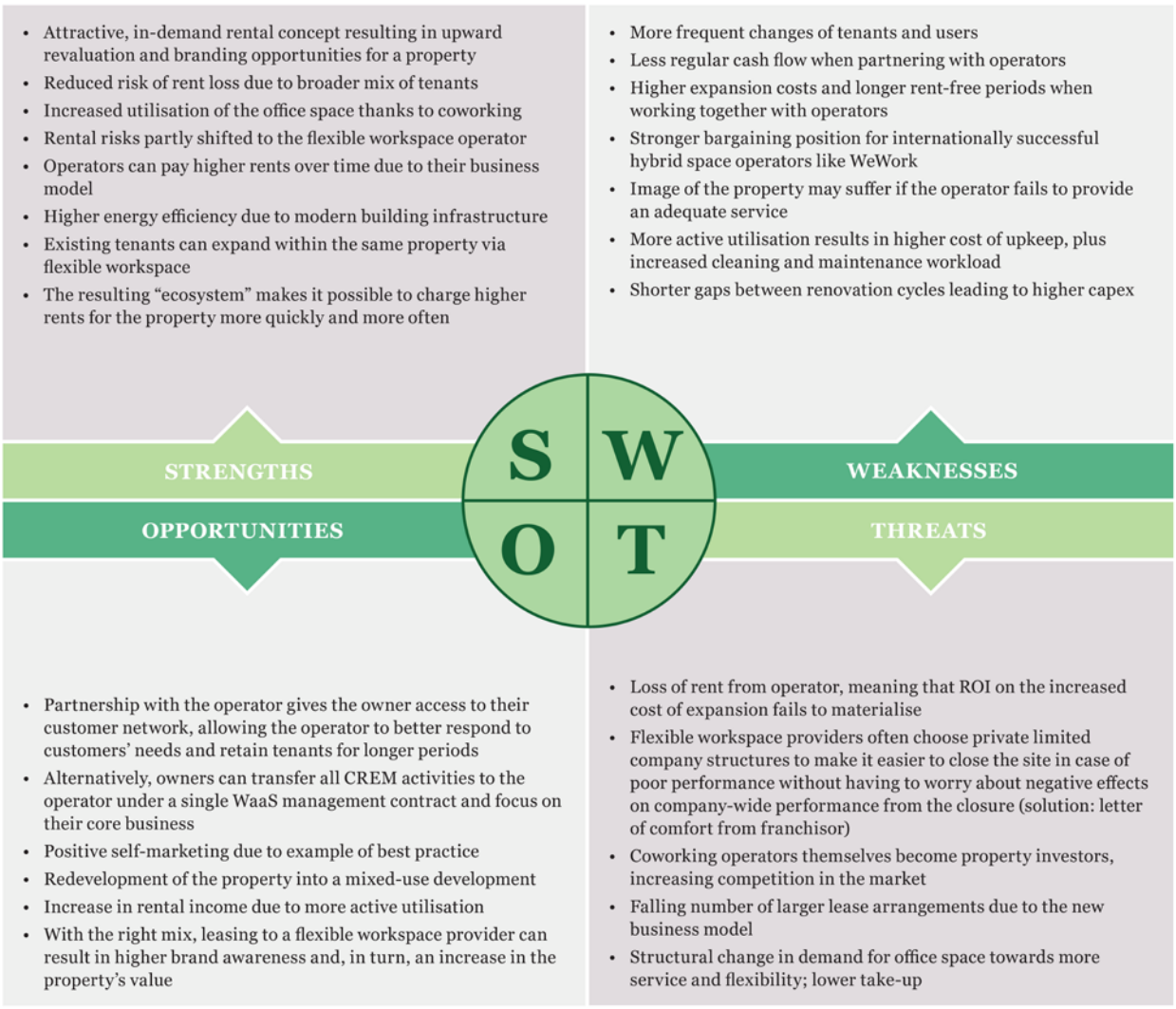
But also for landlords and investors the adoption of flexible workspace in their buildings offer new opportunities. The growing demand for office space from flexible office operators is good news for many owners and investors. While the general trend is towards shorter lease terms, these operators are willing to sign agreements for 10 years, together with extension options.

In addition, leasing to one of the trendy corporate coworking operators helps owners to position and brand their property – creating a much broader foundation for the mix of tenants. The frequency and intensity of use within the property also increase significantly. Both factors help to raise the building's profile with the operator, encouraging better positioning of the property on the market or speeding up the process of leasing vacant spaces.

The operator quite often ends up creating a whole new "ecosystem" also comprising other office users, along with a large number of service providers such as caterers, retailers, gyms and, in some circumstances, even coliving providers. This helps to strengthen the location in the long run

and diversify its range of activities, as well as supporting the transition from a single-purpose to a mixed-use property. This often means that higher rents can be achieved – even from the other tenants. After a few years, many users of the flexible workspace are too large but do not want to leave the location and the competitive environment, so prefer to keep leasing from the same building.

Figure 5: Corporate Coworking SWOT Analysis from Owner/Investor Perspective



Source: Art-Invest

On the other hand, this activity involves frequent tenant changes and much more intensive use of the property. This will result in greater wear and tear, which is likely to make renovation cycles more frequent and cause higher costs to be incurred for building maintenance, repairs and cleaning.

Hybrid space operators have often adopted limited liability company structures. If the operator goes bust, it can become difficult for the landlord - especially mid-contract - to recover outstanding rent or re-let the space on a short-term basis.

5 EVALUATION OF FLEXIBLE WORKSPACE

5.1 Assessment approaches

Only the most successful locations and operators of flexible workspace will survive the next crisis. Small, non-profit or low-profile coworking spaces will disappear, along with those in unsuitable locations. Consequently, landlords and investors will have to evaluate operators properly before they sign leases with them. However, while business centres have already proven their market maturity during the dotcom crisis, traditional and corporate coworking spaces still have to show whether they are capable of coping with a crisis. Similar to the hotel segment, flexible office concepts differ considerably. As a matter of fact, there is very little statistical evidence to indicate how well the industry might whether the first storm. As there is still a lack of transparency, only few benchmarks help to estimate the value of flexible workspace.

Listed companies like the IWG Group offer some benchmarks in their annual reports. To compare the market performance of different spaces and locations, the company has developed a new indicator called RevPaw (revenue per available workstation). Knowing the average daily rate per workstation, the total number of workstations and the average occupancy rate, this indicator permits to calculate the annual revenue, realised only by subletting workstations.

If the number of workstations is not available, it is possible to estimate it deducting the common areas and dividing the rest of space by an average of 7 to 9 sq m per workstation in Germany. While rental costs have been decreasing globally from 43% to 37% since 2016, in Germany rents still account for 54% of total expenses, well above the global average.

Another important difference lies in the split between hot desks and private offices in a flexible office. The latest Workthere Survey (01/2020) reveals that 65% of revenue comes from private offices compared to only 53% of space being allocated to this segment. On the other hand, hot and dedicated desks occupy 25% of all space, but only contribute 16% of the revenue. Consequently, the revenue of flexible offices correlates directly with the share of private offices. To achieve a higher percentage of private offices it is necessary to raise the proportion of larger corporates who - for reasons of privacy - prefer private offices for their employees. For example, start-ups and freelancers only make up one third of all sales for hybrid spaces while at coworking spaces their share is almost 66%.

Renting out workstations is not the only income stream for flexible offices. On average almost 20% of all sales are realised with food and beverage (F&B), by renting conference-, meeting- and event spaces or via partnerships with local partners (e.g. gyms, hotels, restaurants). The importance of these income streams varies significantly depending on the type of flexible office. MICE (Meeting, Incentive, Convention and Event) services can have a share of 20% to 50% of total sales for corporate coworking spaces.

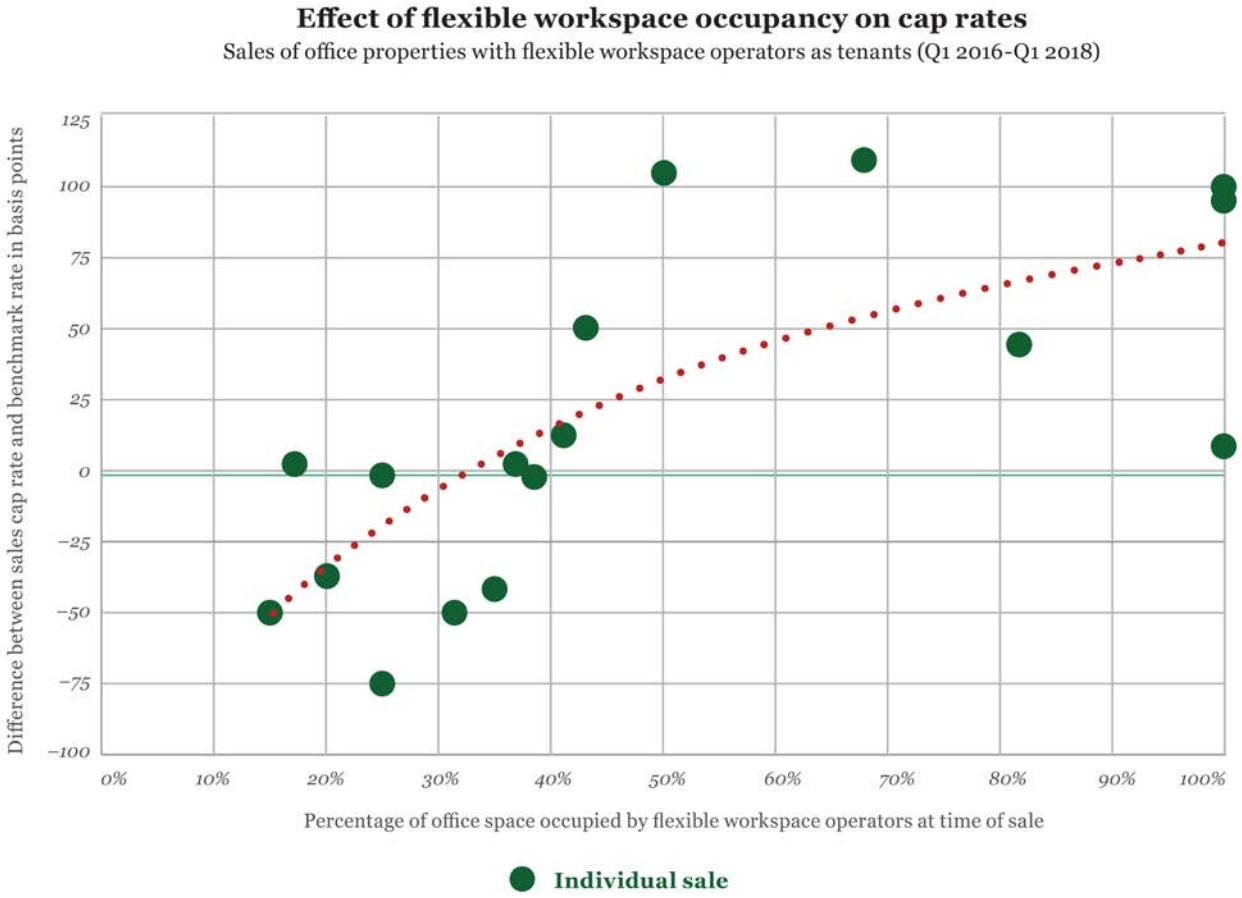
According to the 2019 Global Coworking Survey carried out by deskmag, flexible workspaces become profitable, on average, when 35% of all sales come from renting private offices and 37% from combined membership plans or renting hot desks. Another 28% is generated by MICE services. Experience shows that an occupancy rate of at least 60% is necessary to operate a business centre profitably. For example, Regus went bankrupt in the USA in 2003 as a result of the dotcom crisis when average occupancy fell below this level. For hybrid spaces, occupancy rates can be lower, provided that the share of MICE services is at least 20 to 30%.

By deducting estimated operating costs, salaries and a profit margin from total sales revenue, one can derive the potential rent which an operator potentially can afford to pay. However, since the average desk price and occupancy can vary significantly, this approach can only provide a very approximate result.

5.2 Performance of Coworking Properties

For investors the question remains whether flexible offices have an impact on the property's performance. With this in mind, Cushman & Wakefield evaluated all transactions on the US investment market for the period 2016 to 2018 in which flexible workspace operators were involved. The analysis has revealed that properties where flexible offices accounted for 15 to 35% of the rental income could achieve a yield on sale 40 to 75 basis points below that achieved from the sale of comparable office investments without flexible office tenants. In contrast, properties with a share of more than 35% had to be sold at yields of up to 100 basis points above the comparable office yield.

Figure 6: Valuation of Office Buildings by Coworking Space Occupancy



Source: Cushman & Wakefield, Coworking – Additive or Disruptive to the Office Market?

A survey carried out by Jones Lang Lasalle (January 2019) among German lenders on real estate concerning the influence of flexible workspace on their credit decisions, has shown that 19% would increase their margin, 9% would reduce the amount they would be prepared to lend (LTV)

and a further 29% would do both. Only one-third of the respondents stated that flexible workspace would have no impact on their credit decision.

6 CONCLUSIONS

Only the most successful locations and operators of flexible workspace will survive the actual Covid-19 crisis. Many small, non-profit or low-profile coworking spaces will disappear, along with those in unsuitable locations. However, in general, the outlook for investments in flexible workspace should be viewed positively for a number of reasons:

- Thanks to its scalability, flexible workspace is increasingly becoming an integral part of large corporate groups' office space strategy, whether to make active use of unoccupied office space, to deal with shortages of space within the group by flexibly leasing workspaces or as a means of remaining attractive to well-educated young professionals.
- In the medium term, the demand for flexible workspace will continue to grow. As more and more business activities are outsourced by companies, the demand for flexible workspace will increase.
- Project-based collaboration requires smaller teams set up according to the task at hand. This will also boost demand from corporates.
- The fixed costs for a small private office are disproportionately high for self-employed people and start-ups; it normally takes more than three years for leasing space directly to become more attractive than using flexible workspace from a provider. Neither does a standard property lease allow for a short-term reduction in the space used during times of economic hardship. For both of these reasons, the demand for small office spaces available for rent will shift from traditional offices to flexible workspace and demand will increase accordingly.
- At present, most property investors are still sceptical about flexible work-space operators, especially after their experiences due to the Covid-19 pandemic. In a few years, however, flexible workplace concepts will have become the norm, with the result that yields for office investments comprising flexible workspace will have compressed, even to the extent that such investments will have become more valuable than office investments subject only to standard office leases.

There is no question that flexible office space is here to stay. At present, the evaluation of flexible offices is still difficult, as the necessary benchmarks have yet to be established. In the long term, however, the approach to valuation should not be more complex than for hotel properties. The basic prerequisites for an accurate valuation are therefore a thorough analysis of the operator concept and the location of the property. In general, however, it can be assumed that flexible office operators are only one of several users of the property, which is why there will always be the possibility, in well-chosen locations, to use the accommodation alternatively as standard office space.

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Unravelling the variables to calculate an organisations return on workplace investment: a scoping review process

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ABSTRACT

Purpose: to present the initial findings of the first phase of a research project being conducted in partnership with the Institute of Workplace and Facilities Management (IWFM) to eventually develop a user-friendly 'tool' to calculate the return on workplace investment. The first phase of the project explores the variables that should be measured to eventually incorporate in to the 'tool' in order to calculate the return on workplace investment.

Theory: the paper looks through the theoretical lens of 'workplace' by view the interaction and interconnection between the 'physical space', 'digital space' and 'people' for the overarching purpose of work activity.

Design/methodology/approach: a scoping review was conducted by adapting the framework used by Arksey and O'Malley (2005). A total of 70 sources were eventually found, consisting of peer-reviewed journal papers, industry reports and other research documents.

Findings: the sources were thematically analysed using an inductive thematic analysis approach. A total of six 'high level' themes were uncovered, to which a total of 37 'lower level' themes were established.

Originality/value: Currently there is no holistic tool to assist workplace professionals in making major decisions regarding changes to their workplace environment. This project aims to bridge this gap by developing a user-friendly tool to calculate the potential return on workplace investment.

Keywords

Workplace; return on investment; performance; productivity

1 INTRODUCTION

It can be argued that ‘workplace’ is an emerging professional discipline, engrained in business and management theory and represented by professional standards and ethics.

Pinder and Ellison (2018) highlight that the key components of the workplace are a triangulation of the physical workplace, its culture, and the ability to enable technology. For the purposes of this study, workplace is the bridge between facilities management (FM) and business performance. It can be defined as the interconnection between the physical workspace (FM), the virtual workplace (ICT), and the organisations culture and business performance, including its people (HR).

The workplace has undergone many changes physically, technologically, socially and environmentally (Clements-Croome, 2017) which has coincided with the changing expectations of occupants who desire more from their workplace. Clements-Croome (2017) expresses that occupants desire flexible and expressive places to work which are conductive to creative thought, identifying that expectations of the workplace are changing and workplace professionals need to do more than simply provide a workspace for each building user.

This is exacerbated by the fact that 90 percent of an organisations operating costs are from staffing costs in salaries and benefits, whilst only 10 percent of costs are from energy and rental costs of its premises (Alker, Malanca, Pottage, & O’Brien, 2014). Moreover, there is overwhelming evidence which demonstrates that the design of an office impacts the health, wellbeing and productivity of its occupants (Alker et al., 2014). Yet, Alker et al. (2014) contend that this evidence has not yet had a major influence on the mainstream real estate sector, and is not yet translating at scale into design, finance and leasing decisions. Although some previous research has attempted to quantify workplace performance (Oseland & Burton, 2012), there is no holistic and tangible ‘tool’ or ‘calculator’ to assist workplace professionals in making major decisions regarding changes to their workplace environment.

This raises critical questions about the level of return organisations get from making major decisions to change their workplace environment, such as:

- What are the variables that should be measured to calculate the return on investment to their workplace?
- What are the parameters workplace professionals should work within when calculating the return on investment to their workplace?
- How can they quantifiably calculate a return on workplace investment value, in order to justify and rationalise major decisions to change their workplace?
- What return on investment do organisations actually get from changing their workplace?
- How can a holistic tool, a spreadsheet with a cost-benefit analysis and some defaults values, be developed?

Based on these research questions, a research project has been devised in partnership with the

Institute of Workplace and Facilities Management (IWFM) with the overall aim to develop a user- friendly tool to calculate the potential return on workplace investment, due to performance gains, for several workplace design options.

This paper presents the findings from the first research question, with the objective to systematically review the variables that should be measured to calculate an organisations return on workplace investment. To achieve this, a scoping review methodology was adopted in order to present an overview of a potentially large and diverse body of literature pertaining to a broad topic (Pham et al., 2014). The main themes that were discovered from the scoping review are presented, concluding with an indication of the next steps of the project.

2 METHODOLOGY

A scoping review differs from a systematic literature review approach, which typically considers peer-reviewed academic articles only (Easterby-Smith, Thorpe, & Jackson, 2018). Traditionally, academics tend to favour systematic reviews, but they are not necessarily an ideal method if you are covering a wider field (Easterby-Smith et al., 2018).

The scoping review framework proposed by Arksey and O'Malley (2005) is adopted, which involves six phases: (a) identifying the research question, (b) identifying relevant studies, (c) study selection, (d) charting the data, (e) collating, summarizing and reporting the results, and (f) an optional consultation exercise. For the purposes of this paper, the first five phases will be discussed.

a) Identifying the research question

This review was guided by the question, ‘What are the variables that should be measured to calculate the return on investment to their workplace?’. This is a relatively broad research question, which is recommended for a scoping review, as maintaining a wide approach can generate breadth of coverage (Arksey & O'Malley, 2005).

b) Identifying relevant studies

The goal of a scoping review is to be as comprehensive as possible. According to Easterby-Smith et al. (2018), systematic reviews rely heavily on journal articles over other sources such as reports, which can lead to misconceptions and oversights. Due to the homonymic nature of workplace, it is crucial to use a comprehensive range of sources that are not restricted to journal articles. For that reason, the following sources were used and adapted from Arksey and O'Malley (2005):

- *Electronic databases* – using a systematic search strategy
- *Hand-searching of key journals* – for specific priority journal titles
- *Existing networks and organisations* – to identify industry reports and artefacts

2.1 Electronic databases

Four electronic databases were deemed appropriate to utilise, given their breadth and diversity: ProQuest, Web of Science, Business Source Complete and Science Direct.

A search strategy was adopted in order to systematically review each database, using appropriate Boolean functions to gain maximum coverage:

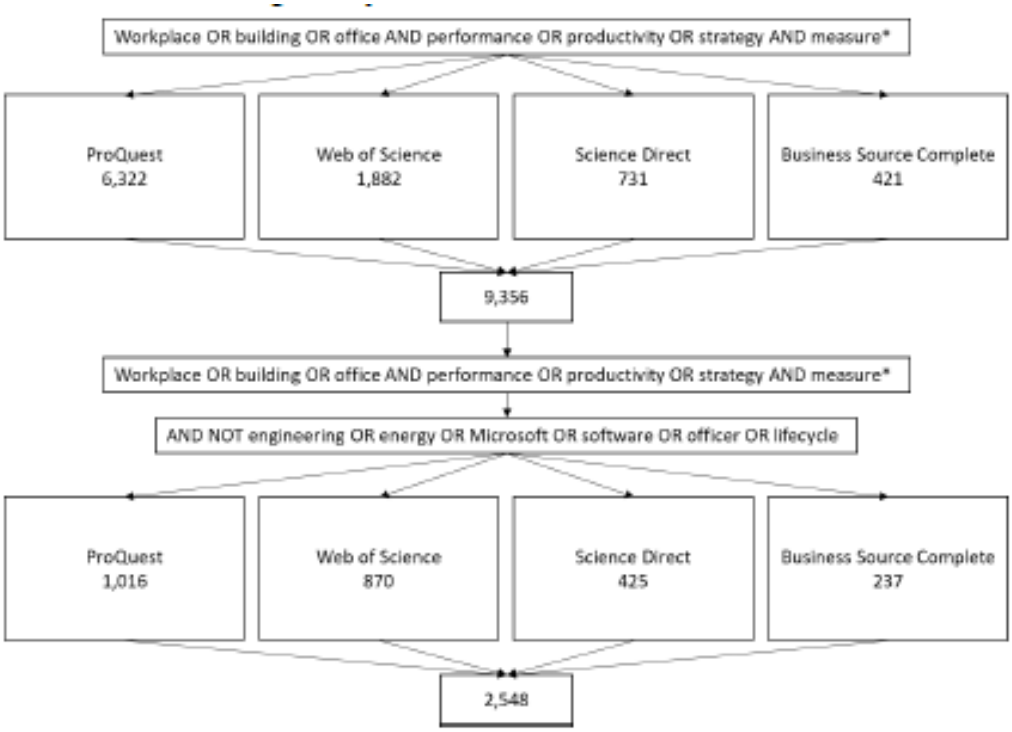
*Workplace OR building OR office AND performance OR productivity OR strategy AND measure**

In the first instance, a total of 9,356 references were identified. It is good practice when conducting search strategies to define exclusion criteria in order to narrow down the results to the most applicable sources. The following exclusion criteria was applied:

AND NOT engineering OR energy OR Microsoft OR software OR officer OR lifecycle

This produced a total of 2,548 final references to be considered, following the adoption of the exclusion criteria (figure 1).

Figure 1: systematic electronic database search



In order to adopt a rigorous review of these references, the system used by Pittaway, Robertson, Munir, Denyer, and Neely (2004) was adopted, where the references were separated into A, B and C lists (table i).

The criteria for determining A, B and C lists were adapted to those used by Pittaway et al. (2004) in order to align with this study:

- A-list - represents articles of particular relevance with clear alignment to the return on workplace concept
- B-list - represents articles of some relevance where there may have been some question over the alignment to the return on workplace concept
- C-list - represents articles that were either of little relevance Table i: A, B and C list by database

Database	Overall	C-list	B-list	A-list
ProQuest	1,016	956	46	14
Web of Science	870	795	58	17
Science Direct	425	407	14	4
Business Source Complete	237	219	11	7
	2,548	2,377	129	42

The A-list articles (42) were selected, and their full papers imported in to a reference management software package. For this study, EndNote was used.

2.2 Hand-searching of key journals

In addition to systematically reviewing electronic databases, it is good practice for scoping reviews to hand-search specific journals.

This is because it can identify articles that may have been missed in the databases, as electronic databases may be incomplete, not up to date or because abstracting services can vary in coverage, indexing and depth of information (Arksey & O'Malley, 2005).

Upon an initial review the 42 A-list papers identified in the systematic electronic database search, papers from the following journals appear to offer very strong alignment to the topic, or by being deemed credible high-ranking journals in accordance to the Chartered Associated of Business Schools (CABS) Journal Guide 2018:

- International Journal of Strategic Property Management
- California Management Review
- Scandinavian Journal of Work, Environment and Health
- Applied Ergonomics
- Facilities
- Journal of Corporate Real Estate
- Journal of Facilities Management

Through hand-searching these journals a total of 28 papers were identified, imported and combined with the 42 A-list papers from the systematic electronic database search in EndNote.

2.3 Existing networks and relevant organizations

One of the benefits of undertaking a scoping review, is it allows for additional searches through existing networks and relevant organizations, which can generate further information about

primary research (Arksey and O'Malley, 2005) and provide commercially, industry-driven sources complimentary to topic area.

A combination of methods were used in this stage, including contacting individual workplace consultants for known sources and references, searching Professional Body[13] knowledge databases and websites, and searching known consultancy firms for company-generated insight

[13] Including World Green Buiding Council, Royal Institution of Chartered Surveyors, British Council for Offices, Chartered Institute of Building Services Engineers

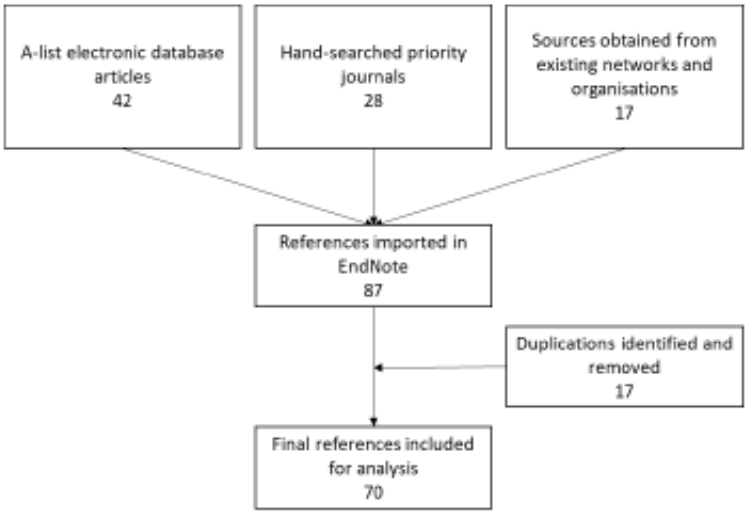
reports.

From this, a total of 17 additional references were identified. These references were predominantly industry reports, but also included other research papers not identified previously. The 17 references were downloaded, imported and combined with the electronic database references and hand-searched journal references within EndNote.

c) Study selection

Once all three sources were fully exhausted (electronic databases, hand-searched journals, and existing networks and organisations), the papers were reviewed and audited within EndNote adding comments and descriptions to each reference. During the stage, a number of duplications were detected, to which 17 references were removed. Figure 2 shows a summary of the final selection process:

Figure 2: study selection



d) Charting the Data

According to Arksey and O'Malley (2005), the next stage of the scoping review process is 'charting', by a process of synthesizing and interpreting qualitative data. For this study, a thematic analysis (TA) technique was adopted Braun and Clarke (2013) using a qualitative data analysis software package, *QSR NVivo 12*.

Inductive TA is deemed appropriate for this study as it identifies themes and patterns of meaning across a dataset in relation to a research question, but also adopts an inductive approach, working from the bottom-up (Braun & Clarke, 2013) by analysing the data initially in to individual associated themes, which evolve in to a connected thematic structure.

e) Collating, summarizing and reporting the results

For the purposes of this paper, the next section will provide an overview of the key findings of the inductive TA process.

3 FINDINGS

Following the scoping review process, the literature was thematically analysed into six key themes, as presented in figure 3:

External performance refers to specific variables that impact the organisation externally, such as the customer, brand and image. *Human resources* refers to conventional metrics and performance metrics that are associated with human resources, such as absenteeism and retention. *Individual performance* refers to variables that specifically impact the individual employee, in particular the theme of health and wellbeing. *Organisation performance* refers to variables that have an overarching impact on the organisation, for example organisational culture. *Task performance* is similar to individual performance, but relates specifically to job functions, processes and attributes. *Workgroup performance* refers to variables that extend beyond the individual but are confined within the organisation, for example at a team or inter-departmental level.

Figure 3: overall themes

Each of the six ‘higher-level’ themes were broken down in to ‘lower-level’ themes, creating 37 in total (Table ii).

Table ii: inductive analysis themes

Theme	Sub-theme
External performance	Customer attraction Customer loyalty Customer satisfaction Promoting sales Supporting brand and image
Human resources	Absenteeism Employee turnover Organisational socialisation Presenteeism Recruitment Staff retention
Individual performance	Employee engagement Health and wellbeing Motivation Satisfaction
Organisational performance	Changing culture Environmental impact Flexibility Managerial process Organisational commitment Organisational productivity Safety behaviours
Task performance	Abilities Basic skills Concentration Cross-functional skills Human error Performance Process skills Productivity Time management
Workgroup performance	Collaboration Communication Information sharing Sense of community Trust Workgroup productivity

4 CONCLUSION

Despite the substantial investment in people in the workplace and the overwhelming evidence that demonstrates that the design of the workplace environment impacts the health, wellbeing and productivity of its occupants, this does not necessarily translate into quantifying workplace performance. Currently there is no holistic tool to assist workplace professionals in making major

decisions regarding changes to their workplace environment. This project, in partnership with IWFM, aims to bridge this gap by developing a user-friendly tool to calculate the potential return on workplace investment.

This short paper has provided an overview of the first objective of the project, which is to systematically review the variables that should be measured to calculate an organisations return on investment when making changes to their workplace environment.

The next phase of the project is to take the variables uncovered in table 2 and critically investigate the parameters workplace professionals should work within when calculating the return on investment to their organisations workplace. Once this is achieved, it is hope that the project team will be able to develop a methodology to quantifiably calculate a return on workplace investment value, in order to justify and rationalise major decisions to change an organisations workplace environment.

In turn, this will hopefully establish, through the creation of a holistic and tangible ‘tool’, the

return on investment organisations actually achieve from changes to their workplace environment.

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SESSION 10: WORKPLACE CULTURE & MANAGEMENT

Levels of Evidence System – Necessary for Evidence-Based Design?

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ABSTRACT

One of the key principles in modern workplace design requests, that the decisions for specific solutions should base on the most recent and significant evidence available. While recency can easily be identified by the date of publication, the evaluation of significance poses a greater challenge. One solution is to hierarchically rate publications in accordance to their evidence. One solution for such a hierarchical rating system is the assignment of publications to predefined "levels of evidence". The research field of medicine has already established several of such schemes. One of those could be transferred to the workplace research literature. Within the scope of the author's doctoral thesis on modern knowledge work environment, 471 publications were collected. They contain contributions from 1969 to 2019, from various disciplines, different publishers, and different genres. The range reaches from scientific journals to practitioners' guidebooks and newspaper articles. This variety made it necessary to get an overview about the evidence within these publications. Therefore, an evidence level rating system from medicine was adapted and applied to the 471 publications using qualitative content analysis. The adapted system contains four main evidence levels, while one is divided into two sub-levels: "A" (highest), "B+", "B–", "C" and "D" (lowest). The coding of the selection of publications was rather easy, efficient and unequivocal. Four publications were rated "A", 67 "B+", 167 "B–", 217 "C", and 16 "D". The results of this feasibility study suggest that such an evidence level system can be established and applied with reasonable effort. Although its limitations – especially in regard of the sampling method – this study brings up some ideas to discuss. For example, programming a digital and self-learning algorithm based on such a rating system, in order to search and label any workplace related publication found in online databases and libraries. Such labels could enable researchers to gain a better overview of the evidence in specific workplace topics. This could be of importance in the dynamic in field of knowledge work and workplace design, as research could provide hard proven evidence only with some delay. In consequence, this short paper aims to give an impulse to the discussion about which quality and recency of evidence needs to be available and sufficient.

Keywords

Knowledge Work, Office Design, Evidence -Based Design, Levels of Evidence.

1 INTRODUCTION

Various authors recommended that decisions in the building design process should be guided by evidence (Martin & Guerin, 2006; Sailer, Budgen, Lonsdale, Turner & Penn, 2008; Vischer & Zeisel, 2008; Zimring & Bosch, 2008). This applies especially to the design of workplace environment. In databases like Google Scholar, one can find an enormous body of research

literature on modern workplace design. In addition, there is a broad range of practical knowledge, often written in guidebooks or product brochures. New electronic tools, fabrics and materials have made this field of workplace research so dynamic, that information on a specific design solution or office environment can only be found in advertisements, user reports, magazine articles, personal blogs, etc. The field of workplace design appears to be developing so rapidly, that science doesn't often manage to keep pace with "the real world". Therefore, the moment academics can publish their research on a new specific phenomenon, these findings may already become obsolete. In addition, this field is very interdisciplinary, encompassing various research methods and approaches. Consequently, there is a lot of knowledge of "any kind, quantity and quality" – as Spinner (1994) puts it. Therefore, both practitioners and researchers face the challenge to identify adequate evidence for their decisions regarding their specific design projects. "Adequate" in this context means specific to the design problem (i.e. valid), recent (i.e. not obsolete) and well-proven (i.e. reliable). While specificity and recency can be identified rather easily (e.g. by keywords and the date of the publication), the reliability of a source of information is often harder to evaluate.

While I was writing my doctoral thesis on modern knowledge work office settings, I faced the challenge to get an overview of the actual situation in this field of both practice and research. In order to solve this issue, I made a broad search for literature, using different strategies. Similar to the above-mentioned literature, I searched through scientific databases using such keywords as "office design" in order to find peer-reviewed journal articles. I received articles from well-known journals such as "Building and Environment", "Environment and Behavior", "Environment and Planning B", or "Facilities". In addition, I followed the citations and references lists within these publications, which lead me to other sources including books, online-publications, or conference proceedings, etc. From practitioners and fellow researchers, I received brochures and information material on new office design products or recommendations for practitioner's guidebooks and manuals. By the combination of the systematic, "snow-ball" and incidental search strategies, I collected 471 publications of different quality, published from 1969 to 2019, consisting of journal articles (62%), conference proceedings (11%), reports (8%), books (7%), and book chapters (6%). The publications are from different disciplines like architecture and design (27%), psychology (26%), facility management (19%), or economics and management (15%). In consequence, I had to evaluate these publications regarding their significance and reliability; and I had to do this in an efficient and effective way.

A seminal approach in this direction was done by Ulrich et al. (2005) and Ulrich et al. (2008) in the context of hospitals and healthcare. They included scientific peer-reviewed journals only, which they found in an electronic database search using keywords. These studies were then "assessed on their rigor, quality of research design, sample sizes, and degree of control" (Ulrich et al., 2005, p. 2). Unfortunately, the authors did not specify the rationale of their assessment any further. The same applies to Martin and Guerin (2006). They established the InformeDesign® database platform with over 1400 research summaries of journal articles on various design topics. Among other information, they provided the readership with a summary of the "systematic inquiry method, sample selection, procedure, and analysis method used in the study" (p. 177). However, it remains unclear[14], whether they provided any rating of the "power" of the articles' evidence and if, what the rationale of such a rating was. To sum up, while providing a great extent of design-related evidence, both teams of researchers were focusing on peer-reviewed

[14] Unfortunately, the InformeDesign® website is down since April 2019.

journals only, without clarifying how exactly they differentiated between articles in regard to the evidence provided (e.g. which evidence should be rated higher than another, and for what reasons).

Table 1 Proposed levels of evidence system for office design and knowledge work studies (as suggested by the author).

A	***"Confirmatory level"*** Statistical meta-analyses resp. meta-analytic literature research; confirmatory factor or cluster analyses by structural equation modelling (SEM) in independent samples; comparison of different models by SEM; series of pre-/post-intervention studies or quasi-experiments (including testing of hypotheses) in independent populations resp. cases.
B+	***"Quantitative level"*** *Quantitatively testing:* single longitudinal studies or single quasi-experiments in the field with pre-/ post-intervention studies; (controlled) laboratory experiments; explorative studies using SEM (with one model to be tested).
B–	*Quantitatively exploring:* single case studies using quantitative methods; explorative factor or cluster analyses (or similar) of bigger (probably pre-existing) databases; simple correlations in quasi-experiments in the field or cross section studies; simple reliability and validity testing of evaluation instruments; primarily studies with new and/or not yet validated evaluation instruments or methods. *Eventually:* sophisticated qualitative studies referring to a bigger database (e.g. cases, interviews, observations etc.)
C	***"Qualitative level"*** Essays in academic journals; experience based reports or guidebooks with references to research evidence; qualitative literature or desk research; research reports without own collection and analysis of data; single case studies using qualitative methods; reports of new products, interventions, evaluation instruments or methods with exemplary testing respectively use case; *Eventually:* well documented articles in non-scientific journals or newspapers.
D	***"Reporting level"*** Articles and reports in popular journals or newspapers; reflective and descriptive essays; blogs; mere subjective opinions or comments, experience reports or guidebooks without to any evidence; product advertisement and brochures; design studies.

Other sciences and disciplines also provide solutions for this challenge. In medicine, several systems or schemes have been developed to judge the content of publications in the form of "levels of evidence" (Burns, Rohrich & Chung, 2011). These systems rate the validity and trustworthiness of research by specific criteria. Such levels help physicians find adequate sources (e.g. by providing keywords for a database search) and/or decide about a certain treatment or medication. As a "blueprint" for a rating system of publications in the field of knowledge work and office design, the approach of the Oxford Centre for Evidence Based Medicine (Howick et al., 2011) was adopted. On this basis, the following levels of evidence system for office design

research are suggested in this work. In the descending order from A (highest) to D (lowest), four evidence levels are proposed. The level B is split in two sub-levels (B+ and B–). Table 1 shows an overview of the suggested evidence-level system. Please note: this is still a preliminary version.

The lowest level of evidence, "D", consists of all non-academic publications without any substantial scientific evidence or references. Same applies to sources with a potential interest in positively biased information. Typically, the first reports or discussions about new phenomena without in-depth research are subsumed in this level. Therefore, it could be characterized as a "reporting level". The next level "C" is comprised by academic publications of a primarily qualitative character. Their evidence is supported by established qualitative research methods (usually applied to single cases or a rather small sample size). If well-grounded and documented, also non-academic journal or magazine articles could be referred by this level. The next is the "quantitative level", which can be split into two sub-levels. With "B–" all evidence gained with exploratory statistical methods without testing pre-defined hypotheses can be placed. In addition, highly elaborated qualitative studies, referring e.g. to a larger data bases, can be classified in this level. On the contrary, publications classified into the "B+ level" involve statistical testing of a priori formulated hypothesis. The highest level "A" encompasses publications summarizing and testing scientific evidence on large-scale data bases. It could be labeled as "confirmatory level".

2 METHOD

After this system was formulated, a coding system was elaborated and applied to the 471 publications described above. In order to do so, an efficient and effective heuristic[15] for rating had to be established beforehand. The heuristic was: searching for specific keywords or features within the publications as indicators for the evidence levels. These keywords were identified in the abstract, methods or results sections.

- For the A level of evidence, the keywords are "meta-analysis" (favorably combined with reported d-values), or "confirmatory factor analysis".
- Keywords for B+ level are e.g. "structural equitation modelling" (favorably combined with model graphs showing statistical residuals), "longitudinal study", "experiment" combined with "randomized sample", or "hypotheses".
- Any other study using statistical methods and/or portraying statistical results is rated B–. As these features can easily be identified in the methods or results section, no keywords are needed for this level.
- The main key feature for C level is the mentioning of any qualitative method respectively scientific analytical procedure, like "literature analysis", or "content analysis" – plus references to academic literature.
- All other publications are rated D.

[15] A heuristic means in this context: a "rule of thumb", which fastens processing information, but for a trade-off with adequacy. The opposite would be a systematic algorithm, identifying exactly but slowly each item. In my case, this would have meant to read each of the 471 publications completely again, to identify their level of evidence. This would have been too time-consuming, so I had to search for a heuristic.

Publications with various evidence like books, reports etc. were screened for specific contributions like studies, analyses etc. The entire publication then got the level of its highest rated contribution within. On this basis, it turned out to be rather efficient and effective judging all of the 471 publications. There were only few ambiguities, mainly in books or publications primarily referring to other studies. In these cases, the rating was generally "benevolent", i.e. opting for the higher possible level of evidence.

3 RESULTS

The results of this analysis are shown in table 2. Four publications are rated A, 67 are rated B+, 167 are rated B–, 217 are rated C, and 16 are rated D.

Table 2 Results of the level of evidence analysis

Level of Evidence	**Number**	**Percentage**
A	4	0.8 %
B+	67	14.2 %
B–	167	35.5 %
C	217	46.1 %
D	16	3.4 %
Total (N)	*471*	*100 %*

The evidence of this analysis is twofold. One half of publications can be considered qualitative with only marginal non-academic contributions. The rest are quantitative, with a majority of explorative studies. The highest level of evidence applies to less than one per cent of the entire body of literature.

A typical example for a "D" rating is the essay of Eickhoff (2017) on office work, expression his own thoughts but without referring to any other specific sources. A typical example for a "C" rating are Hills and Levy (2014) with their qualitative case study on workplace design, including an exhaustive literature search for key concept and a content analysis of in-depth interviews with knowledge workers. A typical "B–" rating are Appel-Meulenbroek, Kemperman, Liebregts and Oldman (2014) with their explorative study of the correlations between work environment elements and workplace activities in different countries, including an exploratory factor analysis of work activities. A typical "B+" rating are Wohlers, Hartner-Tiefenthaler and Hertel (2019) with the statistical testing of their hypotheses about the impact of activity-based work environments on office workers' job attitudes and wellbeing.

The four "A" rated publications are:

- Allen, Johnson, Kiburz and Shockley (2013) with a statistical meta-analysis of studies about work-family-conflicts and flexible work arrangements.
- The indoor environment quality handbook of Bluyssen (2009), citing several meta-analyses.
- De Dear and Brager (1998) with a statistical meta-analysis of the Word Thermal Comfort database (with over 21'000 data sets).

- Ma (2009) with a statistical meta-analysis of studies about variables associated with creativity.

4 CONCLUSION

The system of evidence levels proposed here enabled me to rate the 471 publications with reasonable effort and sufficient results, which demonstrates its applicability. The system provided an overview of the quality of evidence in this sample of publications, which enabled me to devote different attention to various sources and to save time.

Nevertheless, there are some important aspects to discuss. First, does the suggested rating system apply to the field of workplace design? The systems mentioned above (Ulrich et al., 2005; Martin & Guerin, 2006) were (a) focusing on peer-reviewed journal articles only and (b) taking research methods in account (whereas their rationale for evidence rating appears not completely specified). The system suggested here is applicable to any kind of publications and aims to provide a specific rating rationale. This rationale is adopted from the field of medicine, where intervention studies are widely used (also published in peer-reviewed journals). For medical interventions, the research method with the highest level of evidence are large-scale double-blind randomized clinical trials. Such interventions are not possible in the field of workplace design for practical reasons. In best case, unrandomized quasi-experiments with longitudinal before-and-after assessments are performed. Therefore, the highest level of evidence is given here to statistical meta-analyses, which analyze the existing empirical studies on a certain topic in regard to the effect sizes. In the research field of workplace design, it takes quite some time until a substantial amount of suitable studies is published. As this field is developing very fast, and it takes considerable amount of time to perform meta-analysis, so they are relatively rare and often do not cover the latest sources. In consequence, the suggested rating system may be too “severe”, so that the majority of the publications in the prevalent sample was rated with “B” or “C”. Thus, it may prove too little variance to provide substantial information for researchers and practitioners.

The second issue is how to rate different methods used in the publications. Workplace phenomena are studied by various disciplines, which have diverse methodological theories and approaches. How to compare an architectural design study with a case-study in management or a cross-sectional survey in social sciences? The suggested rating system is based on a specific approach from the empirical social sciences, favoring quantitative methods above qualitative. However, does this also meet the standards of other disciplines? Additionally, it may be questionably whether a meta-analysis focusing on few variables provides “better” evidence than an in-depth case-study revealing broad insights of complex phenomena in the field?

This leads to the third issue, the relation between research and practice. The aim of such a rating system is to provide especially practitioners with relevant information. Their decisions in the field of workplace design are often complex, e.g. they have to choose between options or to balance between different technical, financial, esthetical, social, etc. aspects. Most academic research can only focus on some few variables – exploring, describing and testing significant effects. Labelling such publications with evidence levels would probably not help practitioners directly in their daily work. The research findings require to be interpreted and transformed into design recommendations, as it was done by Martin and Guerin (2006).

This includes the fourth issue, a “technical” aspect of the suggested system: the rating heuristics. The system worked rather well for me within the scope of my doctoral thesis. However, such

heuristics are prone to misjudgments. It works well for shorter texts like articles or essays but falls short in judging an entire book. Therefore, it should be transformed into a more systematic procedure. Theoretically, it could be possible to program a self-learning algorithm, which could autonomously detect, analyze and rate any kind of publication in online databases and libraries (preferably in addition with human editing of ambiguous findings).

The sixth and last issue concerns sampling. The numbers in Table 2 apply to my sample of 471 publications – but can they be generalized to the entire field? As my literature search was only partly structured and often rather arbitrary, a different sampling method could lead to a different result. My search was basically open to any kind of literature, if it was related to workplace design and/or knowledge work. Consequently, further and more systematic research, especially with more distinct inclusion/exclusion criteria, is highly recommended.

These six issues contribute to one central question: what would be the use of such an evidence level rating system? Mainly, it could label any publication, including non-academic ones. Such labels could give easy information and are quick to process when screening through many sources. Furthermore, such a label would provide additional information on publication in peer-reviewed media, one of the important criteria in academic literature. Would all this meet the needs of practitioners and researchers? It could help them to choose which publication to read, but still they would have to read and interpret what they read themselves. Therefore, such an evidence level rating system would probably only be of use, if combined with an appropriate scheme of editing the content (i.e. the evidence itself). The closing of InformeDesign® website suggests that meeting market needs sustainably may be a great challenge.

Even though this contribution cannot fully estimate the usability of the rating system proposed here, the very endeavor of bringing such an evidence levels system in the field of workplace design provides some input for reflection on the quality of evidence available, as well as appropriate and required for both practice and research. The TWR network is certainly one of the best places to discuss such issues.

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User-centered office design, designed by users – co-created work environments and their impact on cultural organizational development

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ABSTRACT

For some years now, there has been a growing understanding that the design of products and solutions must be oriented towards the needs of the user, summarized under the term user-centered design. In this article, a co-creative design approach is shown that transfers this development to the design process of future-proof and culture-related work environments, making a subsequent change process superfluous. Users are customers and planners at the same time and change roles continuously to get a holistic view of the issues. They independently analyze, design and implement the conditions of their new work environment with the support of external facilitators. Soft factors, such as necessary cultural agreements, are made visible and negotiated with each other as they arise. The new environment is designed in an agile, iterative process flow that integrates all levels of development and planning. The paper gives insights into working methods, attitudes and techniques, as well as into the structural setup and process of the co-creation. Space creates culture and vice versa.

Keywords

Future adaptable office environments, iterative co-creation, user-centered office design, human-centered office, cultural transformation.

1 INTRODUCTION

We are living in a time period of disruptive changes that have a big impact on organizations, their products and services. The pace of change is so high that traditional approaches and models no longer work to be competitive. This condition is generally summarized under the term “VUCA” – volatility, uncertainty, complexity, ambiguity (Bennet and Lemoine, 2014). This has created pressure on organizations to develop strategies (Du and Chen, 2018) and skills that can be adapted quickly, and applies to all areas of an organization and also to their physical spaces – the office environment. (Doorley and Witthoft, 2012)

In the search for a sustainable solution for the development of user-centered, future-proof and flexibly adaptable offices (Gjerland et al., 2019), “the true co-creation approach” was developed. The term refers to cooperation on an equal footing with all people and stakeholders involved in the process. The approach assumes that the knowledge about the needs and requirements of a development is already available in every organization itself. However, it must be made visible.

The development of a new work environment changes the condition of an organization and at the same time has to keep an eye on performance and profitability (Gjerland et al., 2019). The change in the physical work environment in many cases requires new cultural agreements. This includes completely new aspects and areas that are integrated or redefined, such as, for example, the acceptance to freely decide where (at what location in the office or elsewhere) someone wants to work. The transformation of spatial and cultural conditions has a direct impact on processes and work processes and vice versa (Miller et al., 2014). This requires a clear objective of the transformation and at the same time an adjustment of the organizational strategy and the attitude on leadership and employees.

2 METHODOLOGY

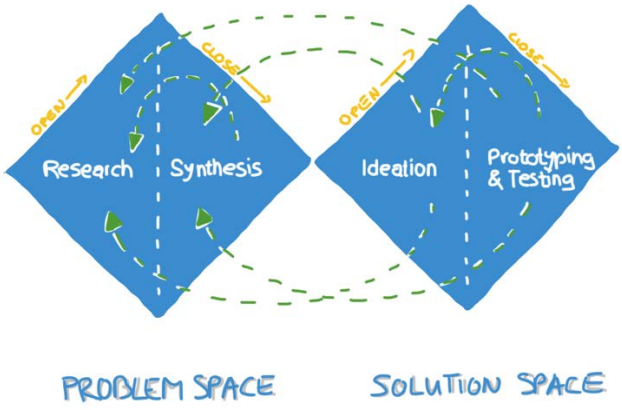
2.1 Fundamentals

The most widely used spatial design processes can in principle be called linear processes because they are usually commissioned by an individual or a committee and are usually developed by external service providers. There are countless processes on the market that offer their own solutions for the development of work environments (Gjerland, 2019). The level of user integration usually focuses on selective and individual interactions. Participation is often limited to visual aspects such as furniture and expression of the design. The project manager or CEO then makes the final decision on the result. Subsequently, the users are prepared for the new environment in a correspondingly extensive change process with high communication effort.

Every spatial and thus culturally shaped change process can have a significant influence on the attitude and behavior of the employees, in a positive and negative sense (Haapakangas, 2019). The approach presented here assumes that collective intelligence leads to better results. At the same time, the collaboration between employees from different sectors of an organization creates a high level of acceptance for the jointly developed results (Wiltschnig et al., 2013).

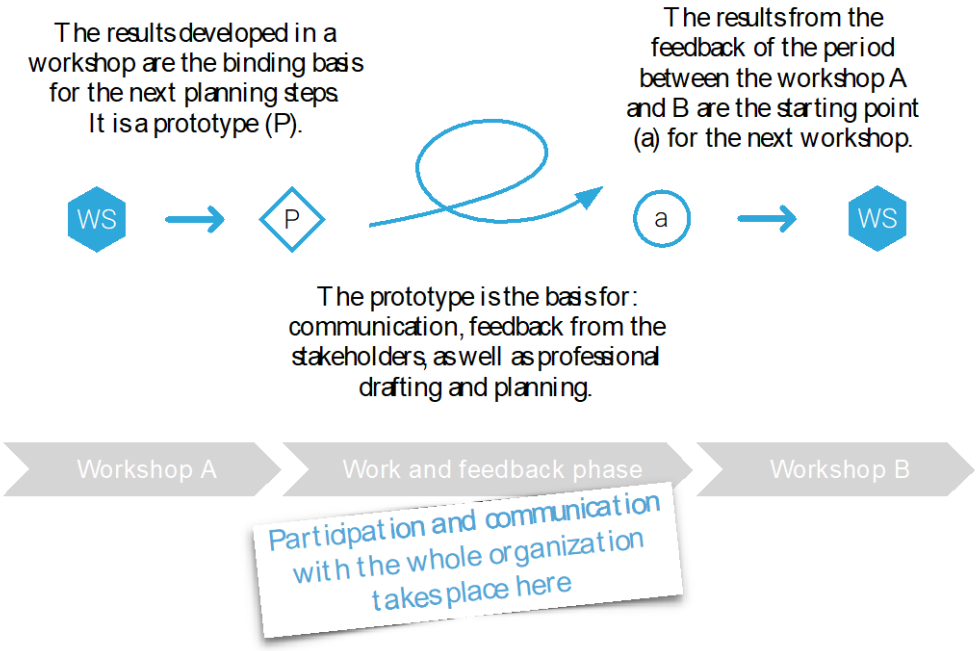
The basic requirement for future office environments applies: they must be human-centered, economically and ecologically sustainable and continuously adaptable to the required situation. In this context, the goal is to create an adaptable (space and culture) work environment, (Doorley and Witthoft, 2012) which was developed co-creatively (Wilkinson and De Angeli, 2014) by volunteers of the organization and experts (internal and external). Users design and decide on their new work environment. The “true co-creation approach” is an agile framework in which participants apply the working methods that are later used in the new environment, such as design thinking (Uebernickel et al., 2015), (see Figure 1) and co-creation (Ind and Coates, 2013). External moderators (integral coaches, architects and agile facilitators) guide the participants together through all steps of the design process.

Figure 1: Design Thinking process (from left to right) and iteration (green)



In order to get a comprehensive picture of the vision, people from different sectors work in small teams across hierarchies on ideas and solutions. The results are regularly shared with each other and thereafter integrated. In iterative sequences, prototypes are developed in workshops, which are immediately provided with stakeholder feedback, which is to be incorporated into the design in the subsequent development step. Through such regular feedback phases, all employees of the organization can participate in the development (see Figure 2) and thus also in the decision making. By analyzing the conditions of one's own working environment, the connections between these subjects become clearly visible: working methods, office space, technologies used and people's attitudes (Amstutz and Schwehr, 2015).

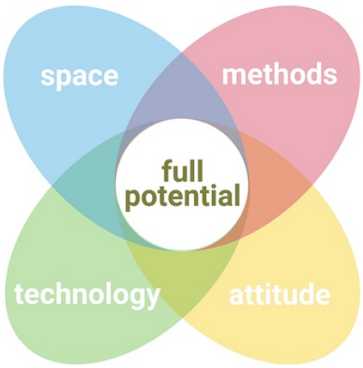
Figure 2: workshop and iteration logic



If these 4 sectors (see figure 3) succeed in developing the interdependencies of their relationship to each other, the full potential of a working environment can be released. This holistic

perspective offers a broad basis for the efficient and intelligent implementation of adjustments that will be necessary in the future.

Figure 3: factors influencing the office environment



It is important to be convinced that people have a great need for a positively characterized work environment (Kulick et al., 2017). The inner attitude of everyone involved in the "true co-creation approach" is therefore an important prerequisite for participation. The purpose of the new office environment – the WHY – must be clear to everybody involved (Sinek, 2011). Everyone must work towards this purpose, including all external planning partners. Therefore, a comprehensive stakeholder analysis is required at the beginning in order to identify the different hurdles and perspectives of the project and to be able to involve all departments and people of the organization accordingly. At the same time, transparent and prudent communication is a key to high acceptance of the change and the success of the transformation. All essential information, such as development status, fundamentals, procedural rules and decisions must be continuously communicated. (Boch and Konkol, 2012).

2.2 Procedure of co-creation

The "true co-creation approach" essentially consists of 4 phases (see figure 4) and begins with the clarification of the goals of the project and ends sometime after moving to the new environment, while the transformation process continues to be observed and accompanied.

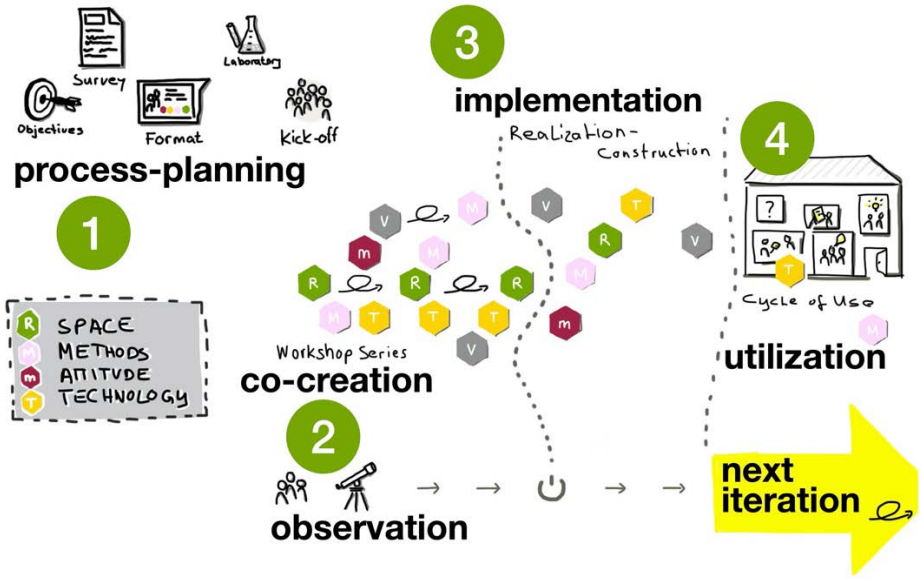
(1) At the beginning goals, stakeholders, conditions and needs are analyzed and a roadmap for the process is developed.

(2) In the second phase the co-creation starts with workshops in all 4 subject areas (methods, space, technology, attitude). Parallel to this, the observation of the process itself begins in order to be able to make adjustments if necessary and at the same time to be able to integrate necessary cultural changes at an early stage.

(3) The implementation starts in the third phase, while co-creation is still ongoing. Prototypes will be tested with user groups to iteratively make improvements based on the feedback received. This happens not only in the 4 subject areas themselves, but also in their overlaps.

(4) The fourth and final phase begins with the cycle of use, the move-in. A large networked prototype of subject areas has emerged from many small prototypes. Now the fine tuning in the 4 subject areas can be started. The observation process from phase 2 continues with a changed focus and frequency.

Figure 4: phases of the approach



3 CASE STUDY

To be able to apply the "true co-creation approach" we work together as a tandem or larger team. We see ourselves as moderators, mentors, supporters, sparring partners and companions for the teams of an organization. Our task is to contribute our competence and experience in all 4 subject areas (methods, space, technology, attitude). At the same time, we are responsible for the guard rails to create a secure framework for the "true co-creation approach".

Over the past 5 years, we have tested and developed projects of different sizes and scope together with our customers. One of these projects is described below as an example.

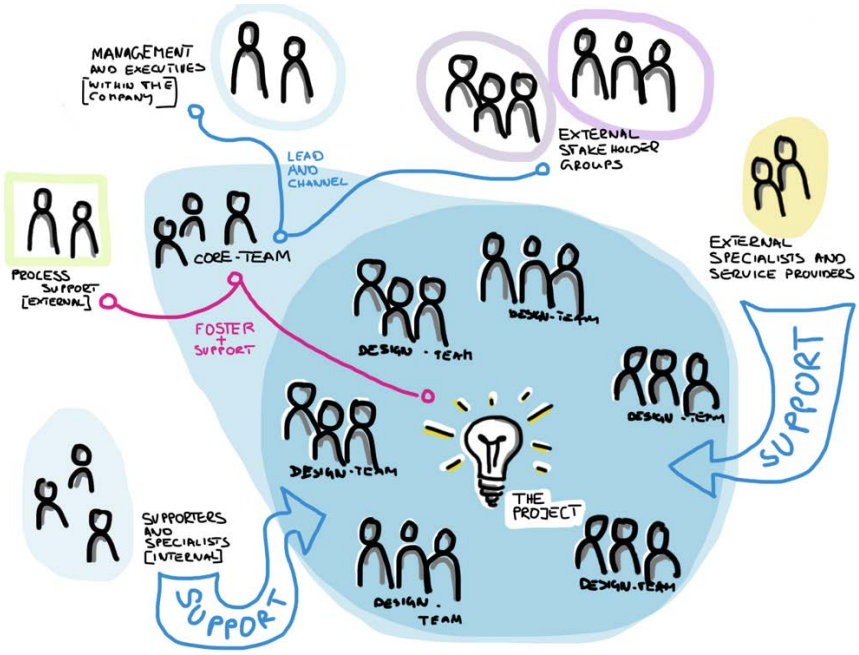
3.1 Starting point

Due to the ongoing restructuring of the organization over the past years and the reduced need for office space, the board of the organization has decided to move to another (new) building. The planned move should therefore be used as an opportunity to improve the entire work culture (towards agile working methods) and the infrastructure and thus adapt to future challenges and become more attractive for existing and future employees. At the same time, space efficiency and cost benefits play a crucial role.

3.2 Procedure

At the beginning the conditions for the participation is worked out and coordinated with all relevant stakeholders (see figure 5). Roles, goals, tasks and communication axes are analyzed and defined together. A team, consisting of seven stakeholders from the organization, the Core-Team is installed as process owner for all topics and teams in order to define and monitor the conditions of the co-creation.

Figure 5: stakeholders and their involvement



Based on the results of the survey of all employees (57% participate) it is analyzed on which topics should be worked on in Project-Teams. In the development of the new building, further objectives, in addition to office design, will be considered. For participation in the Project-Teams, 10% of the 700 employees have volunteered. All Project-Teams are supported by internal specialists, such as IT, works council, occupational health and safety, with their specialist knowledge and can also use external services if required. Tasks and roles within a Project-Team are identified and assigned, transparently and independently by the members themselves. In order to identify the interfaces and overlaps to other Project-Teams (working on further objectives), weekly meetings with all team leaders are planned.

In the next step, the various requirements for the new office building are analyzed in two ways. The quantitative analysis of the online survey at the beginning revealed core issues and personal ideas. In a qualitative observation, special questions are asked in a random sampling procedure - 8% of the employees were interviewed personally (following ISO 9241-210: 2019). Most of the respondents' requirements point to deficiencies in qualitative room conditions, such as indoor air, acoustics, ergonomics and lighting. At the same time, there is a high demand for uniform and modern technical equipment at workplaces and also in meeting rooms. At the time of the first surveys, acceptance of the planned desk-sharing concept is low.

A cluster of all analysis results leads to the requirements to set up 6 further Design-Teams (see table 1) in addition to the office Design-Team, in order to be able to work on the further objectives. In addition to their primary objectives (e.g. mobility), all teams should also emphasize the reciprocal conditions with the cultural agreements.

These additional Design-Teams have each examined the relevant conditions according to their topics and have developed proposals as prototypes. Subsequently, the participants of all teams negotiate together which of the spatial and cultural requirements can or should be met and how.

Table 1: Design-Teams and topics besides the office Design-Team

Design-Team	**Topic(s)**	**Result(s)**
Co-working	Alternative place on the road to transition to new forms of work	• Testing and evaluating the options within walking distance of the new location • Selection of a provider for the next 2 years
Working and meeting culture	Themes and development goals that cause and promote cultural change through spatial transformation	• Development of cultural guidelines and solutions to the topics of Desk Sharing, Activity Based Working, digital technologies, home office, meeting rules, etc.
Technology	Needs of different personas in relation to technological requirements and possibilities affecting the work in the new building	• Derivation of a concept proposal after market analysis and product tests • Implement the concept in the planning processes
Mobility	Development of a sustainable - ecological and economic mobility strategy for the employees of the organisation *(Note: In contrast to the old building, the new building has no parking lots)*	• Analysis of needs and options at the new location • Negotiations with the operators of local public transport, providers of bike and car sharing and providers of digital mobility services
Nutrition	Concept and strategy for a healthy diet for staff during breaks and working hours *(Note: the new office will no longer have a fully equipped canteen)*	• Analysis of the needs and the local market situation (existing canteens, restaurants, mobile services) and development of a concept for a bistro on the ground floor of the new building
Wellbeing and services	Concept for well-being, sport and health, as well as special services for all employees - before, during and after working hours	• Analysis of the needs (survey) and development of solutions, locally and in the form of services (digital and analogue)

3.3 Insight into the co-creation of the office design

Every team member in the process assumes different roles in the co-creation (client, user, manager) and therefore has to temporarily change its perspective, especially members in the office Design-Team. In order to find broad agreement in the organization, the conditions and potential of the design must be well explored. The aim is to develop a balanced and flexible overall concept that is also adaptable to (unknown) future needs.

In five workshops (see table 2) the office Design-Team develops prototypes on various topics of the new office environment. A typical workshop agenda (see table 3) includes the exchange of information (knowledge transfer, attitudes, opinions), as well as learning from each other (e.g. changing perspectives), creating together and discovering new challenges together. The methods, which consist of agile (Papadakis and Tsironis, 2018) and integral elements, vary according to the question posed and the current state of a team and the project.

For most people, the process of developing a new office is usually completely unknown. This is a great opportunity, as it gives rise to surprising and unconventional ideas which, with the professional support of external service providers, can be translated accordingly into buildable reality.

Further information on the objectives and results, as well as an impression of the workshops, can be found in figures 6 to 15 in the appendix.

Table 2: office design workshops

WS No.	Title	Purpose
1	The building: In terms of usage processes and options, spatial options	• Analysis of the structure of the organization • Evaluation employees needs • Spatial relationship of the organization • New building - spatial qualities, areas and zones
2	The floor plan and design options: Spatial layout, furniture, material and surface	• Look and feel of design • Test and feedback process • Concepts of an authentic interior design • Development of floor plans by typologies
3	Status and feedback: All 7 Design-Teams	• Interface planning: topics, content and teams
4	Design and functional concept of: Building, furniture, colour and material world (part 1)	• Input: design, space quality and layout • Designing and detailing: layouts of all areas and levels • The big picture: vision for the entire building
5	Design and functional concept of: Building, furniture, colour and material world (part 2)	• Finalization of the results of WS No. 4 and stakeholder feedback • Final input for planning approval
This structure serves as a basis and should be adapted to changing conditions as required.		

Table 3: structure of a typical workshop agenda

Time	Topic	Agenda	Goal	RFD*
30 min	Check in	Connecting the team / participants	Build compassion	a, m
15 min	Agenda items	Get a clear vision of the objectives	Enabling alignment	m
45 min	Status	Sharing the latest findings (including feedback)	Knowledge sharing	m
15 min	Break (coffee/tea)	Recreational break	Take care of oneself	a
30 min	Impulse or introduction	Introduction to the topic and questions to be worked on	Knowledge transfer	s, t, m
60 min	Design sprint 1	Co-create	Development of prototype(s)	s, t, m
30 min	Presentation 1	Sharing the idea(s)	Understanding (diversity)	s, t, m, a
60 min	Break (lunch/socialize)	Recreational break	Take care of oneself	a
15 min	Physical exercise	Focus activation	Return to common objectives	a, m
30 min	Feedback/ status	Detecting the tensions related to the prototype	Get a holistic perspective	a, m
45 min	Design sprint 2	Co-create	Development of common prototype(s)	s, t, m
15 min	Presentation 2	Sharing final prototype of the day	Iteration basis	s, t, m, a
15 min	Break (coffee/tea)	Recreational break	Take care of oneself	a
50 min	Next steps	Tasks, roles and communication	Clarity on the next steps	m
15 min	Check out	Connecting the team / participants	Build compassion	a, m
**Reference to factors influencing the office environment: s= space, m=method, a=attitude, t=technology*				

4 CONCLUDING REMARKS

• The empirical experience gained through the practical application of the “true co-creation approach” in this case study, as well as in the other cases in recent years, has fundamental similarities. Transformation through spatial change requires a general understanding of how culture and space are interdependent. Therefore, consistent and continuous communication within the project teams and into the organization should be established from the beginning in order to avoid misunderstandings and rumors. External planning partners must also be well integrated into the process. It is advantageous (time, communication, budget) to adequately inform all stakeholders about the working methods and interfaces before the start. Regular keynote speeches (inspiration, information, case studies) can stimulate creativity and lead to special or unusual ideas and results.

Without a clearly defined vision of the (new) cultural goals, the working groups lack the necessary orientation and thus ultimately also an idea of what working in the new spaces might look like. The result of the co-creation shows a fundamentally different and broader picture than at the beginning of the phase, not only spatially but also culturally. When comparing the layouts of the floorplans, the differences become visible, such as an open room structure, a more extensive range of different spatial scenes (see appendix, figures 16 + 17). Topics related to new common rules of conduct and agreements are discussed with each other and iterated if necessary.

Compared to other methodological approaches of developing (new) work environments, one aspect is particularly striking. The way in which employees encounter problems, challenges and themselves in everyday work: open-minded and solution-oriented. It can be assumed that the self-determined and self-responsible approach described here is conducive to this. Almost all team members want to continue to actively participate in the development of phase 4 (see figure 4) and integrate the methods learned in their everyday work.

The spatial and cultural foundations that have been developed must still prove themselves in the future and be regularly validated in interviews with users.

A long-term study could provide additional insights into changes in the role of offices and their use (activities) in general, and serve as a decision-making aid for the selection of methodology for the development of future office environments.

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APPENDIX

Figure 6: Tool, SAP Mosaic** + individual expansion on the right side *(in-house development)*

**(Mosaic licensed under a Creative Commons Attribution, Non Commercial, Share Alike 4.0 International License)*

Figure 7: module cards tool + requirement specification sheets *(in-house development)*

Figure 8: workshop impressions I

Figure 9: workshop impressions II

Figure 10: prototype – material and style collage, result workshop 2 (see also figure 12)

Figure 11: workshop 1, office design

WS 1 (1 day – 8 hours)	**The building in terms of usage processes and options, spatial options**		
Goals	• Analysis of the structure of the organization and their way of working • Evaluation of the needs of the employees and needs for the new work environment • Spatial relationships related to the organizational structure • Get to know the new building - spatial qualities, areas and zones	Methods, materials and tools	• Design Sprint (method) • Keynote: "spatial qualities in the office" • Survey results and evaluation (prints) • CAD plans of the new building (prints) • SAP Mosaic tool (plus individual extension) • Project schedule and process steps of the co-creation (tool)
Results / hands on	• Compare survey with qualitative research • Findings about the possibilities and limitations of the new building • Conditions of spatial and structural (organizational) relationship: who works how and with whom? • Analysis of spatial relationships: qualities (function, size, etc.) and activities (loud, quiet, etc.) • Development of the first prototype in the layout: Which department should be placed where and which special functional areas should there be?		
Feedback participants	• Information on special areas (doctor, warehouse, etc.) is missing • It can be difficult (due to the geometry of the new building) to switch from the current state of the fixed desk (inventory) with the same distribution logic (by department) to the flex desk mode • Not all spatial qualities (loud, quiet, etc.) will be available on every floor		

Figure 12: workshop 2, office design

WS 2 (2 days – 16 hours)	Spatial division of the floor plan, design options, furniture, material and surfaces		
Goals	• Development of design: look and feel as a rough briefing for further processing / detailed planning by specialist planners • Development of a test and feedback process • Concept of an authentic interior design • Development of floor plans with module cards (tool) for these typologies: workplace, formal and informal meeting, break, lounge, telephone booth, agile areas, etc.	Methods, materials and tools	• Keynote: introduction to spatial typologies and their special properties • Keynote: the elements of spatial atmosphere (color and style / composition) • Design sprints • Various mood pictures of existing office environments (positive and negative examples as prints) • Material and color samples for design (analog) • Examples of furniture: small market overview (systems, individual products as prints) • CAD plans (prints) • Module cards (tool) spatial typologies and their properties
Results / hands on	• Development of the division logic for the 8 floors of the new building (division: by departments and functional areas of the organization) • Development of the 2nd prototype layout: spatial division of the floor plans with module maps according to the assumptions from the survey and the formulated goals of the transformation. Variants were developed: a) by department, b) 100% activity based (no further logic), c) "Future 2050" d) by support areas (across departments) and their affiliation •Various test scenarios will be tested with the users in the coming weeks in these three fields: space, culture and furniture • Briefing for the service provider interior design (workshop participant) with information on furniture, material and color • Mood collage to the look and feel: a) furniture, b) material and color • Overall collage of furniture and material as a prototype for feedback (from all stakeholders)		
Feedback participants	• It could be difficult to create loosened areas in combination with the internal needs and requirements for the required space. There is currently a high density and little spatial quality • Pay attention to lighting conditions, especially in computer workplaces • Sound insulation in the phone boxes is important • Movement areas to toilets, telephone boxes, meeting rooms, etc. are noisy areas • The sustainable and resource-saving manufacture of products and materials is an essential basis for the development of new work spaces • When developing the brand identity it should be limited to a previously defined area so that structural developments within the design environment are possible • A basic idea is not to design all in detail, so that spaces remain open for future developments		

Figure 13: workshop 3, status report and interfaces check

WS 3 (1 day – 8 hours)	Status and feedback of all working groups and topics		
Goals	• Interface planning between topics, content and teams	Methods, materials and tools	• Market place • Breakout sessions • CAD planning and visuals (prints) • Flipcharts with informations and status (prints) • Samples (prints)
Results / hands on	• Status of all working groups - knowledge transfer • Update of the interfaces • Determine the next steps and dates		
Feedback participants	• Very important appointment to understand the relationships and dependencies • Important insights into the relationships between space and culture		

Figure 14: workshop 4, office design

WS 4 (1 day – 8 hours)	Design and functional concept of the building, furniture, color and material world (part 1)		
Goals	• Input on the topics of design and spatial quality and layout • Design sprint: designing and detailing the layouts of all areas and levels • The big picture: vision for the entire building	Methods, materials and tools	• Design sprint • Keynote: "How to design" • Product images and catalogs (prints) • Material and color samples (analog) • Current CAD planning (prints) • 3d visuals of the interior in black and white (prints) • Haworth Co-Designer software (with external support)
Results / hands on	• CAD planning requirements • Collages and mood boards of all floors and areas • Requests for changes and solutions, including comments in the plans and visualizations		
Feedback participants	• It is important to have unique, authentic areas in the building that work as an attraction • Decisions on the topics of color and material are determined by individual taste and are not easy to achieve consensus • The 3-dimensional imagination is not equally developed for all participants • Linguistic exchange about spatial qualities is sometimes difficult for inexperienced people due to a lack of experience		

Figure 15: workshop 5, office design

WS 5 (1 day – 8 hours)	Design and functional concept of the building, furniture, color and material world (part 2)		
Goals	• Finalization of the design for further processing for the external specialist • Last feedback for planning approval	Methods, materials and tools	• Design sprint • Product images and catalogs (prints) • Material and color samples (analog) • Current CAD planning (prints) • 3d visuals of the interior in color (prints)
Results/ hands on	• Decisions about products and surfaces • Last adjustments to the planning • Next steps in the realization / implementation phase • Start of the campaign "Our new office" (information about what and how – space and work culture)		
Feedback participants	• A demanding process is still ahead of us • We need more time to test the furniture • Enjoyment of the joint design and the current result • Excited to be able to enter the jointly developed space in 7 months		

Floorplans, layouts:

Figure 16: example layout of the property developer (drawing based on workplace calculator software)

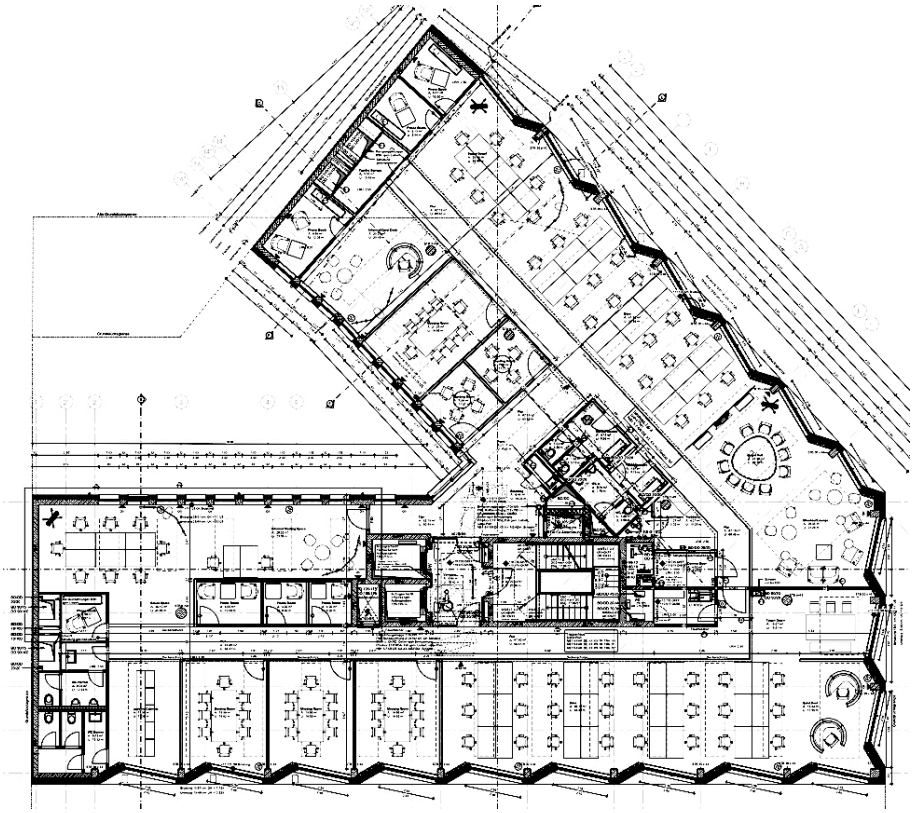
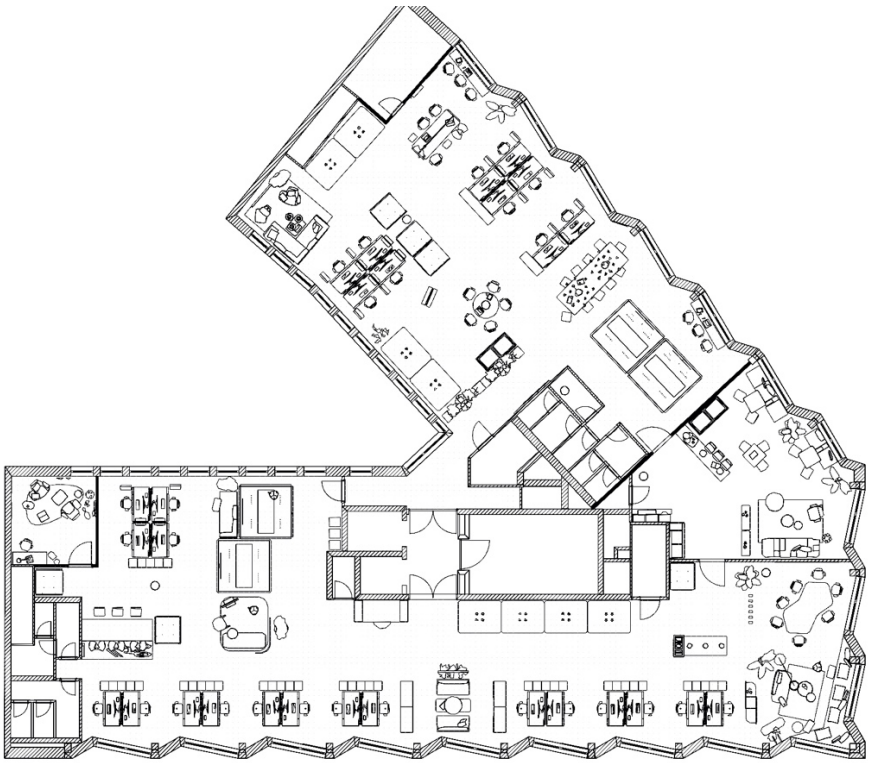


Figure 17: example layout co-creation (drawing by service partner)



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Collaboration platforms as enablers of new work - three case studies on organisational prerequisites for change

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ABSTRACT

Purpose: Collaborative applications have the potential to support a new, networked and self-directed form of collaboration, currently propagated by many companies as “new work”. However, the deployment of new technologies does not automatically lead to new forms of work. There are a number of inhibiting or promoting factors to be considered. An important factor influencing the extent to which technological possibilities can be realised is the form companies organise work. The aim of this contribution is to analyse the interrelation between the use of technology and the ways of organising work, using three case studies on collaboration platforms as examples. We want to describe how the use of collaboration platforms affects organisational change and examine the conditions that promote or hinder a change to “new work”.

Theory: We argue on the basis of John Child's theory of organising (2015), which assumes a fundamental shift from conventional to newer forms of organising. It provides a framework for the empirical analysis of organisational practices.

Approach: This contribution presents findings from three qualitative case studies of medium-sized enterprises (special mechanical engineering, IT consulting, software development) with an advanced use of collaborative applications. The enterprises are located in various sites in Germany and abroad. Our research is based on a longitudinal mixed method and multi-methods approach. We have accompanied these enterprises over three years, implementing and testing an integrated “digital workplace”.

Findings: The case studies reveal that the main challenge of the adoption and use of collaboration platforms is not the command of the technology but rather the complex change in the ways of working and organising. We have found new forms of software-supported collaboration in all three cases, but to a varying degree. This is based on the design of the usage options and authorization concepts of the collaboration platform. It must be decided who is entitled to form groups with whom and who may share content with others and to what extent. Furthermore, the concept of control associated with the use of platforms plays a central role. In the context of an ”imposed” design, more traditional ways of working are encouraged, while an “emergent” design of a collaboration platform encourages the development of “new work”. The case studies suggest that the full potential of software-supported collaboration can only be realised when traditional conceptions of control are overcome.

Originality/value: There is a growing range of literature on adoption challenges of enterprise collaboration systems, however, to date we do not know of any similar case studies on the interrelations of the use of collaborative applications and the forms of organising. Our case studies differ from other companies in their extensive use of collaborative applications.

Keywords

Collaboration plattform, organising, work design, organisational change, new work

1 INTRODUCTION

New ways of working are currently high in demand. Numerous companies present themselves as "new work" companies with new forms of flexible work at any time any place. Simultaneously, collaboration platforms are increasingly being used (Schubert and Williams, 2015). They include tools for communication, task coordination and sharing knowledge and enable to work anywhere, anytime (Hardwig *et al.*, 2020); and they are designed to support teams and also to improve company-wide collaboration. Customers or other external parties can also be integrated.

One might suspect that the massive use of collaboration platforms will considerably promote the transformation away from hierarchical, bureaucratic organisations to "new work". On the other hand, one should not overestimate the importance of technology. "(…) technologies alone do not suffice to apprehend the ascent of the 'new world of work'. A plethora of other forces and factors at the meso, macro and micro levels have shaped how work practices have evolved (…)." (Aroles *et al.*, 2019, p. 287) Against this background, the following contribution will analyse the interrelation between the use of technology and the way work is organised, using three case studies of collaboration platforms as examples. The question is how the use of collaboration platforms affects organisational change. Under which conditions does it promote or hinder a change to "new work"?

2 NEW WORK AS NEW WAY OF ORGANISING

"New ways of work" in a narrow sense are defined as "place- and time-independent working" (Popma, 2013). Under the motto "Bricks, Bytes and Behaviour" propagates the "Smarter Working" movement (Lake, 2015) location-independent, networked forms of work. The slogan emphasises the necessity of a simultaneous interaction of the technologies used, the change of spatial conditions and the work culture (Clapperton and Vanhoutte, 2014). "New ways of working" are seen as part of a long-term trend of workspace differentiation and flexibilisation, which includes the flexible use of home workspaces, mobile working and the office space trends of shared desktops (Kingma, 2019). These new forms of work have seen a relevant increase over the last years (Spreitzer *et al.*, 2017).

For the purpose of our analysis, we refer to Child (2015), who describes the historical change of organisations from conventional to new, networked forms. This change expresses itself in fundamental transformations that affect the three fundamental processes of organising: *"Integration is concerned with ensuring that there is adequate coordination between the different but complementary activities that create collective value." (…) "Control involves setting goals, implementing them, and monitoring their attainment."(…) "Reward is a process fundamental to engaging the motivation among members of a company to contribute positively to the achievement of its goals."* (Child, 2015, p. 9). New forms of organising break with central principles of conventional forms of tayloristic or bureaucratically centralised organisations, following a"*different paradigm - a new way of thinking"* (Child, 2015, p. 74). They have been proven to be more suitable to dynamic market conditions. We understand "new work" as part of this change.

According to Child, the new way of *integration* relies on a horizontal coordination in decentralised units or teams with an increased collective responsibility. Instead of a hierarchical coordination with formal procedures and roles, activities are now coordinated using flexible and direct contacts on the team-level or via information technology inside the network. Bureaucratic *control* and output control are replaced by decentralised control strategies. The new rational is an internalised compliance instead of external constraints. Thus, control is exercised through negotiated objectives and shared cultural values and norms. Leadership by authority is replaced by leadership by guidance of more or less self-organised teams. *Reward*: In order to promote the motivation of the knowledge workers, the organisation of work relies on autonomy and self-organisation of teams, giving room for personal development. Rewards are based upon group performance instead of one's individual hierarchical level. The quality of work, the modernity of the workplace and the freedom to work anywhere and anytime play a central role. Herein lies the most visible part of "new work". Collaboration technology is a central enabling factor of the new network concept. "*With the aid of new technologies, companies can more readily strip out layers of management and shift the pattern of communications from a downward flow along prescribed, hierarchical routes to a more multidirectional and networked process*." (Child, 2015, p. 96)

In order to take a closer look at the conditions under which collaboration platforms promote this development, we present in the following our empirical findings by describing the relationship between the use of the platform and the changes in the three dimensions of organising. Thanks to fortunate circumstances, all three companies have used the same product, MS Teams. Hence, we rely on three case studies: A special mechanical engineering company with 370 employees worldwide (M), an IT consulting firm with about 90 employees (C) and a company for software development (S) with 235 employees. We accompanied these enterprises over three years, implementing and testing an integrated "digital workplace". This contribution focuses entirely on the use of MS teams, leaving out many facets of the topic for reasons of focus. The case description is based on an initial analysis of 36 qualitative interviews held in the first year of the project and 42 interviews and 11 group discussions conducted in the third year. We interviewed employees and managers who used collaborative platforms and those responsible for work design.

3 THE INTERACTION BETWEEN ORGANISING AND COLLABORATION PLATFORMS IN THE CASE STUDIES

3.1 Case M: The global network of a special mechanical engineering company

The company M has grown strongly over the past ten years and recently established two new sites in Asia and South America. The collaboration platform was first implemented in order to support global teams and the forms of usage were developed with these teams under the personal direction of the CEO. There was no release for use by all employees. Instead, management determined who was allowed to form groups with MS Teams. This was based on processes and structures in the organisation. Tight authorisation concepts were defined for the access to content. The teams using MS teams established new forms of collaboration that were appreciated by those involved. For example, all documents of the team were stored in a central repository. They could be edited by all team members. Asynchron "conversations" in written form took place on the platform, in which the status of task completion was reported or questions could be discussed. In some cases, task planning was also used for joint task control. The platform was useful when developing concepts and storing or documenting knowledge in a structured way. Users also had

access to a central wiki system in which the essential information for plant planning was exchanged. Web conferencing was also operated via the platform. This form of collaboration went far beyond the previous phone and email communication and the new form of collaboration is therefore indispensable for the global teams, but it is also considered very advantageous for local collaboration.

As the benefits were recognised by the employees, there was strong criticism of the dominance of management and the limited opportunities to use the platform. There have been many efforts by employees and also by managers to use MS teams independently. Top management resisted and even made sure that IT shut down unofficial MS teams to avoid 'wild growth'. This caused much disappointment. A second point of criticism related to the expectations of transparency formulated by management. Ongoing status reports on the progress of work should be communicated on the platform, but here, the employees were a little reserved. This is expressed in the fact that problems are not named precisely to save face in order to avoid management intervention. It is also questioned by some whether it is relevant for the team to communicate "every little thing". These points touch on the control dimension of organising. Top management has made it quite clear that they want to use the collaboration platform to improve control. This is to be achieved through increased transparency in the status of task fulfilment. Teams should document better and report more strongly. The expectation that MS Teams should also serve to improve management control is made clear further by the expansion of the use of MS Teams for the weekly management round.

3.2 Case C: Collaboration in interdisciplinary customer projects teams

The IT consulting company offers customer-specific solutions for social intranet and digital workplaces. The company is very much characterised by spatially distributed work, which takes place across three locations, home offices and the customers' offices. It has been using collaborative applications for many years. The driving forces are the high dynamics and complexity of interdisciplinary cooperation in customer projects. The introduction of MS Teams took place before the background of shifts in the market for collaboration platforms. The company adapted its product portfolio to the market leader. This was taken as an opportunity to replace older solutions and to rely on MS Teams. The switch has not resulted in fundamentally new forms of collaboration because the new possibilities created by M had practically existed before. Nevertheless, the fundamental difference was that the employees had a far-reaching transparency of all content stored in the collaborative applications and the freedom to contribute to it. Company-wide collaboration thus differed from M in that employees were able to form communities and basically also had access to the content of other projects. MS Teams now offers a uniform platform on which the various functions are more closely integrated. The increase in user-friendliness leads to intensifying collaboration, for example, to a more intensive use of web meetings. Beyond that, management resolved closely-defined documentation processes or strict rules for cooperation and placed greater emphasis on the self-monitoring of employees and teams. For the employees, the network form of collaboration was facilitated by MS teams and has become a matter of everyday life. Criticism desiring more support and structure is sometimes voiced.

At no point is it apparent that top management is seeking greater management control by using the collaboration platform. Projects are controlled by project teams within the framework of target agreements, as was previously the case. The tool will give them better opportunities to exchange information and keep track of the status of work. Incidentally, top management has

learned from previous experience and gives project teams more freedom to regulate their cooperation according to their own needs.

3.3 Case S: Company-wide exchange of knowledge and creation of a community

The software development company S, also has previous experience with collaborative applications. Productive work takes place in joint teams with customers. In contrast to case C, however, the aim is to locate the employees in locations close to their homes and home office is not offered. This is explained with the high intensity of collaboration in the company's agile work concept. Interdisciplinary teams manage themselves and coordinate their work independently. Since the parts of a team at the customer's and at a site of S should work together like a team in attendance, there is a permanent screen transmission. The team members can see each other as if there were a separating window between them and they can also talk to each other, if necessary. Until now, technology has served as a crutch to mitigate the negative effects of working at a distance on collaboration and cohesion in agile teams.

The new initiative for the use of the collaboration platform is intended to contribute to the networking of all employees in the company. The aim of the introduction is to create a digital workplace as an entry point into the corporate community. One might think that the main objective would be to achieve greater efficiency by replacing a large number of similar applications running in parallel with a uniform collaboration platform. However, by connecting all employees with MS teams, communication is also to be improved and knowledge is to be made available more throughout the company. It is also about promoting social cohesion and the community as a company with certain values of collaboration.

In this case, too, there is no sign of usage of the platform for more intensive management control. Rather, the initiative responds to suggestions to reduce the diversity of applications and to create a common solution for company-wide collaboration. It is part of the corporate culture to keep the status of projects very transparent. No question about it, this transparency also applies to the management. However, the use of the collaboration platform should – more than before - promote the self-monitoring of the teams and the integration of the employees into the corporate strategy through high transparency and the possibility of exchange via social media. The use of MS Teams will reinforce the control mode, which is based on (self-)monitoring via shared company values and target agreements.

3.4 "New work" as a reward

All three companies have to deal with the war for talents and try to increase attractiveness as an employer. "New work" plays a role of varying intensity in this. M does not deal directly with "new work", but emphasise innovation, the good internal working atmosphere and builds new company buildings according to an open, transparent architecture. C addressed "new work" directly: Their offices are designed as open, transparent spaces and they actively communicate "new work" and the freedom to work anywhere anytime is put into practice in accommodating home office solutions. With weekly meetings in which all locations are virtually connected, they highlight the cultural element of "new work"; a lively community with team spirit and events. Similar company-wide meetings are also regularly held by S. Membership of the company community is emphasised through various activities. In addition, this company strongly emphasises its agile working methods, which are very consistently developed in the operative teams as well as in the management. In all three companies, the use of modern collaboration platforms acts as a sign of modernity. However, the limited use of the collaboration platform at

M does not support the formation of a lively community of employees, while C – and even more so S – bring the technological potential of the platforms to life in the sense of "new work". The platforms is explicitly used to promote free networking and the experience of a lively community. This is a strong incentive for higher qualified groups of employees with a strong need for autonomy and participation.

4 CONCLUSION

The three companies face different requirements due to their products and services, market conditions and corporate culture. Yet the drivers of the use of collaboration platforms are – in all cases – the needs of integration: global project teams, complex interdisciplinary customer projects or spatially distributed agile software development (Hardwig, 2019). Most of the employees do not need to be convinced of the benefits of collaboration tools, but request that such tools be provided by the company to facilitate collaboration. In some ways, working with collaboration platforms can even have a rewarding function. The freedom to use the latest IT tools, to network company-wide and to exchange via social media meets the autonomy needs of many employees. This also applies to cultural aspects of agile work and working in new workspaces.

Significant differences can be seen in the way collaboration platforms contribute to control. Company M creates considerable unease because it does not support free networking and limits the transparency of content. The suspicion arises that the transparency created by the platform could serve to improve hierarchical control by top management rather than to improve self-monitoring by teams. This leads to a certain reluctance to use the platform. In cases C and S, the collaboration platform is not considered by the parties concerned from a control point of view and its use is generally assessed more positively. It seems that control over internalised values and objectives is not perceived as problematic by these employee groups. Transparency is more of a problem in the case of M, and in the case of S it is seen as a requirement to improve their performance. For the use of collaboration platforms, we can state that the critical point is the handling of control. Their use is more likely to support new forms of control based on shared values and agreed objectives, while corporate cultures with a strong orientation towards hierarchical control find it difficult to exploit the potential of the platforms.

In answer to our initial question: The three case studies show that the use of collaboration platforms can, although not necessarily, promote “new work” or new, networked and more self-organising forms of work. The same product can be designed and used very differently: In the case of M, there is little evidence that the design of the platform promotes “new work”; in the case of C and S, it obviously does. This difference can be described very well with the distinction of “*imposed structure”* and “*emergent structure”* of a team platform (McAfee, 2009). New collaborative applications differ fundamentally from earlier groupware applications and classical knowledge management applications because of their social networking features. They allow new modes of social interaction and collaboration because structures emerge from many more or less uncoordinated actions of different people. Case M demonstrates that not the technical features of collaborative applications but the possibilities provided by the actual work system define the active design principles: The conventional design principle (“*imposed structure”)* connects information and social exchange on the team platform with given processes and structures. By contrast, an “*emergent structure”* of a team platform allows free networking driven by its users.

The cases C and S show how a design of the collaboration platform according to the principle of emergent structure can enable and support the development of “new work”.

This would now need to be examined more closely than possible here. One limitation of this contribution is that both the influence of earlier processes and the influence of parallel activities of work design in these cases had to be left out. Their inclusion would not have changed the result, but could have presented it in a more differentiated way, which gives better guidance to work design practitioners. For example, it would be necessary to analyse in more detail the extent to which new roles and responsibilities of employees and new leadership concepts for the successful use of cooperation platforms need to be developed in order to stabilise new, networked ways of working.

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SESSION 11: ARCHITECTURE AND NEW WORK CONCEPTS

The spatial dimension of the flexible workplace. Exploring the relationship between utilization practices and architectural space quality

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ABSTRACT

Purpose: The observed gap between intended and actual utilization of activity-based workplaces indicates a lack of insights on what drives the knowledge workers to use the space and which are motivators and attractors in the office. Although there is a body of knowledge exploring the influence of factors like socio - spatial relationships, personal factors and preferences, job feature, functionality of the infrastructure and ambience upon the utilization of the workplace, the influence of the overall architectural quality of the workspace remains not widely explored. Therefore, this paper explores the relationship between workplace utilization practices and the architectural quality of activity-based flexible workspaces. This research aims to identify motivators and attractors in the flexible workplace and their relation to popular work zones, identify which dimensions of the office environment play a role.

Theory: The research builds upon a conceptual framework of current literature in the topic of knowledge work, looking at new ways of working and their influence in the role organizational space in knowledge-based organizations. Furthermore, empirical studies in the areas of workplace utilization and workplace attractiveness were analysed to depict the state of knowledge.

Design/methodology/approach: The research case study followed mixed methods approach integrating continuous occupancy monitoring data with survey and observation data. The data was analysed quantitatively and qualitatively and aggregated by means of data triangulation.

Findings: The association of behavioural practices and behavioural traces within the workplace by means of continuous occupancy monitoring data gave insights into how certain architectural and spatial features influenced workplace attractiveness, with ambience, connection to natural elements, task support and socio-spatial features being dominant. The findings have implications for designers, facility and workplace managers, indicating what factors should be focus points in workplace design and management, to create workplaces that better support the workforce.

Originality/value: The value of this approach lays in the triangulation between sources, integrating data on socio-spatial and technological aspects in the workplace. The findings of this study have implications for the practice of analysing, planning and developing workplace concepts, pointing to factors that influence the quality of the workspace and influence workplace utilization. The results of this research further inform practitioners for the development of evidence-based workplace strategies.

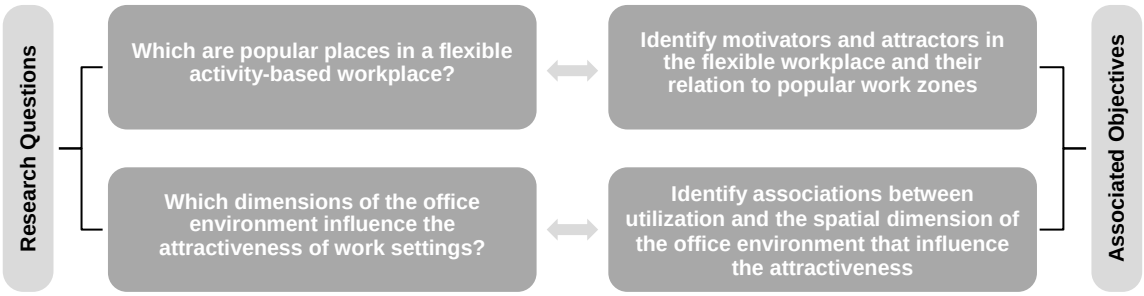
Keywords

Activity-based workplace, workplace utilization, workspace architectural quality

1 INTRODUCTION

Activity-based working assumes that employees work at the most suitable place for the work at hand by switching the setting when they change the work activity (Hoendervanger et al., 2016). However, researchers stated that this type of flexible office is not being used as intended and that users do not switch settings, instead they use the same workstation for different activities (Appel-Meulenbroek et al., 2011). Furthermore, they emphasize the need for further research that examines intended versus actual use, reported against the needs of Corporate Real Estate Management (CREM) for deeper insights into the use of flexible workplaces. Appel-Meulenbroek et al. (2011) also referred to the lack of knowledge on employees' drivers when using the workplace and suggests continuous occupancy monitoring as an alternative method to gather data that can provide evidence of the real use of workplaces. This paper aims to explore how architectural features and indicators of architectural quality in a workspace influence utilization practices and to answer the following research questions (see Figure 1):

Figure 1 Research Questions and Associated Objectives



2 LITERATURE BACKGROUND

With work practices transitioning from a process focus to knowledge focus leading to new paradigms such as New Ways of Working (NWoW). These refer to a philosophy to understand current work practices and the needed support from alternative locations and infrastructure (Ruostela et al., 2014, p. 2). More importantly, the character of the office is also changing and taking the role of a meeting place with new spatial demands and new space typologies (Vos & van der Voordt, 2002, p. 49).

With the recognition of space as a driver of workplace effectiveness and efficiency, its role is transitioning that of a canvas for knowledge transfer that demands active management (Maier et al, 2010). In the workplace, space is a material construction embedded in context in wider network of relationships (Höpfl & Hirst, 2011) that forms an integrated system with people, processes, spatial solutions and technology (Skogland, 2017). Been and Beijer (2014) and de Kok et. al (2016) identified that NWoW promote change in the way people work and behave in the workplace, and combined with technological advances, organizational changes and new business goals trigger the demand for workplace innovation.

This demand for innovation has led to new strategies to configure the workplace with varying levels of flexibility that materialize in different office types that are defined by architectural and

functional features (Bodin Danielson & Bodin, 2009). This paper focuses on the on Activity-based working and the materialized activity-based workplace (ABW). Under the idea of NWoW, knowledge workers should be able to perform distributed work tasks with optimal facility support, regardless of location. ABW concepts enable this support by increasing the space offer within the workplace (de Kok et al., 2016). Hoendervanger et al. (2016) defined ABW environments as those where the employees "work flexibly, using different types of non-assigned activity settings". Activity settings refer to the different space and workstation typologies that support different work tasks. Been et al. (2015) and Skogland (2017) identified the following as principles of ABW: choice of setting that best fits the work activities; myriad of open, half-open and enclosed settings; stimulated communication and knowledge sharing; large amount of openness and transparency; and non-assigned desks with sharing and common ownership of available space. Other authors referred to the association of spatial aspects and utilization in ABW concepts. For example, Appel-Meulenbroek et al. (2015) reported that ABW concepts had a positive influence in satisfaction with architecture and layout. Brunia et al. (2016) asserted this workplace typology addresses of workers' need for control over the environment and provides the opportunity to select a place fitting to personal and work needs.

The diversity of settings in ABW implies these different settings vary in character. Consequently, their popularity among employees can vary. This aspect of ABW has not been broadly explored by research yet, with only three studies referring to this. Conversely, factors that influence attractiveness have been explored to a wider extent. Blok et al. (2012) reported the open space followed by the collaborative rooms to be most popular. Babapour & Osvalder (2017) reported low-focus zones, high-focus zones and enclosed communication zones to be the most used. Been et al. (2015) asserted the varying ration in which these settings are available does not allow employees to use the preferred space when needed, this being a negative factor that affects the usability of the concept.

According to other literature reports, the attractiveness of work settings and workstations appeared to be mostly influenced by socio-spatial features. Qu et al. (2010) found employees tended to select workstation near main corridors and close to meeting rooms as they enabled easier face-to-face communication and shorter distances to ancillary spaces. Similarly, Höpfl & Hirst (2011) found that peripheral desks, in combination to closeness to colleagues, were preferred as they supported connection with the outside and accessibility control. Appel-Meulenbroek et al. (2011) also identified relevant factors such as closeness to colleagues, location known to others, unobstructed view outside, closeness to support facilities, number of people passing by and closeness to meeting facilities. Furthermore, visual and auditive privacy, technology support and ergonomics influenced attractiveness. Ekstrand and Damman (2016) concluded that zones with high control over the environment and high level of privacy were regarded as privileged space including ambiance and technology support as key influences. Skogland (2017) found internal mobility to be more dynamic in the absence of physical and visual barriers and that the socio-spatial practices would transfer from one department to another when located in connected zones. Similarly, Göçer et al. (2018) also referred to workstation location, pointing out that employees preferred for direct connection to the outdoors, daylight and view outside. In summary, literature reports on desk location, distances, connection to the outside, and architectural privacy as factors influencing utilization in association to architectural quality.

3 METHODLOGY

This research followed a **case study research strategy**; which is deemed appropriated for an in-depth analysis of a contemporary phenomenon in a real-life context (Yin, 2014). This case has a **descriptive-explanatory purpose** because it uses description as a precursor to explanation. This research is limited to a **single organization** since it presents unique conditions to observe the phenomenon and gives the option to analyse the phenomenon in ways not previously considered (Saunders et al. 2009). The case concerned is a service organization in Switzerland. The studied environment follows the principles of the ABW concept, where users are motivated to change work setting depending on the task at hand. Two main aspects characterize this workplace:

- **Defined use protocols** including assigned team base, clean desk policy, free choice of workstation, common ownership of space and self-service offer in all floors.
- **Varied array of activity settings** including open space, business garden, silent work area in unoccupied single offices and peripheral workstations, short-time workstations, think thanks, enclosed meeting rooms, open lounges and enclosed lounges.

Primary and secondary Data was collected with **a mixed-method** approach through following methods:

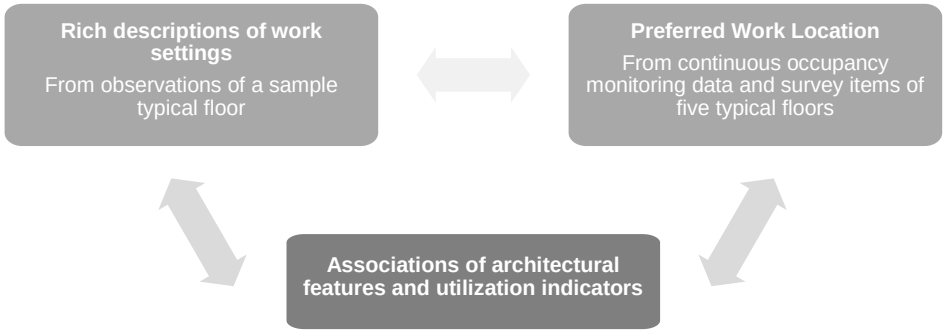
- **Structured observation** of the spatial organization of the office including architectural space characteristics, workspace quality and ambience, and indoor environmental conditions for observable indicators, including acoustics, lighting, control over the environment.
- **Employee survey** with two questionnaire items measuring the importance of work settings and asking about the preferred work location. The sample size was 250 employees.
- **Continuous occupancy monitoring** data including workplace choice data with employees' choice of workplace with a granularity of 5 minute and workplace utilization data with occupancy indicators of the workstations with a granularity of one week. For anonymity and data security, user codes are reassigned every day, thus users can only be followed during one working day. For analysis a period of 22 weeks was considered.

The data was analysed by means of descriptive statistics and through cluster analysis.

4 RESULTS AND DISCUSSION: THE DYNAMICS OF WORK LOCATION CHOICE

The association of behavioural practices and behavioural traces in the workplace with architectural features through data triangulation gave insights into how these features influenced workplace attractiveness. The results of the study are threefold (see Figure 2)

Figure 2 Structure of Results



4.1 Rich descriptions of workplace settings

The settings are characterized by a minimal aesthetic and a regular replicable organization of architectural elements throughout the building (see Figure 3). The work settings can be grouped into three clusters with similar architectural features: standard workstations in open space layout, enclosed spaces and spaces for encounters. See Table 1 for detailed descriptions of the setting including architectural features and task-setting support.

Figure 3 Schematic Configuration of the Office Layout

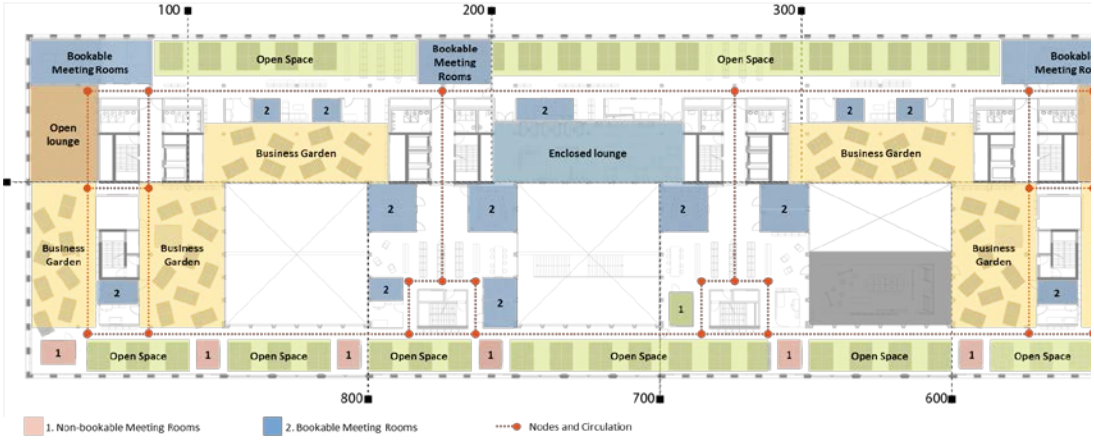


Table 1: Rich Descriptions of Work Settings

Work Setting	**Descriptive Architectural Characteristics**
Open space	Supports desk-work and unplanned communication Multiple access points, visually connected to adjacent areas and the outside Fixed room, room-in-room elements, and storage units create desks clusters and limit the openness, defining two hierarchies of space Furnished with standard workstations, arranged in a lineal axial symmetry with clear straight lines; formal character Absence of partitions between desk area and circulation ways confers the space a bigger scale in comparison to adjacent areas Two variants: with and without indoor plants
Business Garden	Supports desk work and communication in the adjacent meeting rooms Three variants: semi-enclosed, open space facing the inner courtyard and an open space facing the perimeter of the building Proximity to vertical circulation nodes Above average amount of indoor plants and flexible functional elements Furniture arrangement follows a rhythmic pattern with blocks of two desks, distributed in a pattern of repeating angles; arrangement breaks the formality dominating the spatial arrangement in the workplace
Bookable meeting rooms	Enclosed symmetrical spaces characterized by a minimalistic aesthetic: formal character, none to minimal transparency, minimal ambience, little to no decoration and no storage Visually connected to the indoor courtyard or visual connection to the outside Typical functional meeting room furniture and supporting elements Varying in size: 3 to 15 sqm (6 people), 27 sqm (12 people) and 42 sqm (18 people)
Non-bookable Meeting Rooms	Enclosed space with maximum transparency but with control over privacy, minimalistic aesthetic and minimal furniture Visually connected to the space where they are located Varying in size: 8.5 (4 people) and 10 sqm (6 people)
Enclosed lounge	Supports desk work, collaborative tasks, regeneration and self-service activities Enclosed space with two access points, with a kitchenette, partially flexible lounge furniture and with some supporting elements Four types of furniture elements create four inner zones supporting the different tasks. Decoration elements, including indoor plants and decals on the wall with silhouettes of natural elements.
Open Lounge	Supports communication and regeneration activities Semi-open space delimited by the partitions of the surrounding areas, directly accessible from the adjacent spaces, with minimal transparency to the adjacent areas, whole windows façade with direct view to the outside. Furnished with partially flexible elements and a coffee line Furniture arrangement does not follow a pattern: elements are used to create inner zones supporting different communication modes. The ambience is colourful in contrast to the rest of the office, with neutral base colours and vibrant accent colours for the furnishing elements. Indoor plants in the corners of the space and visual textures of natural birch wood.

4.2 Preferred Work Location

The popularity of work settings was analysed in three variants, namely, number of employees using the space, time of the working day the space was occupied, and reported importance of work settings to employees. The analysis of workplace choice data (see Figure 4) indicated that most of the employees used the open space (30.34%), followed by open space with plants (28.58%) and the business garden (27.74%). The analysis of percentage of occupied time by setting (see Figure 5) indicated the lounge was the most used work setting with 41.23%, followed by the business garden with 40.07%; the least used work settings were the non-bookable meeting rooms with 19.14% and the bookable meeting rooms with 22.23%. The analysis of reported importance of the work settings (see Figure 6) indicated the open space with standard workstations and plants as the most important work setting by 50.34% of the employees, followed by the open space with standard workstations as second most important with 40.10%; think tanks rooms and meeting rooms were third more important with 25.85% each.

The location criteria describing the preferred work location are shown in Figure 7 “Close to team or project partners” (93.67%) and “close to a window” (87.90%) were indicated by the participants as the two most important criteria describing their preferred work location. Having an “unobstructed view of the outside” (50.97%) and “visual privacy” (48.12%) were indicated as the third and fourth most important criteria. The three least important criteria describing the preferred work location were “close to meeting rooms” (10.02%), “close to communication zones” (8.39%), and “close to a corridor” (2.39%). Participants commented on further criteria such as closeness to circulation elements and rest rooms; indoor environment in relation to temperature, oxygen levels and air quality; indoor plants; no heat (e.g. “not too close to the windows”); no disturbing ceiling lights; support for concentrated uninterrupted work (e.g. “no permanent noise pollution”; support for creative work; IT infrastructure (e.g. double screen, practicality of docking station location); and closeness to team corners.

Figure 4 Distribution of users over work settings

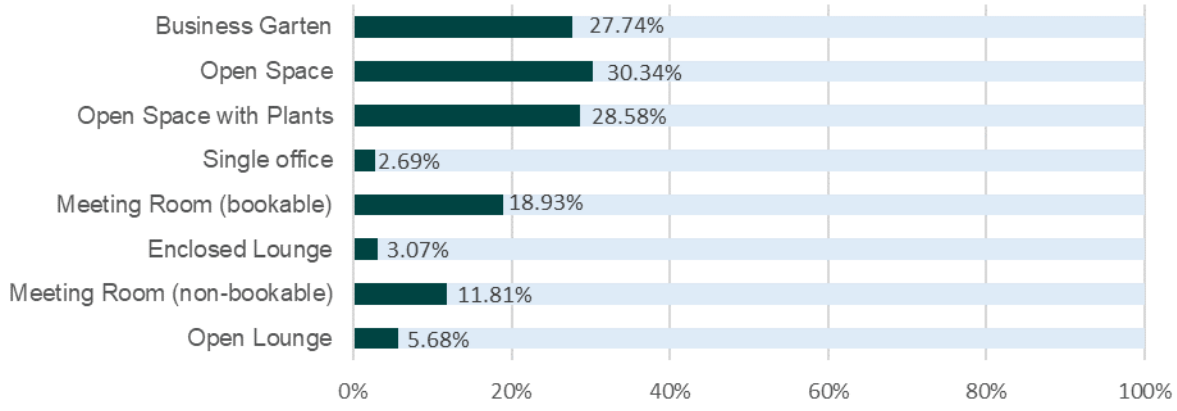


Figure 5 Proportion of usage hours

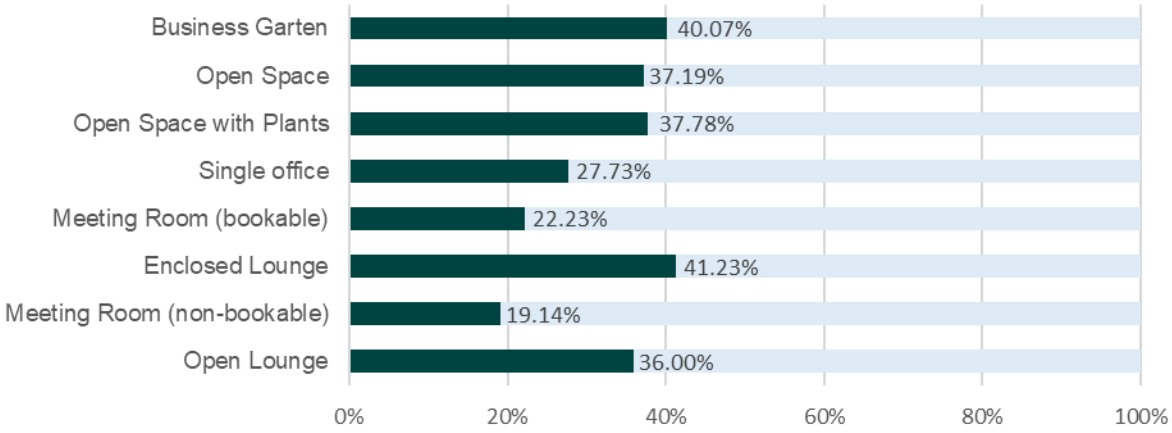


Figure 6 Ranked Importance of Work Settings

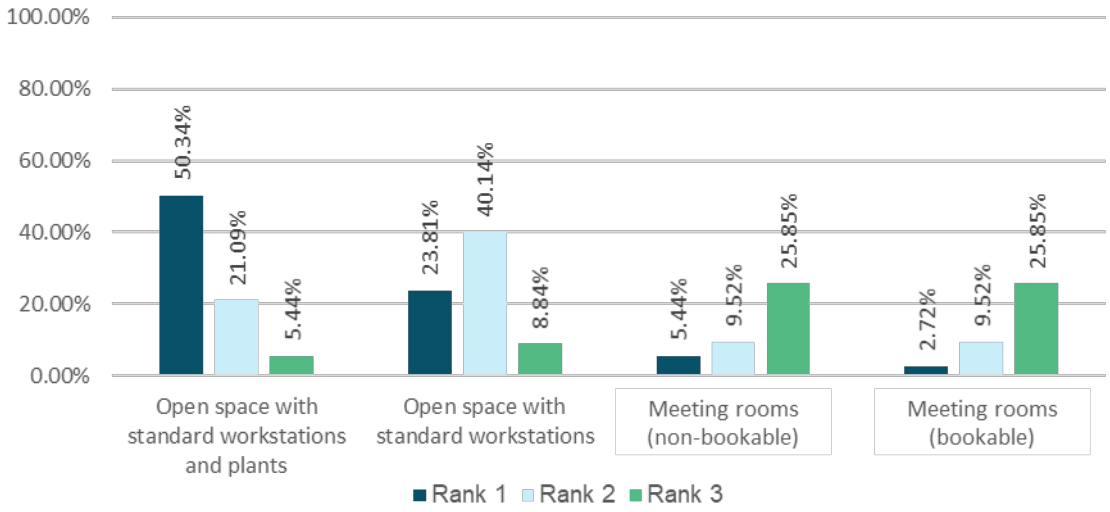
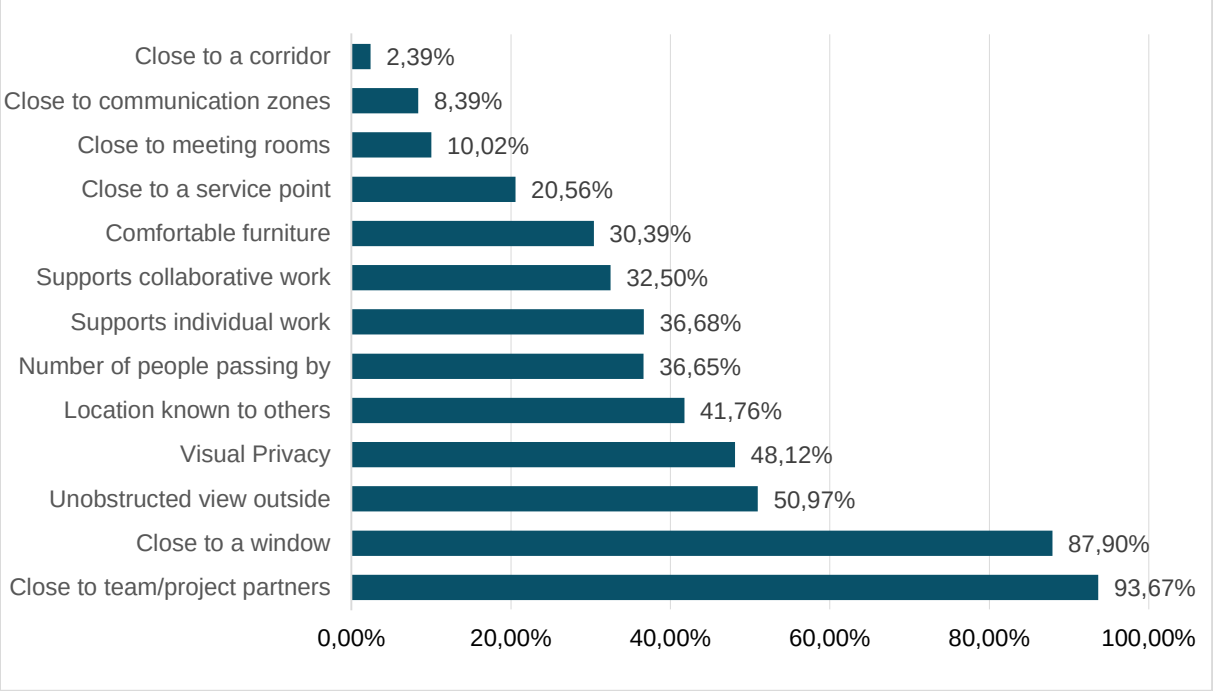


Figure7 Frequency Distribution of Preferred Work Location Criteria



4.3 Association of workplace utilization with indicators of architectural quality

A more detailed analysis of the utilization on the workstation level linked to the rich descriptions in the observed area (300, 400, 500 and 600) of the sample floor showed architectural features that could be positively associated to attractiveness and work location popularity (see Figure 8). The findings in the different observed areas are described separately to enable easier comparison between the work settings.

- **Zone 300:** The most used workstations are next to the windows, around the centre of the desk clusters, near a service points and storage spaces. For the workplaces on the side of the corridor, there are plants that provide visual privacy. There were ongoing conversations at higher volume and frequency than in the zone with the least used workstations. The least used workstations are located next to the transition space towards zone 200, the entrance to the enclosed lounge and adjacent to meeting rooms (two of them are marked as reserved). These workplaces are all fully visible from the door.
- **Zone 400:** In the open space the most used workstations are next to the windows, near the service points, the storage units and are not visible from the corridor nor from the access to the business garden. In the business garden, the most used workstations are near the storage units and are not directly visible from the think tanks in the middle, as the partition is made of glass panels. Among the meeting rooms, the least used one is reserved as an office.
- **Zone 500:** Overall the most used workstations are in the inner business garden. Among these workstations there is an above average amount of plants. There is an adjacent service point and a directly accessible meeting room. That area is also more active and

closer to the windows than the rest of that business garden. In the outer business garden, the most used workstations are right next to the windows and close to the non-bookable meeting room. In the open space the most used workstations are located the closest to the circulation and the storage. The least used workstations were indicated as settled.

- **Zone 600:** This zone had a silent working rule defined by the team and has a different layout, with two workstations towards the façade and ancillary spaces occupying most of the area. The most used workstations are next to windows and located in the silent zone. Following, the least used workstations are in the quiet zone further away from zone 500 where the ambience is more active.

From these descriptions the following architectural features that influence work setting and location attractiveness can be identified, namely: ambience, connection to the outside, transparency of materials, natural elements, controllable privacy, openness and task-setting fit.

Figure 8 Context details of preferred work location in observed building area - Floor A

5 DISCUSSION

The results of this research are comparable to those of previous studies. Similar to Blok et al. (2012) and Babapour & Osvalder (2017), open space, some collaborative spaces, low focus and enclosed communication zones were found to be popular, although to varying levels. The apparent contradiction between setting popularity based on user choice and setting popularity based on usage time, can be explained in the difference in task-setting fit. The settings with low number of users, yet high percentage of use hours support multiple work activities including low focus work, regeneration, planned and unplanned communication, while the settings with more users and usage hours support the core work activity being desk work. As indicated by Been et al. (2015) the varying ratio of availability of the settings might explain the minimal differences between the settings that support desk work (open space and business garden), as in this case study these as well assigned to specific teams and their use is influenced by the use protocols. The preferred location criteria show that socio-spatial factors are the most important reason behind work location choice. The specific location attributes indicate employees highly value privacy regulating elements and connection to the outside and natural elements similar to Höpfl & Hirst (2011), Appel-Meulenbroek et al. (2011), Ekstrand and Damman (2016) and Göçer et al. (2018). Contrary to Qu et al. (2010) corridor workstations were only associated to higher use in combination to closeness to team members and natural elements, in other cases the workstations were avoided. With over 80% of employees in this study having considerable to moderate share of deskwork, it was expected that employees would indicate the desk as the most important work setting/location. Furthermore, this shows that individual desks, even in not territorial offices, are still associated to private use and employees' value highly the possibility to have an assigned workstation for a day.

6 CONCLUSIONS

The results of this study add to the body of knowledge on the relationship of ABW and architecture. Addressing the design of office spaces in association to the empirical study of space utilization and associated factors lead to implications for evidence-based office design. Initially, the results highlight how spaces changes in the created ambience and the multiple task-setting fit influence the popularity of the setting and the length of usage in a positive direction. It also indicated that spaces with mere functional purpose can support well single activities, yet the utilization length is negatively affected. For ancillary spaces, the study indicated, the multifunctionality, inspiring ambience and support for both, work and regeneration activities, positively influence utilization. The implications can assist design practitioners in creating office spaces that drive workplace efficiency and effectiveness.

ACKNOWLEDGMENTS

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Analysing the Impact of a Room on our Perception and Experience – an Architectural Psychology Approach to Modern Working

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ABSTRACT

To improve employees' work efficiency, it is of importance that organisations provide them with optimum work conditions. These include among others the work environment. perspectives GmbH focusses on the person-environment relationship in the workplace setting and aids companies and organisations in finding their way in that relationship. To create a workplace environment that empowers employees and where efficiency and motivation are enabled is the ultimate goal. In order to do so, employees' needs and motivations must be researched. We are permanently influenced by the rooms we find ourselves in. The way we behave and the emotions we experience are directly impacted by our conscious and subconscious perception of our surroundings. On the one hand, we are actively shaping our environment. On the other hand, we often find ourselves passively navigating through it. Therefore, it should be taken into consideration in what ways this applies to work environments. People, places and technology are at the core of these working environments. If these factors interact in a positive way, they can form the basis for employees to live up to their potential.

Having worked with different kinds of organisations and numerous leaders and employees for years enabled us to also observe their general needs and motivations regarding work conditions and work environments. With architectural as well as social psychological findings in mind we were able to detect certain ways of how premises affect employees at the workplace. In this paper we aim to give insight into the way rooms affect us, as well as proposing practical implications in navigating them in a productive manner. We take in an architectural psychological approach as we present and analyse our experiences in this field.

As our findings show, work environment not only plays a crucial role for employees' work efficiency, but even more so for their behaviour and their use of premises. Since a room and its interior shape people's perception and emotions, it also affects people's behaviour in the room and their choice whether to use a room or not. For instance, a common fear in office spaces is noise, hence employees tend to act unnaturally and overly quiet in premises they share with others or that are new and open or worse avoid using them. Accordingly, this leads to discomfort amongst employees which then again influences their work performance.

We found that room arrangement can make a difference, as well as particularly the preparation and training of leaders and employees. This applies for behaviour in and use of premises.

Our findings come from years of experience with different kinds of companies. While each person reacts differently to their environment, the emotions that are triggered are often very similar. In close cooperation with a company, its leaders, as well as employees, we try to find the best ways for individuals to interact with their working places. It is critical that employees feel good in the rooms they work in in order to get the best possible results from their labour.

Keywords

New Work, Architectural Psychology, Modern Working Environments, motivation, spatial effect

1 INTRODUCTION

Rooms usually have specific technical and functional tasks. For example, a kitchen provides the functional setting for processing food. In addition to these tasks, a room also fulfils social functions. How rooms are perceived and interpreted differs from person to person and depends strongly on their individual needs. This individual perception of spaces influences whether the signals that the architecture wants to send out are also received by the user in the right way. It can always happen that rooms are not used according to their originally intended function. Only when working conditions are optimally adapted to the individuality of their users the best performance can be achieved (Gerhardt, 2013). However, humans not only act as users of the built environment, but also as its designers. It is possible for us to make small changes or even irreversible ones, such as the construction of a building. Consequently, humans are attributed a dual role in their environment as users as well as designers (Richter, 2009). For example, studies about the archaic basic human need to be able to see further than to the next corner, describe how the design of interior spaces affects people's lives. Only if this requirement is given, a person can at the next corner, instead of continuing straight ahead, dodge to the left or right if necessary. Rooms can thus help us to work in a more relaxed or tense way (Richter, 2009).

The best performance can only be achieved, when working conditions are optimally adapted to the individuality of the user. Interior design is concerned with the art and science of understanding people's behaviour in order to create functional spaces within a building through creative and technical solutions. Through this process it influences how employees work and how satisfied they are with their work (El-Zeiny, 2012). A survey of 6000 employees shows that an optimally designed workplace increases employee productivity by 19 percent. Optimal workplace effectiveness and an optimal workplace experience by employees also significantly increases their satisfaction and commitment (Gensler, 2019).

Brill et al. (1984) defined the most important factors of interior design that influence the workers productivity as furniture, noise, flexibility, comfort, communication, light, temperature and air quality. Noise seems to be an especially important factor for the work environment. The lack of acoustic privacy reduces worker productivity by almost 40 percent and increases their error rate by about 27 percent (El-Zeiny, 2012). This can be explained by the fact that background conversations impair employees' cognitive performance in short-term memory and working memory tasks. However, noise not only reduces employees' performance, but also increases their stress and annoyance levels. However, the ideal working environment is not completely free of background noise. Natural sounds and music, for example, can enhance workers' performance and well-being. Furthermore, unexpected noises in rooms that are too quiet can cause negative reactions (ASID, 2019).

Additionally, the lighting conditions have a major influence on the productivity of workers. For example, adequate warm lighting and the influence of daylight can reduce the absence rate of employees by 15 percent. Light also has a decisive influence on whether we make emotionally creative or rationally conventional decisions and has a significant impact on our mood (El-Zeiny, 2012).

Interior design not only influences workers productivity, it also influences their health. For example, it is scientifically proven that aspects of work design have an influence on mental and physical well-being (Gesundheitsförderung Schweiz, 2018). The evolution of single space towards more open workspaces has triggered an ongoing debate about the presumed negative effects on employees' health. For example, open plan offices without the possibility of private retreat have a higher absenteeism rate due to illness and lower mental and physical health of employees. The larger the office space, the more health complaints occur. One reason for this could be the increased noise level in large workspaces. Therefore, it's important to take health-promoting factors into account when designing an office space (Colenberg et al., 2020). However, there is no universal recipe for the optimal and health-promoting design of office spaces. Rather, each organization has to determine for itself which factors in the office space are crucial to positively influence the mental and physical well-being of their employees. The effect of an office space design should always be considered in relation to other issues such as work tasks, leadership, cooperation, culture or flexible working (Gesundheitsförderung Schweiz, 2018). In summary, good workplace design makes a difference in employees' performance and can therefore have a positive impact on the company's productivity. In order to run a company successfully, it is important to understand what makes people efficient and happy at work (El-Zeiny, 2012). As a consulting firm, it is our goal to, along with a company's leadership and its employees, create a working world that encourages individuality, creativity and productivity to unfold and efficient cooperation can take place. With a psychological approach and keeping up to date with research, we aim to find a way for each of our clients to create a working world best fit to their specific needs and goals. Over the past two decades we have worked with different companies, all having unique needs, hopes, fears and reservations about upcoming change. In this paper we would like to give insight into what we have learned from our experience. On the basis of the multi space concept, we break down different factors that we have found to be crucial to a successful workplace change.

2 THE MULTI SPACE CONCEPT

Many companies that we have accompanied in the change process have not only moved into new office buildings but have also taken on a change of office concepts. In the course of this, a changeover to the so-called multi space concept (multi space) usually took place. In the multi space office different office functions are combined in the same room. This includes open office structures and office spaces, which are divided into four areas. These are the workplace, the exchange zone, the retreat zone and the break zone. This creates group and multi-person offices of 4 to 12 workstations. Improved communication and spontaneous teamwork are the key to a successful implementation of this concept.

So-called special office areas are integrated into the open office space to provide an environment for all kinds of working activities. The four areas of the open plan office concept are combined in the form of, for example, work and meeting bunks, standing conferences, retreats or coffee corners. Employees are given the opportunity to work in the area of choice.

Therefore, most of our findings include observations in the setting of multi space and apply to people's behaviour and room perceptions in these very structures.

For multi space offices to function, an elaborate layout, design or good choice of materials do not suffice. Individuals must be willing to adapt their behaviour as well as their communication and

cooperation with others. Communication and leadership are crucial for benefitting from the concept's advantages.

3 RESEARCH APPLIED

In our experience, executives and employees often express fears and are sceptical towards above mentioned office concept changes. Usually, and especially in more traditional, well established companies that we've worked with, this fear stems from stepping into something new and changing well-rehearsed processes and habits. However, many of the fears expressed are, though understandable, unfounded, as our experience has shown. Interestingly, this has been observed by research for a long time but is, from what we have seen to be true in practice, still often ignored or not applied by practitioners. In the following, we want to show that we have been able to make similar observations in practice as science has long recognized. By combining science and practice, we experienced that successful and sustainable results can be achieved for clients.

The four main topics noise, behaviour, usage of premises and communications will be addressed in the following section. Our observations from over 25 years of experience in guiding companies ranging from independent businesses to state-run companies and from smaller companies to up to 3'000 employees in their change process will be linked to scientific research results.

3.1 Noise

When we ask our clients' employees about their fears regarding the change to a multi space office, noise is a common fear expressed. Employees are afraid of offices being too loud and noisy, of other employees disturbing them with their use of telephones or the unpleasant effect of short meetings on their ability to focus. Most employees automatically expect to experience noise as an additional stressor in the new work environment and fear its impacts. But what, as we observed, often happens is that employees' expectations influence their perception of the actual noise. Because of their fears and expectations, they tend to negatively evaluate the new premises and attribute their dissatisfaction or unproductivity to a noisy environment. Often the problem is not the noise itself but negative emotionality towards it. This tends to surface upon moving into the new environment and employees can falsely perceive the noise level to be inadequate. In one project we accompanied noise levels were measured after the move into the new building, showing that the measurable noise itself was not significantly louder than recommended scores even though employees were complaining. Later we were able to evaluate that the problem was not the noise but the employees' insufficient amount of preparation and supporting actions. They did not feel appropriately prepared for the change and thus could not get fully involved in the new environment.

Similar findings from research suggest that noise and its perception are subjective matters and can be linked to emotions. Asutay and Västfjäll (2012) found that the same sound was reported as more fear-inducing and negative when conditioned with an emotionally arousing event, compared to when used as a control stimulus and the sound was perceived as louder. In line with these findings Kozusznik, Peiro, Soriano and Escudero (2018) state that positive emotions moderate the relationship between the noise level and the judgement of noise, therefore supporting the fact that people's appraisals can be impacted by emotions.

Therefore, we have sought to approach the matter early on by addressing and discussing these fears with leadership as well as the employees. Furthermore, we encourage team leaders to create certain ground rules together with their employees. Through this we aim to foster the active participation of employees in creating these rules as well as encouraging teams to find a way by communicating clearly and openly. Hereby we ensure that workers are not only informed, but also know that they are allowed to express their concerns and be a part of shaping the new environment and culture.

3.2 Behaviour

Employees also tend to act unnaturally in open office structures such as multi space. Often, they do not dare to talk in a normal manner or walk around in the office as they did before. They start to behave in an unnatural way because they feel observed and on display. An uncomfortable atmosphere evolves and negatively influences employees' already tense behaviour. This has not only been noted by employees but also by visitors or external partners.

Our interpersonal behaviour, our conduct in rooms and thus also our communication is influenced by the work environment (Erni Baumann & Boutellier, 2013). As Baumann and Boutellier (2013) show, the communication time between employees decreases significantly after moving from a single room office to an open space office. It is also shown that workers move significantly less in a multi space environment than before in a single room office. This may be due to the fact that workers are under greater pressure to consider how their activities might affect those of their colleagues. This, in turn, may inhibit interaction, as workers may refrain from talking or using the telephone to avoid distracting their neighbours (Lansdale et al., 2011). Bernstein and Turban (2018) show that face-to-face interactions in an open space office decrease by 72 percent. Face-to-face interaction is thereby replaced by virtual communication via e-mail. The reason communication is being redirected to digital channels is that in an open space office everyone has to work more observably and transparently, and so other privacy options are being sought.

What we have observed to have a positive influence on people's movement in the multi space is using carpet flooring. Carpet dampens echo and noise and reportedly makes people feel less on display when walking down the hall. This also aligns with suggestions by researchers to include noise-reducing materials when designing offices (Kozusznik et al., 2018). Another aspect that helped normalise employees' behaviour was educating them on the new situation and openly addressing the topic.

3.3 Usage of Premises

When organisations move to new buildings with new office concepts or change their existing offices to the concept of multi space, new opportunities evolve. Not only in the sense of an altered office layout but also in the availability of spaces. Despite the availability, some premises are not used. We found that in addition to the room's location, room atmosphere, equipment and especially knowledge about the room availability is important and has an impact on employees' usage.

Since in a multi space office employees are given the opportunity to choose their place of work according to their needs, it is important that the spaces meet their needs. Influencing factors for example are room climate, noise exposure and lighting (Engel, 2014; Leather, Pyrgras, Beale & Lawrence, 1998). We have seen in the field that if these factors are left out in the planning of

premises or not given enough attention, their occupation will more likely be low. Another important aspect, as we found, is that the company or its executives should inform their employees about what different types of rooms offer and clarify and possibly even suggest how and when to use them. In one of our recent projects we worked with a company with around 3'000 employees as they were moving into an entirely new campus, built according to the multi space concept. In order to make sure the multi space would be efficiently used we first discussed through the changes these new structures would bring with department managers and elaborated how they would best navigate their subordinates in these new working worlds with them. Furthermore, representatives from each department were chosen and asked to take part in structuring the special office areas. This ensured that both employees as well as their leaders were already familiar with the new structures and would even be able to have a say in its design, so that it would suit the specific department's needs. This company has since adjusted very well to the new campus and employees have given positive feedback about the multi space structure.

3.4 Communication

As Näsänen and Vanharanta (2017) show, contradictory attitudes of managers and workers towards the transformation often emerge in change processes. While managers think positively about the change process and tend to view current structures negatively, employees often show negative reactions and fears about moving into a new working environment. When communicating, managers and employees use the same arguments but for different purposes. This can lead to unnecessary internal tension and hinder the change process. In order to avoid this, the involvement of employees and the sending of clear messages by managers is crucial. By actively involving the employees, managers are able to respond to individual needs and thus carry out the change process from the beginning without internal tensions. Successful implementation of the new spatial concept therefore requires a focus on socio-material relationships and concentration on the importance that employees attribute to the change (Skogland & Hansen, 2017). Our aim is always to involve employees in the entire change process as soon and as much as possible, since they are the ones that eventually will be working in the new working worlds being created. Nonetheless, our experience has shown, that a change process is inevitably a top-down, rather than a bottom-up process. Employees look to their superiors for guidance and security. Especially in an uncertain situation like a change process. Therefore, we seek to motivate leaders to listen to their employees and encourage them to see the possibilities such a change might bring. We have found that involving both managers and employees has helped both sides engage in an open conversation about their apprehensions, uncertainties and expectations in regard to a new working world, which in turn prevented unpleasant surprises upon moving in.

4 CONCLUSIONS

Work environment plays a crucial role not only for employees' work efficiency, but even more so for their behaviour, like interactions or their movement in respectively their use of premises.

A room and its interior shape people's perception and emotions. Individual perceptions and emotions also affect people's behaviour in the room and choice whether to use a room or not. A new building concept can thus bring up negative emotions and apprehensions. For example, it can be seen that emotions have a great influence on how disturbing background noises in an open space office are perceived. In addition, the fear of disturbing your employees in an open space

office can also trigger unnatural behaviour. This can be seen in a significant reduction of face-to-face communication and employee movements after moving to an open space office.

We found that room arrangement can make a difference, as well as the preparation and training of leaders and employees. For example, it's important to involve the employees in the change process. Actively engaging employees in certain decisions as well as helping their leaders effectively lead them into new working worlds has, in our experience, proven to make a significant difference. To bridge the communication gap between employees and management as well as facing fears and concerns concerning change long before it is applied has shown to motivate entire companies in seeing change in office structures as an opportunity instead of a threat.

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SESSION 12: CHALLENGES OF NEW WAYS OF WORK

Social interaction in an office environment: A qualitative study after relocation to a smart office

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ABSTRACT

The purpose of this study was to examine user experiences on social interaction after moving into a smart office environment. The study was conducted after the relocation to 'Stadhuistoren,' a smart office building of Eindhoven Municipality. Semi-structured interviews with eleven office users and observation for five working days were conducted. The data was analyzed based on grounded theory and thematic analysis. The results revealed various components of social interaction happening in the new office environment and emphasized the importance of spontaneous meetings and the need for non-work-related conversations. This study further suggests that the spatial configuration, and if possible smart applications, should facilitate social interaction in an office environment.

Keywords

Social interaction, privacy, user needs, user satisfaction, smart offices.

1 INTRODUCTION

Organizations that relocate to a new office environment consider user satisfaction since it has significant impacts on occupants and organizations in various aspects, such as productivity, efficiency, and stress-related issues. As social interaction plays an important role on user satisfaction in an office environment, in this study, we aimed to identify user experiences on social interaction after relocation to Stadhuistoren, a smart office building of Municipality of

Eindhoven, the Netherlands. We investigated factors related to user experiences on social interaction after the relocation.

1.1 Literature Review

The office environment has an important role in maintaining or avoiding social interaction. For instance, the open-plan layout is promoted with absent interior barriers and walls to facilitate better communication, and activity-based offices to create more balanced communication and social interactions among employees (Brand and Smith, 2005; Appel-Meulenbroek, Janssen, and Groenen, 2011). Scholars have mostly associated the impact of social interaction on occupants and organizations with various issues such as productivity, satisfaction, and user stress (Croome, 2001; Danielsson, Bodin, Wulff, and Ores Theorell, 2015; Haynes, 2007; Kim, De Dear, Cândido, Zhang, and Arens, 2013). Researchers investigated factors related to social interaction whether they are perceived as a positive (Chiaburu and Harrison, 2008; Sias, 2005) or negative components (Haapakangas, Hallman, Mathiassen, and Jahncke, 2019; Labianca and Brass, 2006; Oksanen, Kouvonen, Vahtera, Virtanen, and Kivimäki, 2010) from occupants and organizations.

Privacy also plays a vital role in social interaction in the office environment. Considering the desired level of privacy indicating the need of individuals for more or less privacy (Altman, 1975); Haans, Kaiser, and De Kort (2007) investigated privacy in office environments by developing a scale that evaluates users' motivation to withdraw from social interaction and to seek a social exchange. Their results present that users engage in activities that help them to either increase or decrease social exchange based on the strength and the direction of the individual's need for privacy or social interaction.

Numerous relocation studies investigate social interaction before and after moving into a new office environment. For instance, some relocation studies on activity-based offices show improvements in social interaction after relocation (e.g., Robertson, Huang, O'Neill, and Schleifer, 2008), while others observed negative effects on users (e.g., Berthelsen, Muhonen, and Toivanen, 2018; Blok, Groenesteijn, Schelvis, and Vink, 2012). However, the literature on the understanding of the needs and expectation for social interaction from smart workplaces after the relocation is rare. Therefore, we focus on social interaction after relocation to a smart office environment by the following research question: *How do office users experience new office environments in means of social interaction after the relocation, and what kind of preferences they have for smart offices?* In this study, we define smart office building as referring to the working environment that provides flexible, efficient, effective, and attractive use in means of the combination of spatial, organizational, and information and communication technology (ICT) based solutions. We focused our research methods to specify user needs and expectations for social interaction and to understand the relation to user satisfaction in smart offices.

2 METHOD

A qualitative study was designed to understand user experiences on social interaction in a new (smart) office environment after the relocation. It consisted of semi-structured interviews and observation. The study was conducted approximately 6-12 months after relocation to Stadhuistoren. The building was renovated as a smart office building for the Municipality of Eindhoven in 2018. The motivations for the renovation as a smart office were not only to achieve

sustainable building goals (e.g., energy efficiency, reduction of CO2) but also to enhance the quality of the office building by improving user satisfaction and productivity. Accordingly, (new) technologies were implemented (e.g., sensors, individual climate control system). The relocation started in August 2018 with moving 355 out of 590 employees from Stadskantoor (previous building) to Stadhuistoren and the others to two other municipal buildings in the centre of Eindhoven. The previous building had six floors (of which four were in use for the municipality) with an overall 11000 m2 floor area. Several departments shared each floor (2000 m2) with an open floor layout, a variety in adjoining rooms for single offices, closed offices, silent offices, and meeting rooms in different sizes, and a pantry which separately located from workplaces. Unlike the previous building, Stadhuistoren has nine floors with an overall 5500 m2, and each floor (450 m2) is dedicated to only one department with an open layout, flexible desk use, single offices, and meeting rooms in different sizes. However, employees are also provided flexibility to choose to work on other floors or other municipal buildings. Different from the pantry in the previous building, a shared area with a table and kitchen is located on each floor, adjacent to the workplaces (Figure i). At the time of the study, only four floors were occupied, and a common area for the entire building on the ground floor was temporarily closed due to ongoing renovation.

2.1 Interviews

Semi-structured interviews were originally designed particularly focusing on three aims: users' general attitude towards relocation, user experiences after relocation and appraisal of the new office, user expectations for smart office concept. Based on the objectives of this study, the data about users' experiences on social behaviour in the new office was analyzed in this study. The lead author conducted interviews with eleven participants between 02 April and 28 May 2019. The interviews lasted on average, forty-five minutes. At least one participant presented one floor, which was occupied at the time of the study (Table 1).

Table 1 The socio-demographic profile of interviewees (N=11)

Demographics	**Frequency**	**%**
Sex		
Female	4	36.4
Male	7	63.6
Location & Department		
3rd floor (Communication)	3	27.3
6th floor (Call Center)	2	18.2
7th floor (Control)	5	45.5
9th floor (Security)	1	9.1
Age		
25-34	2	18.2
35-44	3	27.3
45-54	4	36.4
55-64	2	18.2
Education		
Bachelor	9	81.8

Master	1	9.1
PhD	1	9.1
Time Experience		
3 months	1	9.1
3-6 months	2	18.2
12 months	8	72.7

2.2 Observations

The observation was designed to understand the user experiences on social interaction in the new office environment. The data gathered from observation provided the complementary data for this study. The main observed activities: observing office users' actions and interactions (how they behave and use of office spaces, and how they interact to each other); identifying different types of activities; finding varieties among physical and social settings on floors. The lead author conducted the observation during working days between 08 - 12 July 2019. Only three floors (third, sixth, and seventh) were observed because the access to the ninth floor was denied. Therefore, the interview data of one participant from the ninth floor with three-months experience was removed before the analysis. Three observation points selected from the open office area and one from the common area on each floor (Figure i). The observation conducted with approximately two hours intervals.

Figure i The Observation Locations (dots) on 3rd (communication), 6th (call centre), and 7th (control) floor.

2.3 Data Analysis

The interview and observation data were transcribed verbatim and anonymized. The purpose of the analysis was to examine the data with a focus on social interaction in the new office environment and understand the issues from a user perspective. The analysis was based on grounded theory and thematic analysis. The analytic software ATLAS.ti® (Scientific Software Development GmbH, version 8) was used for coding. All transcription data were re-read and coded for multiple times, and relevant themes on social interaction emerged.

3 RESULTS AND DISCUSSION

The majority noticed a change in social interaction in the new office environment. Most participants emphasized the lack of the spontaneity of encountering with colleagues, and the difficulty of finding a place for unscheduled, short meetings. Some noted they had less privacy and less possibility to have informal conversations in the new office. Most seemed to be dissatisfied with the decreased amount of social interaction, while a few were satisfied as they mentioned they were easily being distracted by those interactions.

The new spatial configuration of the office layout seemed to influence social interaction, where each floor is being used in two parts because of elevator and facilities located in the middle of the floor. In conclusion, the main implication of the data is some experiences with social interaction was satisfying, but some seemed to be missing (i.e., non-work-related conversations, the spontaneity of meeting). The results identified within the data analysis are listed in Table 2 and will be discussed respectively in the following sections.

Table 2 The components of experiencing social interaction for an individual, derived from interview and observation data analysis

Groups	**Codes**
Interaction initiators	Physical confrontation (spontaneous)
	Visual interaction
	Conversation involvement
Spaces – office layout	Workspaces

	Facility and social areas
	Available places for spontaneous meetings, conversations
	Possibility to meet with colleagues
Contents of interactions	Work-related
	Non-work related
Individual/cultural related factors	Personality
	Past experiences
	Job-task
	Culture of the department
Problem-based	Seeking solutions
	Acknowledgement of the change

3.1 Interaction initiators

'Physical confrontation', 'visual connection', and '*conversation involvement'* were identified as they contributed to initiate interaction. The majority of the participants pointed out that the spontaneity of *'physical confrontation'* was less in the new office. *'Visual connection'* among colleagues was also reduced, and it induced difficulty to know whether a colleague was in the office or not. Hence, a few participants noted that they tended to proceed with their task, sometimes without discussing with a colleague, because they wanted to avoid spending time searching for them in the office. Accordingly, several participants expected that smart technology could enhance social interaction and communication and could decrease the difficulty of finding their colleague in the office. However, smart technologies implemented in the office at the time of the study did not have this intended function.

Another initiator was identified as '*conversation involvement',* which perceived as a positive or negative experience by participants. A few participants noted that they prefer to overhear the conversations because they believed this could enhance the knowledge sharing among colleagues. However, they experienced that such interaction was less occurring in the new office. On the other hand, several participants noted that when they discuss with colleagues somewhere in the office, they mostly received a warning to speak quietly from other colleagues. They were agreed with their colleagues because they were also experiencing a similar distraction while working. This experience also seemed to avoid them to initiate or prolong these conversations in order not to disturb their colleagues. Several participants emphasized that they had less privacy in the new office, especially because of their conversations were easily hearable from surroundings. Additionally, it was also observed that noises from the coffee area were easily hearable from workplaces. Hence, the way of communication and interaction among colleagues seemed to be influenced because of not having a good balance of quiet and social spaces in the office environment.

3.2 Spaces – Office layout

'Workspaces', 'facility and social areas', *'available places for spontaneous conversations',* and *'possibility to meet with colleagues'* were identified as they were influencing user experiences on social interaction. The conversations happening around workplaces seemed to enhance knowledge sharing among colleagues; however, this needs to be further verified. As mentioned

in the previous section, the conversations happening around the common area caused a distraction for users in workspaces. Thus, some noted that their social interactions decreased during their coffee breaks as they tend to keep their conversations short since they did not want to disturb their colleagues in the workplaces. Therefore, this shows the need for social areas to be located separately from working areas, where distraction can be less in working areas.

Another factor mentioned as missing was '*available places for spontaneous meetings, conversations'*. Most emphasized the need for places where they can have spontaneous meetings, phone calls or short conversations with privacy and without disturbing others. *'Possibility to meet with colleagues'* was noted as important, indicating spontaneous encounter with colleagues from different departments. One expressed that she was glad she already met with many colleagues from different departments in the previous office; because she doubted if she could have a chance to meet with them in the new office easily. Hence, interaction with colleagues from different departments seemed to be reduced since each department is located on different floors in the new office. But also, encountering with colleagues within the same department seemed to relatively also reduced as each floor has two separated workplaces. Some emphasized they would prefer to share one working area instead of sharing two workplaces within the same floor in order to have more interaction with their colleagues.

3.3 Contents of interactions

Most participants emphasized the need for *'non-work-related conversations'* as they experienced the lack of having informal and non-work-related conversations with their colleagues. Some further noted that non-work-related conversations were salient as much as *'work-related'* ones in the office environment. Participants, especially managers, seemed to be discontent as they wanted to engage with their peer by having more satisfying conversations to know more about them. Not having a good balance of quiet and social spaces (as mentioned in Section 3.1 and 3.2.) seemed to decrease the amount of these conversations.

3.4 Individual and cultural characteristics

'Personality', *'past experiences'*, *'job-task'* and *'culture of the department*' were identified considering their relation on participants' social interactions. Some participants had different preferences for social interaction in the office environment. For instance, one participant was disappointed while the other one was content with experiencing less interaction with their colleagues in the new office. Unsurprisingly, a few, who had a job task required reading and concentrated work, explicitly needed for a quiet and isolated workspace with less interaction. Based on this need, the communication department agreed to use the office floor for two different working types: one part was dedicated to collaborative work, while the other part was dedicated as a silent part for working without distraction. Besides, social interaction observed in the call centre department was observed differently compared to the other two departments. For instance, the noise level was noted less since people were talking most of the time quietly, especially when they were on phone-consulting. Also, short interactions with colleagues around while waiting for the next call seemed to be a motivational factor in the call-centre. Thus, using two separate workplaces on the same floor was creating distance between workstations, which also seemed to influence (may reduce) these interactions.

3.5 Problem based

'Seeking solutions' and '*acknowledgement of the change'* were identified as they were related to user experiences on social interaction and relevant problems. Participants, who were dissatisfied with the decrease in interaction with their colleagues, sought for possible solutions to foster communication. Some attempted to change their desk every day; however, this did not continue. Because changing desk every day required an extra effort in daily bases, and the experience they had also was not the same as having spontaneous meetings in the office environment as before. Like mentioned in Section 3.1., some expected smart technology could help them in means of an application which can foster interaction by various functions, such as suggesting to switch desks in a daily (or weekly) basis or finding a colleague.

3.6 Limitations of the data collected

The data in this study should be considered in the context of the aims of qualitative research, including a small sample of office users (n = 11) and observations for five days from one office building. Further research is needed to elaborate and examine the representativity of the users' perspectives and experiences found in this study. As some participants were recruited through other participant's referrals, there is a possibility that this sample may be more likely to share similar attitudes rather than a random sample. It must further be noted that at the time of the study, not all smart features of the office building were operating and experienced by participants as well as not all floors were occupied. This data needs further investigation when all floors are in use. Eventually, future studies can further investigate the factors discussed in this study by identifying needs for social interaction and how to facilitate and enhance communication with smart technology applications in future office designs.

4 CONCLUSIONS

The results of this case study show the importance of spontaneous meetings the need for non-work-related conversations for office users, as these two components of social interaction seem to affect user satisfaction negatively when they are absent. Even though smart technologies implemented in the office did not have an intended function for social interaction, the results reveal that users expect for smart technologies to enhance their social interaction in the office environment.

The result of this study supports the need for informal conversations, which can increase the bonding among colleagues as well as satisfaction (Altman, 1975; Haynes, Suckley, and Nunnington, 2019; Inalhan & Finch, 2004; Oseland, 2009). The results show the need for social areas to be located within a proper distance from workspaces to create an office layout that provides the desired level of privacy and interaction. As proposed by Haynes (2007), the results support the view on the physical environment include linkages between space, work patterns and organizational culture. Thus, this study further provides evidence for the importance of identifying specific needs for social interaction based on individual and cultural characteristics of each department while designing office environments.

Eventually, this study supports the view on a good balance of quiet and social spaces in the office environment, by enhancing social interaction with spontaneous meetings but also providing a minimum distraction within the office environments. This study further suggests that

the spatial configuration, and if possible smart applications, should facilitate the needs for social interaction in an office environment.

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Well-being in flexible workspaces supported through coaching, collaboration and empathic understanding of users

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ABSTRACT

Companies are increasingly introducing flexible workspaces when changing their office design (Kratzer & Lütke Lanfer, 2017). However, such open office environments are suspected of causing stress among employees (Vischer, 2007), while the impact on employee satisfaction remains unclear (Danielsson & Bodin, 2008; De Been & Beijer, 2014). The objective of the PRÄGEWELT project was to better understand the influences of flexible workspaces (referred to hereafter as 'open space') on employee well-being. Among others it explored how employees perceive the open space, how they cope with it and what aspects influence their satisfaction. Furthermore, the project aimed to develop suggestions for how to improve the introduction of this new office form. The purpose of this paper is to share the tools that have been conceptualized and present the data considered for tool development.

The transdisciplinary project PRÄGEWELT stands for 'Prevention-oriented design of new (open space) work environments'. During the mixed-method research eight organizations were investigated in a case study design using semi-structured interviews (N = 66), observations (N = 62) and a quantitative survey (N = 516).

The PRÄGEWELT team derived three key insights: 1) Open space demands from the individual that s/he acquires new behaviours that need to be learnt. 2) There is no perfect open space, as the spatial concept always encompasses conflicting expectations (e.g. concentration versus cooperation). Therefore, the collaboration of the user community is key. 3) Open space is more than a spatial concept. It incorporates several processes at the level of the organization itself. Therefore, space and organization "must fit" in order to be experienced positively by the employees. The transdisciplinary team conceptualized two formats in order to give practical answers to the identified challenges: 1) A workshop based on coaching methodology in order to enhance the individual participants' spatial learning and self-care. 2) A workshop that facilitates collaboration at the level of the user community. RBSGROUP subsequently extended the practical approach by adding a workshop format based on *User Experience Methodology*. It allows leadership to empathically understand their employees' perceptions and derive strategic levers for well-being.

The article concludes that an open space requires self-responsibility at different levels. Since well-being is not inherent in the space, the potential of the open space needs to be actively

created by its users. This can be supported by change management and the use of innovative tools engaging the individual, the user community and the organization.

Keywords:

Open space office, employee well-being, workspace coaching, change management, occupational health

INTRODUCTION

Increasingly, companies are opting for activity-based space or so-called 'open space offices' when modernizing their offices (Kratzer & Lütke Lanfer, 2017). The open-space approach goes beyond the classic and the open-plan office forms. It is a mixed structure in which different spatial options are available to users in parallel. Characteristically, the open-space office has a flexible seating arrangement (desk sharing). Employees exchange their personal fixed desk for a multitude of spatial options (Ekstrand & Damman, 2016). However, open space offices are suspected of causing stress among employees (Vischer, 2007). Reasons for stress that have been discussed are, among others, lack of privacy and increased disturbances due to the open office arrangements (Wohlers & Hertel, 2017).

The transdisciplinary project PRÄGEWELT aimed to better understand the trend of this office concept. Furthermore, it endeavoured to understand its impact on employee well-being and give practical advice regarding how to better introduce open space offices. The project was funded by the German Federal Ministry of Education and Research (BMBF) within the program 'Innovations for Tomorrow's Production, Services, and Work' and managed by the Project Management Agency Karlsruhe (PTKA). PRÄGEWELT was jointly pursued by science (University of Freiburg, Department of Psychology and ISF Munich - Institute for Social Science Research) and practice (AECOM and RBSGROUP – Part of Drees & Sommer), and was conducted from January 2016 to July 2019. Overall the project had three phases:

1) Trend analysis (Main focus: How do offices change and how is this change perceived by employees?) (Kratzer & Lütke Lanfer, 2017)
2) Case study (Main focus: What influences employee well-being and their satisfaction with the open space?) (Becker et al., 2019; Lütke Lanfer et al., 2019)
3) Tool development (Main focus: Develop and test practical tools based on the research results.) (Kratzer, 2020)

The aim of this practical paper is to share some research results as well as to present the tools developed by PRÄGEWELT and later by RBSGROUP. This text presents almost solely the qualitative data of phase 2 (see above), as this data in particular inspired tool development. A further reason for focusing on the qualitative data is that it captures users' perceptions and deepens the understanding of the impact of open space offices. Therefore, it is deemed to be especially interesting for a transdisciplinary conference. The article presents the data using the multi-stakeholder approach that was used for tool development: (1) The individual user of the open space (2) The user community sharing the open space and (3) the organization maintaining the open space.

METHODOLOGY

Based on the idea that well-being in an open space office is not caused by spatial factors alone, a design of eight case studies was selected. The main guidelines for sample selection were mixed industries, mixed time-span after moving and mixed desk-sharing policies. The aim was to have a mix of 'rich' cases but not to cover a representative sampling (Yin, 2014). The case study phase contained a mixed-method design based on a quantitative survey (N=516) and two qualitative methodologies.

The quantitative survey was conducted in five out of eight organizations over a time period of three weeks. The questionnaire included items concerning the office environment (e.g. number of spatial options), workspace utilization (e.g. number of spatial options used), workspace satisfaction (five-level Likert scale), job demands (workload, cognitive demands) resources (control, social support, supportive leadership and resilience) and subjective well-being. The response rate for all companies was over 50 per cent (Becker et al., 2019).

The two qualitative methodologies consisted of observations and semi-structured interviews. Observations (N=62) were conducted according to predefined criteria: overall impression of office characteristics, through traffic, individual behaviour of employees and employee interaction. It was always assured that observations were carried out by several observers and on different days, at different times and from different positions in the office. The semi-structured interviews with employees (N= 66) took around 1.5 hours and comprised seven themes:

1. Personal situation in the organization (e.g. working hours)
2. Demands at work (e.g. tasks, decision latitude)
3. Organizational change (e.g. perceived changes, impact of change)
4. Space (e.g. overall perception of the office, perception of rules)
5. Daily work & workplace (e.g. criteria for choosing workplace)
6. Stress & recovery (e.g. perceived well-being, coping strategies)
7. Future perspectives (e.g. aspired work environment in the future)

The data was fully transcribed and analysed with MaxQDA. The data analyses followed broad codes based on the research interest. From reviewing these broad codes further sub-codes were identified inductively.

The tool development arose from intensive interaction with the involved practitioners. The tools were performed and tested within organizations and adapted concurrently. The 'Balance Workshop' (see below) was tested nine times. The 'Workspace Utilization & Resource Mapping' (see below) was tested ten times.

1 RESEARCH RESULTS: WHICH ASPECTS OF THE OPEN SPACE HAVE AN INFLUENCE ON EMPLOYEE SATISFACTION?

This section summarizes some of the qualitative data crucial for the thought process of tool development. Many studies support the argument that satisfaction with the working environment is related to motivation, general job satisfaction, performance, productivity, the health of the employees and thereby their overall well-being (Hoendervanger, 2018; Bauer, 2014; Rashid & Zimring, 2008; Veitch, 2007). However, the quantitative research results of the PRÄGEWELT

project concerning satisfaction showed a rather unclear and not very convincing pattern. Out of 516 employees, 55 per cent were satisfied or very satisfied; 25 per cent were unsatisfied or very unsatisfied with the open space; and 20 per cent were neutral (Becker et al., 2019). This triggered the PRÄGEWELT research team to further explore satisfaction with the office environment in the qualitative research analysis. The data will now be presented in line with the multi-stakeholder approach (individual user, user community, and organization), that also covers the developed tools.

1.1 The individual user

The quantitative data showed that, unlike intended by design, employees made little or sometimes even no use of the alternative spaces created in the open space offices. Minimal switching among spatial options within the open space is also a result shown in several other research projects (e.g. Hoendervanger et al., 2016). The qualitative data showed that employees often had their 'favourite place', which is also a research result across literature (Appel-Meulenbroek, 2011; Qu et al., 2010). Furthermore, some employees found the flexible use of space to be an additional workload causing stress. The transformation to a new, spatially flexible work environment and the adoption of the associated work style posed a challenge for some employees. Often, missing or insufficient support with regard to space usage was indicated. Lack of clarity and knowledge led to decreased satisfaction. It was also reported by employees that the flexible workstyle demanded additional self-management skills and proactivity (Becker et al., 2019; Kratzer, 2020).

Consequently, PRÄGEWELT derived from the qualitative data that an open space is something that also has to be learned. Apparently, it requires the employee to 'try out' and learn how to use the available spatial options. Furthermore, it seems to demand reflection on working routines and individual needs. An open space offers many options, but the individual has to find out how these options can serve his or her own demands and needs. A similar argument can be found in Babapour et al. (2018) and Skogland (2017). PRÄGEWELT therefore derived that change management should enhance spatial learning and questioning spatial routines in the new environment. The 'Workspace Utilization & Resource Mapping' tool below proposes one practical approach with which to facilitate this process.

1.2 The user community

The qualitative data of the research showed that employees perceived the open space to be putting a variety of demands on them (e.g. disturbances, lack of privacy) but also offering them a range of resources (e.g. community feeling). No interviewee was completely satisfied with the office. Their thoughts tended to revolve more around the various factors that they did and did not find satisfying (Becker et al., 2019).

It was found that demands and resources linked to the open environment interact dynamically. However, often more of one aspect is almost automatically less of the other. For example, approachability of colleagues causes the creation of more overall disturbances, and vice versa. PRÄGEWELT thus interpreted the open-space office as posing a dilemma, as the spatial openness is associated with contradictory expectations. The project clustered three '*Fields of Tension*' containing these conflicting expectations (Becker et al., 2019):

1. Concentration vs Cooperation: The open space should promote cooperation and communication, but also enable concentrated work.
2. Open vs Confidential: The open space should offer openness but also allow confidentiality.
3. Individual vs Flexible: The open space should guarantee flexibility but also has to offer options for individuality.

These '*Fields of Tension*' have a specific structure: positive expectations are at both poles, which means that the dilemma cannot be resolved. Rather, the poles or expectations towards the open space need to be balanced in a way that is contextually appropriate. In practice, this means that the user community of an open space needs to collaborate and to actively define ways with which to use their space most effectively. The 'Balance Workshop' below presents a practical tool for how to support a socially positive work climate by working along this line of critical opportunities.

1.3 The organization

The qualitative data showed that the utilization and satisfaction were often influenced by the perceived 'fit' between the open space and organizational culture. Interviewees mentioned the importance of a corresponding management culture. It was, for example, indicated that a positive relationship to leaders improves well-being in the open space and perceived privacy, as it reduces the feeling of 'being monitored'. Further, many interviewees mentioned a lack of acceptance if cultural factors did not allow a flexible organization of work. The possibility of working from home was indicated to be important here. Another aspect was the 'fit' between the spatial design and accepted behaviours (e.g. informal seating in a lounge) that prevented the flexible utilization of office space (Becker et al., 2018).

PRÄGEWELT concluded that open space is more than a spatial concept. It also contains an organizational concept. It seems that the introduction of the open space should be seen as a process that has to be actively supported by organizational reflection and reform. Moving to open space does not in itself create new management behaviours or organizational rules. What is needed is an ongoing discourse on the issues that are closely related to the space (e.g. autonomy). RBSGROUP is searching for ways to enable managers to empathetically understand the connection between space, organizational processes and well-being. The 'Well-Being Workshop' tries to enhance this empathy with *User Experience* methods and is presented below.

2 HOW TO PRACTICALLY SUPPORT WELL-BEING WITHIN AN OPEN SPACE?

In the third phase, PRÄGEWELT developed and tested tools that help practitioners handle identified challenges. The following section presents the three practical tools supporting change management and well-being in the open space. Two of these tools ('Workspace Utilization & Resource Mapping', and 'Balance Workshop') were conceptualized by PRÄGEWELT. One tool ('Well-Being Workshop') was subsequently developed by RBSGROUP.

2.1 Prägewelt Tools

PRÄGEWELT aimed to develop tools that enhance individual 'spatial' learning and self-care in order to facilitate spatial utilization and well-being. Further, the team endeavoured to find a workshop methodology that allows the user community to work on the '*Fields of Tension*' that have been identified. The tools are presented below and theoretically reflected in the last subsection.

2.1.1 Workspace Utilization & Resource Mapping

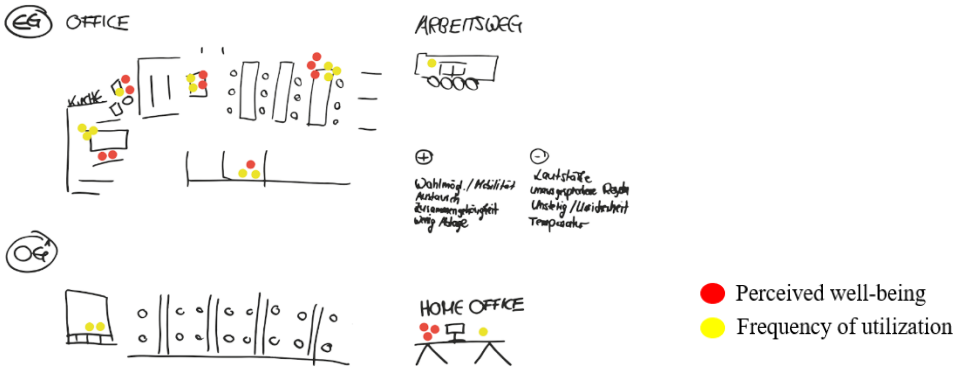
The 'Workspace Utilization & Resource Mapping' tool presents one out of three tools included in the 'PRÄGEWELT Toolbox - Self-Reflection in Open Space' (Pfitzner & Gunkel, 2019). The development of the tool followed the perspective that well-being in the open space is something subjective as it is something that employees themselves actively construct and make sense of (Kesebir & Diener, 2008; Weick et al. 2005). Anchored therein, employees are understood as active agents striving to maintain or enhance their well-being in the open space (Daniels, 2011). The workshop tool was further mainly inspired by Transactional Stress Theory which proposes that stress does not simply arise within the individual due to factors in the environment, but as a result of the interaction of the two. The relationship linking a person with the environment is captured in the process of *cognitive appraisal* where the individual evaluates the situation and weights the options for coping with it (Lazarus & Folkman, 1984).

The 'Workspace Utilization & Resource Mapping' is a coaching tool adapted to a workshop situation. It facilitates the reflection of one's own spatial utilization and self-care in the open space. The individual derives concrete conclusions from the process on how to adapt spatial behaviour, increase well-being and use space more effectively.

Procedure: The participants of a three-hour workshop form pairs. One takes on the role of the coach, the other the role of the coachee. Under the guidance of the coach and based on guiding questions (predefined in the tool), the coachee draws up a rough map of his or her working environment (see Figure 1). The different workplaces are evaluated according to the frequency of use and the well-being perceived at these places (see colour.) Coach and coachee reflect on the demands and resources of the spatial environment as well as the use of space. Finally, with the help of the coach, two to three key findings are obtained as to which places work best under which circumstances and what this means for the coachee's behaviour. Afterwards, the roles change. The results are worked on in small groups of three pairs to enhance mutual learning.

The tool allows for reflection on the *appraisal process* and underlying interpretations of the spatial environment that guide spatial behaviour. It thereby raises awareness about the potential impact of individual utilization and about self-responsibility concerning well-being in the open space.

Figure 1: Example of a Workspace Utilization & Resource Map



2.1.2 Workshop 'Balancing Act Open Space'

The workshop 'Balancing Act Open Space' (short: 'Balance Workshop') supports the user community that shares an open space (Becker et al., 2019b). Theoretically it is inspired by the Job-Demand Resource Model (JD-R Model) that proposes that all types of job characteristics can be classified into two categories: Job Demands and Job Resources (Bakker & Demerouti, 2007). Demands are defined as all work aspects that have some kind of cost for the employee. Job resources have some kind of gain for the employee (Schaufeli et al., 2009). Accordingly, job demands require effort and job resources enable one to cope with job demands (Bakker et al., 2005).

Figure 2: Workshop situation where participants line up based on their satisfaction

The 'Balance Workshop' is based on the previously identified '*Fields of Tension*' (see above) and aims to balance them by enhancing user collaboration on spatial issues. An essential part of the workshop is to identify demands created and (new) resources provided by the space. Procedure: The workshop tool first addresses the satisfaction of the participants regarding the topics that arise from the '*Fields of Tension*' (e.g. concentration vs cooperation, etc.). Participants line up in the workshop room according to their satisfaction with the different fields (see figure 2). When standing at their chosen position in the room the participants openly reflect on their decision, which enables a discourse on the specific '*Fields of Tension*' within their user community.

In the remainder of the workshop smaller groups discuss one '*Field of Tension*' each. They identify demands and resources and move on to brainstorm new collective coping ideas. The results are then shared and discussed in the plenary session and processed into an action plan.

2.1.3 Theoretical Thoughts on the PRÄGEWELT Tools

Both workshop formats support active reflection on the demands and resources provided by the open space and facilitate the development of coping strategies. They follow arguments of positive psychology and the idea that stress in any work environment is a product of the handling of demands and resources (Demerouti et al., 2001). The self-reflection tool specifically responds to the idea that stress and well-being are grounded in the individual's *appraisal* and sensemaking (Lazarus & Folkman, 1984; Weick et al. 2005). It promotes the reflection process on spatial behaviour and the impact of one's own well-being. The outcome is that it creates a starting point for individual adjustments. Both tools have the potential to facilitate learning and the appropriation of space by creating an inner and/or collective discourse on how to use the available space more effectively and increase well-being.

2.2 Prägewelt inspired: RBSGROUP – WELL-BEING WORKSHOP

The PRÄGEWELT results inspired RBSGROUP to develop a workshop format that familiarizes managers with the topic of 'well-being in an open space office' and that allows them to tap into the aspect of organizational culture. RBSGROUP's consultancy approach is deeply rooted in the *User Experience* (UX) perspective and methods. In short, UX starts with the mindset that problems are best understood through the eyes of the user. It provides a range of methods that facilitate this type of empathy at different levels (Steimle & Wallach, 2018).

Based on this approach, RBSGROUP developed a workshop that helps managers to empathetically understand the *meaning* of working in a open space from the employees' perspective. This leads to facilitating the identification of context-specific factors that are relevant for the well-being of employees and raises awareness of the multitude of levers (e.g. leadership style).

Procedure: Managers develop profiles of certain groups of employees and discuss their specific needs. Through the eyes of the employees a normal working day is visualized in the form of process map. Obstacles as well as highlights or potentials for well-being are identified within it (see figure 3). Facilitators enrich the reflection process by posing questions.

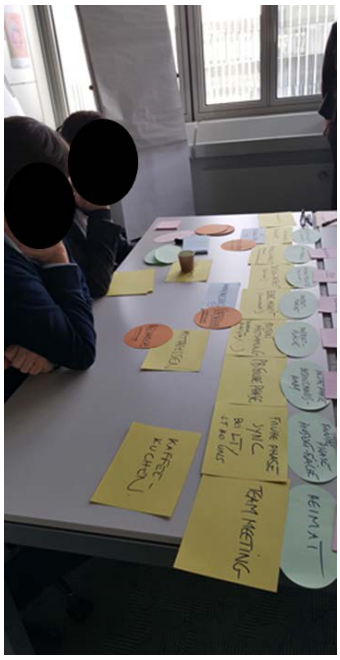


Figure 3: In the workshop, factors for well-being are empathically understood

Through the empathic approach, managers realize the importance of their own behaviour and the role of organizational culture when introducing an open space. In other words, the relevance of specific organizational topics can be highlighted in a bottom-up manner.

3 CONCLUSION

This article briefly presented the PRÄGEWELT research project and focused on the practical relevance of the results. At the levels of (1) individual user, (2) user community, and (3) organization, the topics influencing employee satisfaction in the open space were presented, and corresponding solutions promoting well-being were outlined. This included two tools that were developed in the PRÄGEWELT network, as well as an RBSGROUP workshop format that was inspired by PRÄGEWELT.

The article has established that an open space requires engagement and self-responsibility from employees and organizations. Well-being is not inherent in space. Rather, the open space has the potential to promote well-being among its users if the following aspects are considered:

- Flexibility and spatial utilization must be learned by the individual.
- There is no perfect open space office. Each one has contradictions that need to be balanced by the user community.
- Furthermore, open space is not merely a spatial arrangement but a process where space and organization merge together and change.

To summarize, change management is key when introducing an open space office. Space can be a lever to strengthen the well-being of employees and to design modern *and* healthy work. Approaches at an individual level offer potential to introduce reflection on healthy behaviour. Approaches at the level of the user community and organization can improve work conditions and collaboration, and structurally prevent stress. Consequently, the open space concept is an entry point for change management but also for new approaches in corporate health management. This perspective allows rethinking and practically supporting the interaction of people, organization, health and office space.

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Personal Office Preferences

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ABSTRACT

The debate on open plan versus enclosed offices rages on, but workplace design is not a such a simple dichotomy. Furthermore, office occupants clearly have different workplace preferences depending on factors like personality, personalisation, flexibility and sense of belonging etc. The research was aimed at unravelling some of the more personal factors underlying preferences.

An on-line survey was conducted and approximately 700 survey responses were received, equivalent to a response rate of approximately 15%. The participants were asked to rate their preference for a number of office solutions including private offices, open plan and agile working. The respondents also completed a personality inventory.

Landscaped offices and agile working were more highly preferred than open plan and, surprisingly, private offices. Home-working was rated fairly high whereas hot-desking is rated low as a preferred option. Landscaped offices and agile working appear to be more agreeable options. When considering the current primary workplace of the respondents, those in private offices prefer private offices, whereas those in open plan prefer open plan. It therefore appears that those who have not actually experienced open plan are more opposed to it.

Preferences were found to significantly differ by personality. Introverts are more in favour of private offices and least prefer open plan, agile working and hot-desking compared to extroverts. Interestingly, there is little difference between introverts and extroverts in the preference for home-working; with both groups rating it relatively high.

The research clearly shows how the preferences for office type differs by personal factors such as personality type. It also verifies that the preference for a particular office type is biased towards the office type that people are familiar with and that there is fear and distrust of those office types not experienced.

Keywords

Workplace, Personality, Preferences, Workstyle, Agile working, Open plan.

1 INTRODUCTION

The assault on open plan offices rages on in the press e.g. Guardian (2018), Inc (2018) and Entrepreneur (2019). Such articles are fuelled by a number of research studies which supposedly demonstrate that open plan is results in poor interaction, performance and health. Studies such as that by Danish researcher Pejtersen et al (2011) who found that the average reported sickness absence of 2,403 Danish workers was higher in open plan working environments (8.1 days) compared to private single offices (4.9 days). Or that of Australian researchers Kim and de Dear (2013) who reanalysed U.S. survey of 42,764 respondents and concluded "our results categorically contradict the industry-accepted wisdom that open-plan layout enhances communication between colleagues". More recently, after studying an organisation who moved to open plan, Bernstein & Turban (2018) report that "Contrary to common belief, the volume of face-to-face interaction decreased significantly (approx. 70%)".

However, as pointed out by Oseland (2013, 2018) these studies have several flaws. For example, the Danish study did not control for variables such as autonomy, job role and seniority when comparing those in private offices with those in open plan. They also report that noise, viruses, ventilation, privacy were the key factors, which can occur in all workplaces. In the Australian study, only 6.7% of the respondents work in "true open plan" whereas 60% reside in cubicles. The study actually showed that overall satisfaction, interaction and sound privacy was better in in open plan than cubicles. They also found that the "amount of space" explained the variation in responses, indicating that density is a confounding variable when exploring open plan offices. Bernstein & Turban had their participants wear a sociometric badge which included a microphone, infrared sensor, accelerometer and location tracker, which most likely affected the behaviour of the participants and their colleagues. Furthermore, the interaction prior to the move was 5.8 hours per day and post-move was reduced to 1.7 hours per day, which seems more practical. In addition to the above oversights, the most significant common to all studies is that the "open plan" environment is not fully described. Workplace design is not a simple dichotomy of private offices versus open plan, there are a range of offices types and open plan designs, some of which are poor and some of which are very good. In particular, open plan environments vary by density, with some having a high number of desks in the same space with few facilities, and by the level of partitions, with some having none at all and others being broken up occasionally by screens, planting, storage, quiet pods and meeting spaces.

In contrast to the above studies, case studies presented at conferences and occupant feedback surveys, like the Leesman Index (2019), often highlight the benefits of good open plan workplaces. These are usually agile or landscaped offices specifically designed for the occupants with an accompanying change management process. Mixson (2019) highlights how an open plan office layout can improve collaboration and spark creative thinking as well as reduce occupancy costs. Brem (2019) points out that it is not so much the space but how open plan offices are managed and used that causes problems.

A wide range of modern workplace design solutions are now available such as the landscaped office and activity-based working. Furthermore, office occupants clearly have different workplace preferences. The workplace industry needs to understand what drives these individual preferences. Is it factors like personality, personalisation, flexibility, sense of belonging or familiarity that affect where people prefer to work?

2 APPROACH

2.1 Respondents

Invitations to participate in the survey were emailed to 4,900 Herman Miller and Workplace Trends contacts. Some 700 survey responses were received, equivalent to a response rate of approximately 15%, which is considered good for an unsolicited survey.

Approximately two-thirds (67.6%) of the respondents are based in the UK and Ireland with a further 9.9% from North America, 5.8% from Central/Southern Europe, 5.7% from Northern Europe and 3.4% based in Eastern Europe. One-half (49.5%) consider their role as management and a further one-quarter (25.4%) as technical. A further, 14% worked in business, 2.9% in sales and 2.7% in admin. The respondents also included a small (4.5%) group of researchers.

The sample consisted of a range of ages. The majority (60.9%) were born 1961-80 (Gen X), but 10.4% were born 1945-60 (Baby Boomers) and 26.0% were born 1981-95 (Millennials). Tenure, the time with the organisation also varied: 15% have worked <1 year, 25.9% 1-3 years, 31.3% 4-10 years and 27.1% >10 years.

2.2 Rating scales

Various subjective rating scales were used in the survey. For example, participants rated their preference for various office designs and practices on 7-point semantic differential scales labelled “not at all preferred” (1) to “very much preferred” (7).

The respondents also completed part of the Big Five Personality Inventory (John, Naumann & Soto, 2008) specifically the Extroversion and Neuroticism scales. The sample was grouped into those scoring higher on introversion and higher on extroversion, with the remainder classed as ambiverts. The authors’ full database (Oseland & Paige, 2017) was used to determine the upper levels based on one standard deviation from the mean scores. Similarly, the respondents were grouped into those rated higher on neuroticism or emotional stability.

2.3 Analysis

The sample size is sufficient to provide statistically robust and significant results. The data was analysed using SPSS and only the statistically significant results are presented here. The size of the effect, sometimes referred to as practical significance, was also computed using eta squared (η^2) for tests of differences. An η^2 of 0.01 is considered a small effect, 0.06 a medium effect and 0.14 a large effect.

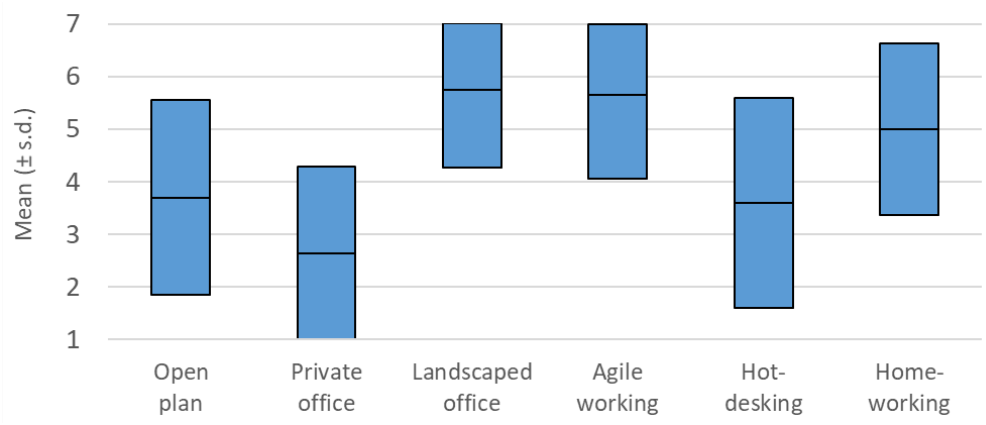
3 RESULTS

3.1 Office preferences and primary workplace

Six office designs were rated by the participants on a 7-point semantic differential scale: open plan, private office, landscaped office, agile working, hot-desking and home-working. Note the “landscaped office” option was described as “hybrid office (open plan but broken up with semi-partitions, pods, meeting rooms etc), “agile working” included “agile/flexible/smart/ activity-based working” and “hot-desking” was also referred to as “desk-sharing”.

Figure 1 shows the mean ratings with the standard deviation of the six office designs. The chart shows that the order of preferences is: landscaped office, agile working, home-working, open plan, desk-sharing (hot-desking) and private offices. Paired t-tests confirmed that the differences between the mean ratings of each office type are all statistically significant ($p<0.001$), except for the ratings between landscaped office and agile working.

Figure 1 Mean ratings (and standard deviation) of office designs and practices



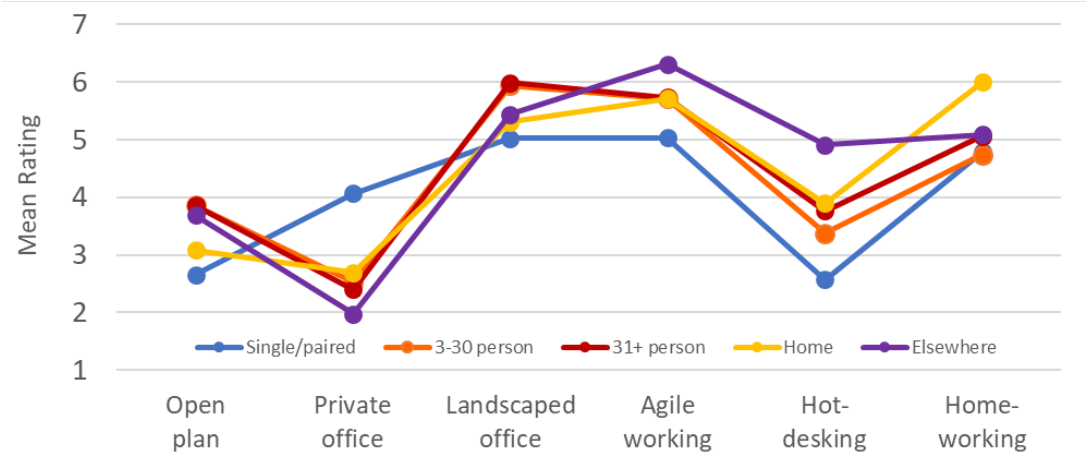
The mean office preferences were compared with the current primary workspace of the respondents. Figure 2 shows that those currently in single or paired offices (blue) have a significantly higher preference for private offices compared to those already located in open plan (orange and red) or other office types ($df=4,576$, $F=13.49$, $p<0.001$, $\eta^2=0.086$), and vice versa. Furthermore, those in single or paired offices have the lowest preference for agile working ($df=4,576$, $F=9.79$, $p<0.01$, $\eta^2=0.028$) and hot-desking ($df=4,576$, $F=9.43$, $p<0.001$, $\eta^2=0.061$).

As expected, those who work from home have the highest preference for home-working ($df=4,576$, $F=9.09$, $p<0.001$, $\eta^2=0.059$) and those who mostly work “elsewhere”, in and outside the office, rate agile working and hot-desking higher. So, overall the respondents prefer what they know and have experienced.

There is little difference between the preferences of those in small (3-30 person) or large (>31 people) open plan offices. Whilst there are statistically significant differences for the preference of landscaped offices between the current primary workspace, it is less marked than for the other office preferences ($df=4,576$, $F=8.29$, $p<0.001$, $\eta^2=0.054$) and is rated high by all groups.

Nearly two-thirds (61.3%) of the sample have allocated desks with the remainder hot-desking. Those who hot-desk have a higher preference for agile working ($df=2,579$, $F=20.02$, $p<0.001$, $\eta^2=0.065$) and hot-desking ($df=2,579$, $F=56.54$, $p<0.001$, $\eta^2=0.163$) compared to those with allocated desks. So, again those who have experienced non-traditional ways of working rate it higher. In contrast, compared to the hot-deskers those with allocated desks have a higher preference for private offices ($df=2,579$, $F=14.49$, $p<0.001$, $\eta^2=0.048$).

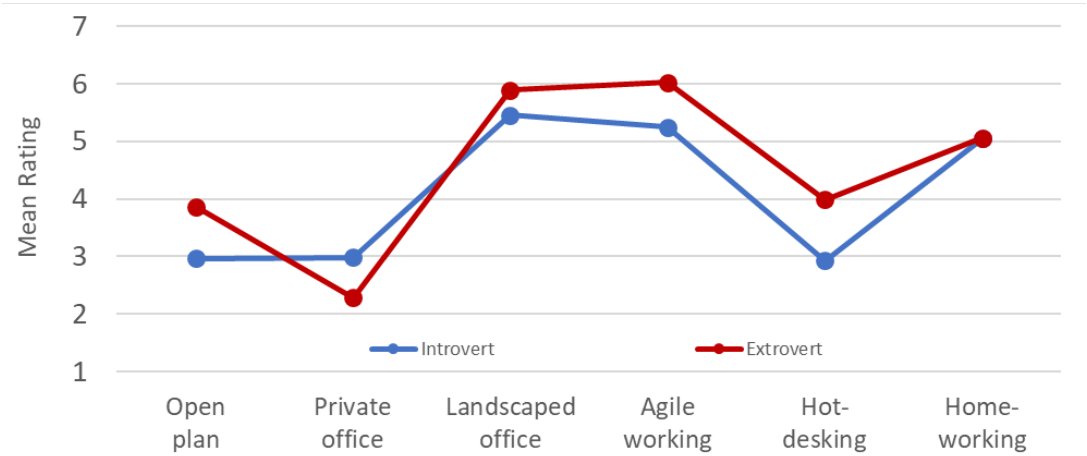
Figure 2 Mean rating of office preferences by current primary workspace



3.2 Office preferences and personality

Figure 3 shows a comparison of those scoring high on Extroversion (blue) compared with those scoring high on Introversion (red); the ambivert mean ratings have been omitted on the chart. The introverts have a higher preference of private offices compared to extroverts (df=2,573, F=4.31, p<0.05, η^2=0.015). In contrast, introverts rate open plan (df=2,573, F=6.88, p=0.001, η^2=0.023), agile working (df=2,573, F=6.50, p<0.01, η^2=0.022) and hot-desking lower (df=2,573, F=7.39, p=0.001, η^2=0.025). Interestingly, there is little difference in the preference for home-working and landscaped office between introverts and extroverts.

Figure 3 Mean rating of office preferences by extroversion



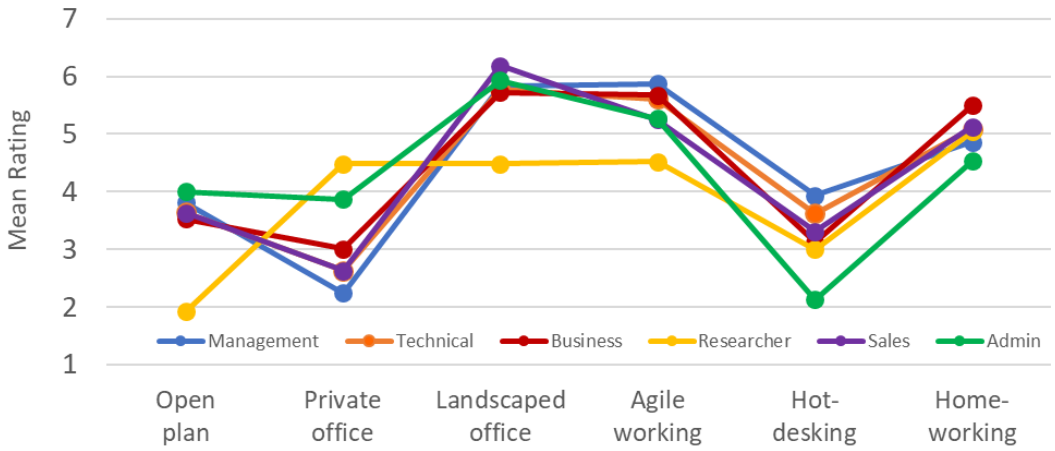
Unexpectedly, there were few differences between office preferences for those more neurotic (i.e. anxious, apprehensive) compared to the emotionally stable. The only statistically significant difference found is that the more neurotic respondents have a much lower preference for hot-desking (df=2,571, F=4.21, p<0.05, η^2=0.015).

3.3 Office preferences and socio-demographics

No statistically significant differences in office preferences were found for tenure, the time at the organisation. Perhaps status and expectations of a private office are less of an issue nowadays. Furthermore, unexpectedly, no significant differences in office preferences were found for age group. Previously reported differences in expectations of millennials etc are not supported.

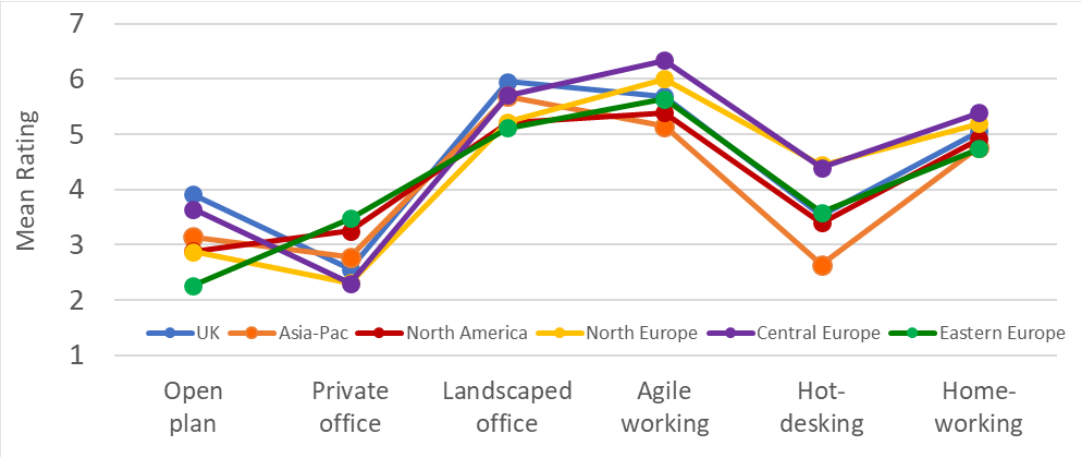
Figure 4 shows that there are statistical differences between mean office preferences for different job roles. For example, unexpectedly, those in management roles (blue) rate private offices the lowest ($df=7,550$, $F=8.82$, $p<0.001$, $\eta^2=0.101$), but rate agile working ($df=7,550$, $F=3.88$, $p<0.001$, $\eta^2=0.047$) and hot-desking ($df=7,550$, $F=3.17$, $p<0.01$, $\eta^2=0.039$) higher than other job roles, but quite similar to technical staff. Those in research roles (yellow) rate the preference for private offices the highest but rate open plan offices ($df=7,550$, $F=3.63$, $p=0.001$, $\eta^2=0.044$), landscaped offices ($df=7,550$, $F=3.44$, $p=0.001$, $\eta^2=0.042$) and agile working the lowest. The percentage of researchers in the survey sample was small (4.5%) but nevertheless the results are statistically significant. Therefore, it may be possible that researcher bias for private offices could influence their studies of open plan environments. Those in business roles (red) rate home-working the highest. Administrators (green) rate open plan the highest compared to other roles, but also rate private offices high. In contrast, those in admin roles rate hot-desking and home-working lower than all other roles.

Figure 4 Mean rating of office preferences by job role



Significant differences in mean office preferences were also found for the country (grouped) where the respondents mostly work. For example, Figure 5 shows that those in the UK (blue) rated open plan ($df=6,558$, $F=6.21$, $p<0.001$, $\eta^2=0.063$) and landscaped offices ($df=6,558$, $F=4.32$, $p<0.001$, $\eta^2=0.044$) higher than elsewhere. Unexpectedly, the respondents in Antipodes and the Far East (orange) rated desk-sharing the lowest ($df=6,558$, $F=2.97$, $p<0.01$, $\eta^2=0.031$), possibly due to too mixed grouping. Northern Europeans (yellow) rated private offices ($df=6,558$, $F=2.81$, $p<0.05$, $\eta^2=0.029$) the lowest and hot-desking the highest. In contrast, Eastern Europeans (green) rated open plan and landscaped offices the lowest and private offices the highest. North Americans also rated their preference for fully open plan offices as low and rated private offices higher. In the survey sample, there are little differences in the preference for home-working across countries.

Figure 5 Mean rating of office preferences by grouped country



4 IMPLICATIONS FOR RESEARCH AND DESIGN

Based on the initial analysis, the following key implications are supported:

- For the study sample, the landscaped office, agile working and home-working are more preferred than open plan, hot-desking and (unexpectedly) private offices. The preferences for landscaped/hybrid office and agile working environments, both types of "open plan" solution, tend to be excluded from those articles comparing open plan with private offices.
- The respondents located in single or paired offices have a higher preference for private offices and a lower preference for open plan offices, agile working and hot-desking than those located in other types of office space. It therefore appears that those who have not actually experienced open plan are more opposed to it.
- Introverts prefer private offices compared to extroverts, but they rate open plan, agile working and hot-desking the lowest. As found in previous studies, additional care and change management is required when moving introverts into open plan and desk sharing environments. Unexpectedly, there is little difference in the preference for home-working between the introverts and extroverts in the survey sample – it's quite popular with both types.
- No significant differences in office preferences were found for tenure or age group. So, previously reported differences in expectations of millennials etc are not supported.
- However, researchers have a preference for private offices, which could influence their studies of open plan and resulting recommendations on office design.
- Unexpectedly, those in management roles rate private offices the lowest, but rate agile working and hot-desking higher than other job roles. Administrators rate open plan the highest, but also rate private offices high. In contrast, they rate hot-desking and home-working lower than all other roles. These results highlight the difference in requirements for different job roles.
- Differences for office preferences were also found between countries. For example, those in the UK rated open plan and landscaped offices higher than elsewhere. In contrast, Eastern

Europeans rated open plan and landscaped offices the lowest and private offices the highest. North Americans also rated their preference for fully open plan offices as low and rated private offices higher.

5 CONCLUSION

As found in previous published articles, the survey respondents had a low preference for "open plan offices", however they had a high preference for landscaped office and agile working, the new variations of open plan. Furthermore, across all the sample the preference for private offices was rated low. Thus, office design is not a simple dichotomous solution but a range with appealing variations dependent on personal factors.

The current workplace of the respondents, i.e. what they know, and the workplace conditions they consider important, affect their office preferences. Furthermore, personal factors such as their personality, job role and country all affect office preferences. Such variables need to be considered when designing and moving occupants to new offices.

Published press and research articles often claim that open plan offices do not work and negatively affect performance and health. In contrast, case studies and occupant feedback surveys often highlight the benefits of good open plan workplaces – usually agile or landscaped offices specifically designed for the occupants with an accompanying change management process. The survey highlights some personal factors that may explain the differences in research reports.

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SESSION 13: PHYSICAL WORKPLACE ISSUES

The influence of indoor environmental quality and workspace design on employees' health and work performance

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ABSTRACT

Human health and well-being have gained growing attention in the societal debate as well as in research. It is widely acknowledged that employees' health and well-being contribute to a decent work environment which can positively contribute to economic benefits for the employers, the social-welfare and health system as well as the building owners. However, the office environment is complex and constitutes of various factors affecting employees' health and well-being, for example, indoor climate, architectural design, and social work environment. Therefore, this paper will focus on indoor environmental quality (IEQ) and workplace design, and their influence on employees' health and work performance. A multi-disciplinary approach is developed integrating the subjective survey, semi-structured interview, and physical measurement for an in-depth investigation of the physical office environment and employees' self-reported health and work performance. A large office building with BREEAM certification has been studied at the end of summer in 2019. In total, 160 employees were involved by an online-based survey and individual interview and workshop. The main aspects of IEQ were measured, including the thermal environment, air quality, acoustic and lighting. The correlations between IEQ and workspace design factors and 5-symptom based self-reported health and self-reported work performance concerning self-evaluation and leader's feedback were studied. Results show that physical office environment shows a large association with self-reported health and self-reported work performance. IEQ factors of air quality and relative humidity are significantly correlated with PSI. Size of individual workspace and aesthetic appearance of the office gain the highest correlation with self-reported health status among the factors of workspace design. Noise and artificial lights are studied to be significantly associated with work performance, and distance between work desks is largely associated with work performance. Considering the needs of employees on the physical office environment, air temperature, air quality and availability to work concentrated still underperform but perceived as highly important by the employees. The study made efforts to study the complex factors existing in the office environment with a multi-disciplinary approach, which can be utilized in other case studies to evaluate office environment and identify the key factors. Thus, the study made it possible to review and compare the influence of physical environment factors affecting

employees' health and well-being. The data collected will contribute to an office database which is under development by the authors.

Keywords

Indoor Environmental Quality, Workspace design, Health, Productivity, Office building

1 INTRODUCTION

Human health and well-being have gained growing attention in the societal debate as well as in research. It is widely acknowledged that office employees' health and well-being influence a decent work environment which can positively contribute to economic benefits for the employers, the social-welfare and health system as well as the building owners [WGBC, 2014].

Indoor environmental quality is studied to be one of the main influential factors for human comfort and health indoors. Generally, it includes four aspects from thermal environment, air quality, acoustics, to lighting and daylight, such as the temperature, carbon dioxide and particles, noise level, and illuminance [BPIE, 2018; REHVA, 2011]. They have been linked with occupant comfort, health and productivity [Frontczak and Wargocki, 2011; Wolkoff, 2013; Jin et al., 2016]. More factors from the physical environment, such as layout, greenery, colour have been studied to impact the physical and mental health of people living and working in the building [Jacobs and Suess, 1975; Poulter Hair, 1998; Ulrich, 1991]. In general, sustainable buildings impact significantly on occupant productivity, especially in the office environment [Feige et al., 2013].

The sick building syndrome (SBS) consists of a group of mucosal, skin, and general symptoms that are temporally related to working in particular buildings. It is the workers who are symptomatic, but the building or its services which are the cause [Burge et al., 2004]. In offices, the consequences of occupant discomfort and ill-health caused by bad indoor environmental quality in offices can lead to low work performance and increased sick leave. In 2016, sick leave of the public employees in Sweden increased by more than 30 % compared to 2002, and the cost of absence from work amounted to about 4 % of the gross domestic product.

However, an office environment is complex and constitutes of various factors affecting employees' health and well-being, for example, indoor climate, architectural design, and social work environment. The results of employees' comfort and performance are also of a challenge to quantify and achieve since both physical and mental factors need to be considered. Therefore, this paper aims to introduce a multi-disciplinary approach to explore the influence of physical work environment on occupant health and well-being, focusing on different factors of IEQ as well as workspace design. Moreover, a large-office case study was conducted to collect the data and explore the preliminary influence of the physical work environment. Both quantitative and qualitative methods were used to collect the data from the physical environment and employees' perceptions.

2 METHODS

The study developed a multi-disciplinary approach integrating subjective survey, semi-structured interview, and physical measurement for in-depth investigations of the physical work

environment on employees' comfort, health and productivity. The design of the questionnaire addressed detailed questions in order to holistically investigate the influence of the factors of indoor environment and workspace design. The questionnaire collects the responses of perceived physical work environment from the occupants, with regard to the main aspects of IEQ of thermal environment, air quality, acoustic and lighting and daylight, and workspace of size, distance, aesthetic appearance, privacy, and visual protection.

As part of the semi-structured interviews and the focus-group interviews, there was a workshop done where the participants had to evaluate from their own personal perspective the importance of the physical work environment characteristics and qualities in the office, along with their satisfaction with exactly these characteristics and qualities. The collected dated is analyzed and clearly show the discrepancy between importance and satisfaction. Consequently, with a high level of satisfaction but not really importance, it is concluded as "over-performing", and with a regarded really important but not at all satisfied, it is concluded as "under-performing".

To evaluate employees' health status but caused by the office environment-related problems, such as sick building syndrome (SBS), a series of common health symptoms were asked in the questionnaire. There exist a variety of questions and questionnaire designs. Some of the questions have been considered to be fundamental symptoms of SBS, including itching/irritated/dry eyes, dry/irritated throat, blocked/stuffy nose, headache and lethargy [Burge et al., 1993; Raw et al., 1996]. These five symptoms were also used by the commonly used personal symptom index (PSI) which represents the number of building related symptoms from the subject [Burge et al., 1993]. Hence, in the study, each employee's health status was calculated based on these five symptoms. In detail, in the questionnaire, the employees were asked "How often have you had the symptoms that you attribute to your work environment" and the listed symptoms are irritation of eyes, irritation of nose, irritation of throat or stuffy nose, headache and difficult concentrating or lethargy. To study the productivity at work in the office, the employees were asked in a format of self-reported work performance. It is a complex process to investigate how the employees perform. Thus, in the study, we concerned two aspects, one is self-expectation on the tasks to be finished, and as well the reflection of feedback from the leaders and supervisors. In the questionnaire, the employees were asked "Indicate the extent to which you agree with the aspects: I feel I have performed well; and leader feedback about my work is positive".

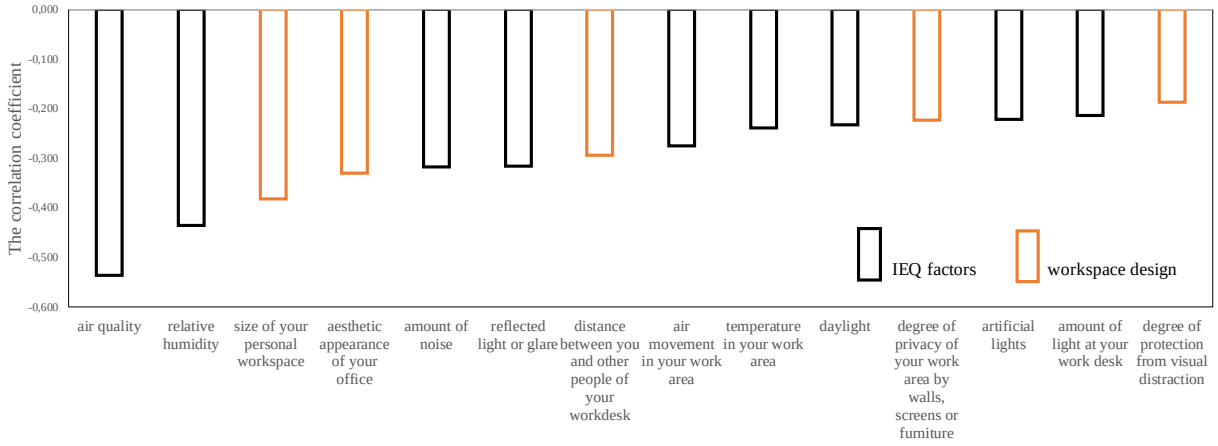
A large-scale office with a floor area of about 4000 m^2 and occupied by hundreds of employees located in the western part of Sweden was selected as a case study building. The building was newly renovated to be low-energy demand and good indoor comfort. It was certified by the international scheme of BREEAM as Silver rating. The study was conducted in August and September 2019. During the study weeks, questionnaires were filled in by the employees in the office, and selected employees joined the interview. In total, 160 employees participated in the survey and provided effective response samples. The ratio of female participants and male participants is 1.3:1. Moreover, a total of 45 in-depth interviews and two focus group interviews were conducted with a representative selection of the employees with the aim of gaining an even deeper understanding and insights into individual needs.

3 RESULTS

3.1 Self-reported health status physical work environment

Pearson correlation analysis was used to analyze the correlations between the dependent variable of self-reported health status and the variables of the factors of the physical work environment. The correlation coefficients between 5-symtptom based self-reported health status and IEQ factors and workspace design are shown in figure 1. All the results are significant at the level of $p < 0.05$. The higher the absolute value of the correlation coefficient, the larger the association. Regarding IEQ factors, air quality, relative humidity, noise, glare, air movement, indoor air temperature, daylight, artificial lights and the total amount of light at the work desk are shown to be significantly correlated with employee's health. Thereinto, air quality has a large association, relative humidity and noise show a medium association, and temperature, air movement and lighting and daylight have a small association. Regarding the aspect of workspace design, size of workspace and aesthetic appearance of your office are studied to be mediumly associated with PSI, following distance of the work desk to the other people, privacy at work desk and visual protection of the work desk showing a small association.

Figure 1. The correlations between self-reported health status and the factors of physical work environment



Moreover, from the analysis, the overall satisfaction of physical office environment including IEQ and workspace is significantly associated with employees' health with a large correlation coefficient. Overall IEQ perception also shows a significant correlation with self-reported health with a medium correlation coefficient.

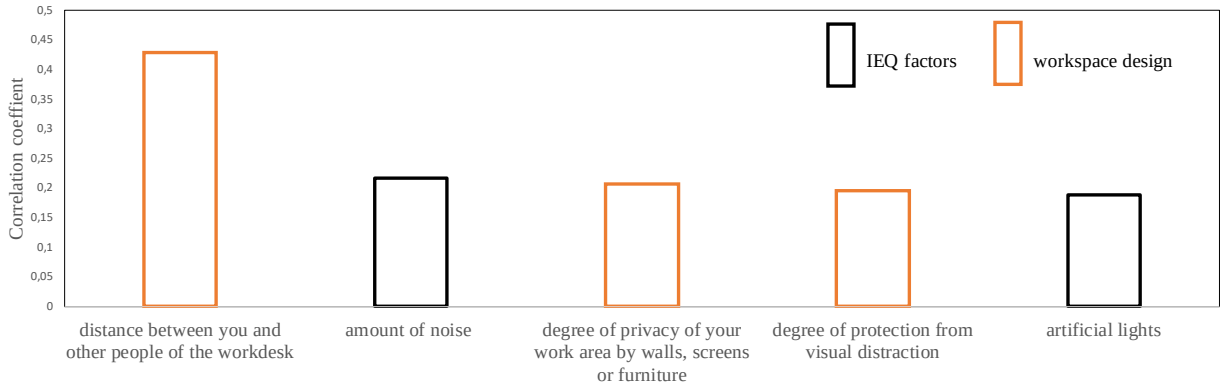
Analysis of variance (ANOVA) was used to test the significant difference on self-reported health status between the employees sitting in different offices. There are two types of offices, 2-people shared and 8-people shared. The difference of health status between these two types of office was tested, and the result is not significant. It indicates that the office type does not significantly influence the health status in this study.

3.2 Self-reported work performance and physical work environment

Pearson correlation analysis was used to analyze the correlations between the dependent variable of self-reported work performance and the variables of the factors of the physical work environment. The associations between work performance and physical environment factors are analyzed by calculating the correlation coefficient. Figure 2 shows the factors which are

significant for work performance: IEQ includes the amount of noise and artificial lights; workspace design includes distance with other people at work desk, degree of privacy and visual disturbance protection at work desk. Except for the distance with other people with a large association, the other workspace design factors show a small but significant association.

Figure 2. The correlations between self- reported work performance and the factors of physical work environment



Moreover, employees' satisfaction with the physical office environment as a whole is studied to be largely and significantly associated with work performance.

ANOVA was used to test the significant difference on self-reported work performance between the employees sitting in the two different types of offices, 2-people shared and 8-people shared. The result shows that the difference of the work performance is not significantly different concerning the factor of office typology in this study.

3.3 Importance and satisfaction of physical work environment

By the semi-structured interview with 45 participants and two focus groups, the perceived importance to different factors of IEQ and workspace design were investigated. In parallel, the satisfaction to the exact same factors was asked simultaneously. Therefore, the difference between the perceived importance to support the office life and perceived satisfaction can be in-depth understood. Consequently, the outcomes from the interviews regarding the work environment and the IEQ reveal a greater difference between what each aspect means to everyone and how it is experienced in reality: almost all aspects underperform significantly, resulting in a very low level of satisfaction. The most significant difference is observed for "air temperature" and then "ability to work concentrated" as well as "air quality" where the difference between importance and perceived reality is huge. These are closely followed by "access to daylight" and "acoustic quality". The greatest correspondence between perceived reality and expected performance applies to "artificial lights", despite a few divergences.

3.4 Measured indoor environment

Indoor climate was measured for a week in August/September at the end of summer, from Monday to Friday during the work time 8:00 - 18:00. The measurement points were selected at representative workstations in the building. In total, fourteen workstations were selected, locating in two-people shared office and eight-people shared office, respectively. The data was collected through continuous logging. Indoor climate toolkits were used to measure the physical conditions, including air temperature, relative humidity, carbon dioxide, acoustic and

illuminance at the work desk. Seven of the work desks have been analyzed with the measured results (average ± SD): 22.4 ^{o}C ± 0.5 of air temperature, 59 % ± 9 of relative humidity, 586 ± 73 of carbon dioxide concentration, 43 dBA ± 9 of A-weighted sound pressure, and 582 lux ± 284 of illuminance at horizontal level. The average indoor climatic parameters are all within the recommended limits according to the standard EN16798. It means the measured indoor environment meets the hygiene requirement in this office building. If we look at the average self-reported health status of the employees, it is perceived as seldomly have the symptoms. If we further check the percentage of the employees who perceived the five symptoms at times or often, the ratio is 24 % of the total employees. Thus, it shows that although the indoor condition is measured as qualified, it can only guarantee a relatively major part of the employees' healthy environment.

4 DISCUSSION

We interestingly found that employees' satisfaction with the indoor environment and measured indoor environment exist discrepancy. As the results shown from the semi-structured interview and physical measurement, air temperature and air quality are considered under-performing, however the measured air temperature and carbon dioxide concentration at the average values are up to the standard. Thus, it indicates the gap between the perceived and measured indoor environment. There seem to exist the interactions between the indoor environmental quality (environmental parameters) and workspace design (non-environmental parameters) on the employee's satisfaction. For example, some research has indicated that office layout contributed to employee's satisfaction with thermal and visual comfort [Kwon et al., 2019]. However, the interactions have not been sufficiently quantified. As a further step of this study, using the existing subjective data, the influence of workspace design factors on employee's satisfaction with indoor environment will be analyzed.

From the correlation associations between the factors of indoor environment and workspace design and self-reported health status, we see the highest correlations are shown with the IEQ factors of air temperature and relative humidity. Although with the limited sample size, we cannot conclude that IEQ factors are more influential on employees' health status than workspace factors, we could see the difference. One possible reason to explain for that is health is closely related to the hygiene condition that indoor air quality provides. Health is also affected by workspace design but more from the psychological aspect. To further understand the difference, the study will go deep to this question as the next step of data analysis to compare the different level of associations from different factors.

5 CONCLUSION

The influence of the physical office environment on employees' health and productivity in the office environment in terms of correlations and associations were studied by a multi-disciplinary approach including survey, semi-structured interview and physical measurement. The design of the survey is able to holistically explore the status of employees' comfort, health and work performance in the office. Furthermore, individual interview enables a deeper insight into employees' expectation and needs on the work environment.

The physical office environment shows a substantial association with self-reported health and self-reported work performance. IEQ factors of air quality and relative humidity are significantly correlated with employee's health status. Size of individual workspace and aesthetic appearance of the office gain the highest correlation with health status among the factors of workspace design. Regarding the influence on work performance, noise and artificial lights are studied to be significantly associated, and distance between the work desks of workspace design is largely associated with work performance, which is closely followed by privacy and visual protection at the work desk. By comparison, the IEQ aspect would be more related to self-reported health than workspace design, which achieves the highest correlation. In contrast, workspace design factors indicate a greater influence on self-reported work performance. Considering the needs of employees on the physical office environment, air temperature, air quality and availability to work concentrated still underperform but perceived as highly important by the employees. The indoor climate was measured to fulfil the requirement of physiological and hygiene needs in the office environment.

The multi-disciplinary approach developed in the study can be utilized in other offices to evaluate the office environment and identify the influence and critical factors. Since the preliminary results are based on the case study, more building and data collection are needed to conduct advanced statistical analysis and further verify the achieved conclusions.

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The Effects of Personal Comfort Systems on Thermal Comfort, Cognitive Performance and Thermo-physiology in Moderately Drifting Temperatures

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ABSTRACT

Strict ambient temperature control is common practice in modern office environments aiming to satisfy the thermal comfort demand of an average person: the one-climate-fits-all paradigm. However, three consequences arise: (i) Due to inter-individual differences, individuals' thermal comfort is compromised; (ii) Strict climate control results in high energy demands and therefore hinders achieving sustainability targets; (iii) Thermal resilience may decrease as people are no longer exposed to natural thermal variations. A more dynamic environment allowing more temperature variations may reduce the building energy demand substantially. However, thermal comfort may be jeopardized. Studies indicate that a Personal Comfort System (PCS) can improve thermal comfort. Most studies still apply PCS in a rather strict ambient environment, aiming at thermal comfort only. The influence of PCS in a dynamic, i.e., drifting, environment on individual thermal comfort, cognitive performance and physiology remains largely unstudied.

Therefore, preliminary results of a study on PCS in a dynamic indoor environment are presented, targeting only those body segments that are most sensitive to thermal discomfort. In this study, a personal comfort system was developed consisting of a heating desk, a heating mat and a personal fan aiming at conditioning the most uncomfortable body segments under mild cold and mild warm environments. Two equal drifting temperature scenarios were performed, with PCS and without PCS, starting at 17˚C in the morning and increasing to 25˚C in the afternoon. So far, eight subjects were enrolled, including three males and five females. Thermal perception, body temperatures and cognitive performance were measured.

The results suggest that the tested PCS can improve thermal comfort in moderately drifting temperatures. The application of PCS may not change the effectiveness of drifting temperature on vasomotion in terms of the underarm-finger skin temperature gradient. The cognitive performance can even be enhanced by the use of PCS, depending on the task and environmental temperature.

Keywords

Drifting temperatures, Personal comfort system, Health, Thermal comfort, Cognitive performance

1 INTRODUCTION

The one-climate-fits-all paradigm has been applied worldwide since the proposal of the PMV/PPD model, which was developed by P.O. Fanger [1]. The model uses a theoretical heat-balance equation, which is used via empirical study data to estimate the mean thermal sensation vote. A predicted mean vote (PMV) of a general population is calculated from six parameters: mean radiant temperature, air temperature, airflow, relative humidity, clothing and metabolic rate [1]. The recommended bandwidth of PMV (-0.5<PMV<0.5) leads to the common practice of controlling indoor temperatures in a rather small range. Three consequences arise. The first consequence is compromised individual thermal comfort. The assumption of the "average person" ignores the considerable variation of the population due to age, gender, thermal history and so on. Different individuals may require different thermal environments. A recent large-scale field study indicates that the prediction of the PMV/PPD model has a low accuracy and overestimates the discomfort outside neutral thermal environments [2]. The overall prediction accuracy of the PMV/PPD model is 34%, including the data from air conditioned, naturally ventilated and mixed mode buildings [2]. The PMV has higher accuracy near the "neutral" vote, but never more than 60% regardless of the building type [2]. The second consequence is high energy consumption. The building sector is responsible for up to 40% of the global energy consumption, of which half is associated with indoor temperature control [3][4]. The third consequence is possibly decreased thermal resilience as people are no longer exposed to naturally varying thermal environments. Staying in the neutral temperature range will impose less thermal stress on the body and therefore reduce the "exercise" of thermal regulation. Numerous studies show that regular exposure to heat and cold pre-trains the body, enables the body to adapt to its environment, increases thermal resilience, and therefore mitigates the physiological strain in hot and cold environments respectively [5][6].

The metabolic syndrome is one of the main health challenges in Europe [7]. Temperature variations may elicit important health benefits, specifically pertaining to the metabolic syndrome, as demonstrated by previous studies [8] and may reduce the building energy demand substantially. However, thermal comfort may be jeopardized. Schellen et al. [9] demonstrate that subjects were feeling less comfortable during the temperature drift in comparison to a constant temperature, but a temperature drift up to ±2 °C/h in the range of 17–25°C did not lead to unacceptable conditions. However, a personal comfort system (PCS) can compensate for thermal discomfort outside the neutral temperature range. By providing building occupants the possibility to manipulate their environments locally, the PCS possesses the potential to achieve thermal comfort at an individual level. In addition, the feeling of 'being able to control' may also provide

positive psychological effects on thermal comfort [10]. Literature shows that a PCS can extend the comfortable temperature range down to 14°C and up to 32°C [11][12] and substantially reduce building energy consumption [13]. However, to our best knowledge, no study of a PCS was conducted in a dynamic environmental temperature and the majority focused only on thermal comfort. The individual thermal perception, cognitive performance and physiology remain largely unknown.

This study hypothesizes that applying a PCS which targets only those body segments that are most sensitive to thermal discomfort in combination with a dynamic indoor environment, maintains positive health effects of a drifting environment while thermal discomfort can be mitigated. Besides, the effects on cognitive performance were tested.

2 METHODOLOGY

2.1 Personal comfort systems

The personal comfort system was developed in collaboration with Ahrend®, a Netherlands-based company for office furniture, consisting of a heating desk, a heating mat and cooling fans. These systems are aiming at the most uncomfortable body segments under mild cold and mild warm conditions. The heating desk, heating mat and fans are designed for hands, feet and head respectively. Each device has four different settings: off, low, medium and high.

2.2 Recruitment of subjects

Thus far, eight subjects (5 females and 3 males) gave written consent before participating in this study, according to the declaration of Helsinki. All the subjects are healthy, Caucasian race, age between 18-40 year, BMI between 18 to 27.5 kg/m^2. Female participants are on contraceptive pills and were tested outside the menstrual period. Volunteers who smoke, present of Raynaud's phenomenon, possess extreme chronotype, or joined another biomedical study a month before, were excluded from the study.

2.3 Measurements

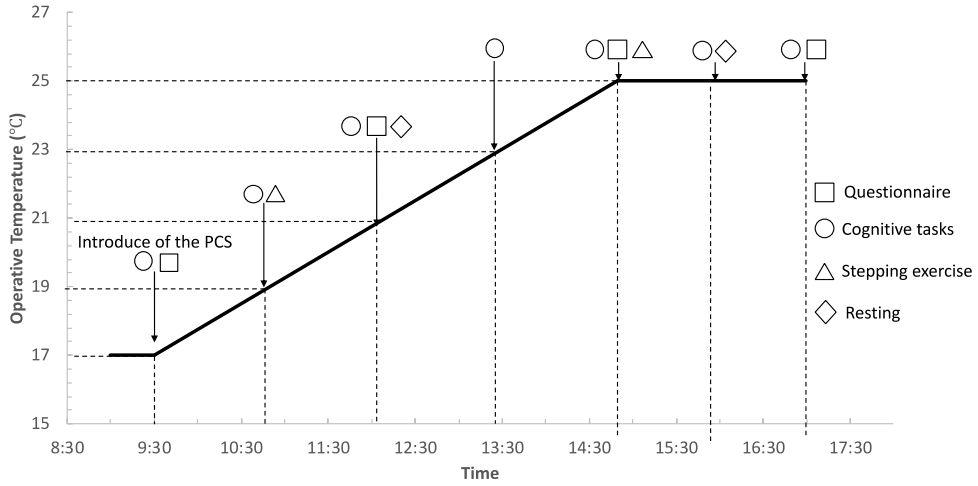
The air temperatures were measured at a height of 0.1 m, 0.6 m, and 1.1 m near the subjects. The thermal sensation and comfort were evaluated using visual analogue scales. Fourteen wireless skin temperature sensors (iButtons, Maxim Integrated Products, California, USA, Accuracy: ±0.5°C) were attached to the skin sites, according to ISO 9886 [14]. Three additional skin temperature sensors were added at the underarm, middle finger and supraclavicular to gain more insight of vasomotion [9]. The mean skin temperature was calculated using the 14-point method of ISO 9866 [14]. Four different types of cognitive tasks were employed to test four different aspects of cognitive ability related to office work, consisting of working memory, verbal ability, mental rotation and planning. All the tasks were provided by Cambridge Brain Science Inc and on the ground of classic cognitive tasks from the psychological literature [15]. For measuring working memory, a forward digital span task was adapted, which asked subjects to remember a sequence of numbers. For verbal ability, a grammatical reasoning task was used that required subjects to judge if a description matches the geometric graphs or not. For mental rotation, a spatial rotation task was used for assessing the manipulating ability of mental representations of objects by asking subjects if two pictures are the same through rotation. For planning, a Hampshire Tree task was adapted, where subjects needed to rearrange out-of-order numbered balls to a numerical order in a tree-shaped frame.

2.4 Experiment procedure

A cross-over design was performed, consisting of two conditions (with PCS condition and without PCS condition (NOPCS condition)). All the subjects finished two conditions, which were conducted on two separate days. In between the two test days was a break of at least one to a maximum of fourteen days.

The two conditions consisted of identical procedures except for the application of PCS. The procedure of testing is shown in Fig1. The subjects arrived at the lab in fasting state at 8:00 h and had standardized clothing (underwear, long-sleeve shirt, sweatpants, socks and shoes ~0.65 clo), followed by resting for one hour in a room at a constant temperature (23-25°C). Afterwards, subjects transferred to a respiration chamber for eight hours to simulate daily office work. In the respiration chamber, subjects were asked to perform office work (estimated activity level of 1.2 METs), provided with a standardized breakfast and lunch, and allowed to consume water at libitum. The temperature in the respiration room stayed at 17°C for the first half hour to let subjects inhabit to the environment. Afterwards, the PCS was introduced in the PCS condition and subjects were allowed to freely control the PCS-devices. At the same time, the temperature started increasing from 17°C to 25°C with a ramp of 1.5°C/h. The temperature remained at 25°C for two hours at the end to achieve a stable state of thermal sensation. The questionnaires were answered every two-degree of temperature rise and every hour after the temperature remained stable at 25°C. The cognitive tasks were performed every four-degree temperature rise and at the end of the test. In addition, two times 5-minute stepping exercises and 30-minute resting metabolic rate measurements (RMR) were performed. In between the measurements, they were allowed to use their computer at their desire.

Fig1 Procedure of the experiment. The indoor temperature starts to increase at 9:30 h and remain stable from 14:50 h onwards. The arrow indicates the time at which measurements took place.



A day preceding every condition, subjects got familiar with the PCS and practiced cognitive tasks to eliminate, or at least limit, possible learning effects. They were also asked to refrain from alcohol, coffee, strenuous exercise and food after 22:00 h.

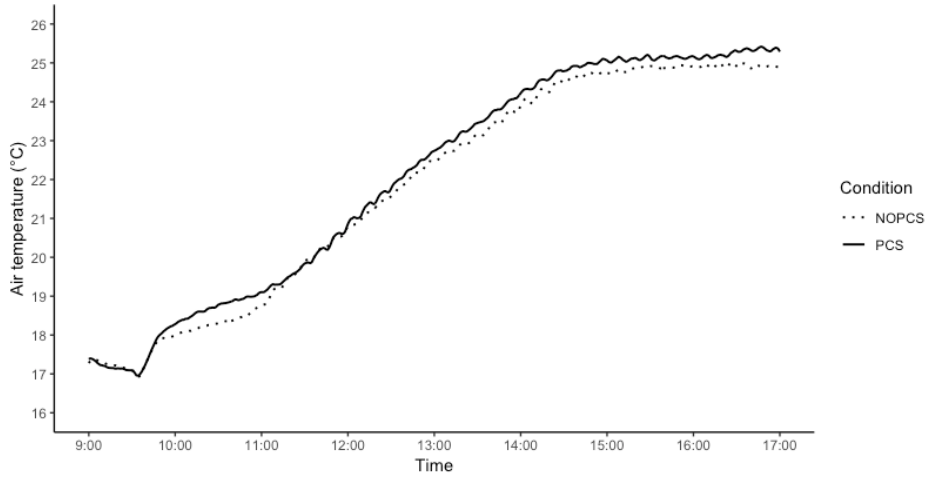
3 RESULTS

The preliminary results of the study are presented by box plots and line plots. In the box plot, the filled diamonds indicate the average value of the eight subjects. The outliers are shown as filled circles. In the line plot, the dotted curve represents the air temperature in the NOPCS condition and the solid curve that in the PCS condition.

3.1 Air temperature

Figure 2 shows the air temperature in the room. The air temperature profile complies with the designed profile in both conditions. Although the average air temperature in the PCS condition is generally higher than in the NOPCS condition, the difference (0.23 ± 0.15°C) between PCS and NOPCS condition is regarded as acceptable.

Fig 2. Measured air temperature over time

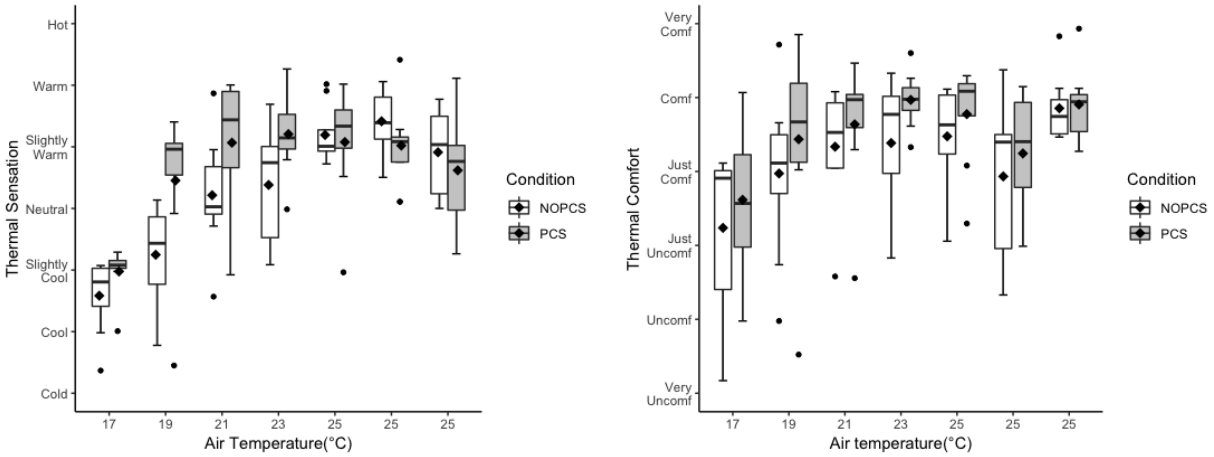


3.2 Thermal perception

Figure 3a shows box plots of the thermal sensation in the two conditions. Without PCS, the thermal sensation changes from “cool” to “slightly warm” along with the increase of air temperature. The individual difference is evident in our study as one subject vote lies between “slightly cool” and “cool” at 21°C while another one’s vote between “slightly warm” and “warm”. The average range of thermal sensation under the same temperature is 2.08±0.70. With PCS, the average thermal sensations are warmer in cold conditions and cooler in warm conditions compared to those in NOPCS. The average range of thermal sensation under the same temperature is 2.69±0.84.

The average thermal comfort vote is higher in the PCS condition comparing to the NOPCS condition (Figure 3b). In the NOPCS condition, 72% of the votes is higher than “just comfortable” while in the PCS condition this is 84% of the votes. By applying PCS, the average thermal comfort improved by 0.34±0.16.

Fig 3 Thermal perception votes *('Comf' is the abbreviation for 'comfortable'. 'Uncomf' is the abbreviation for 'uncomfortable')*



(a) Thermal sensation votes

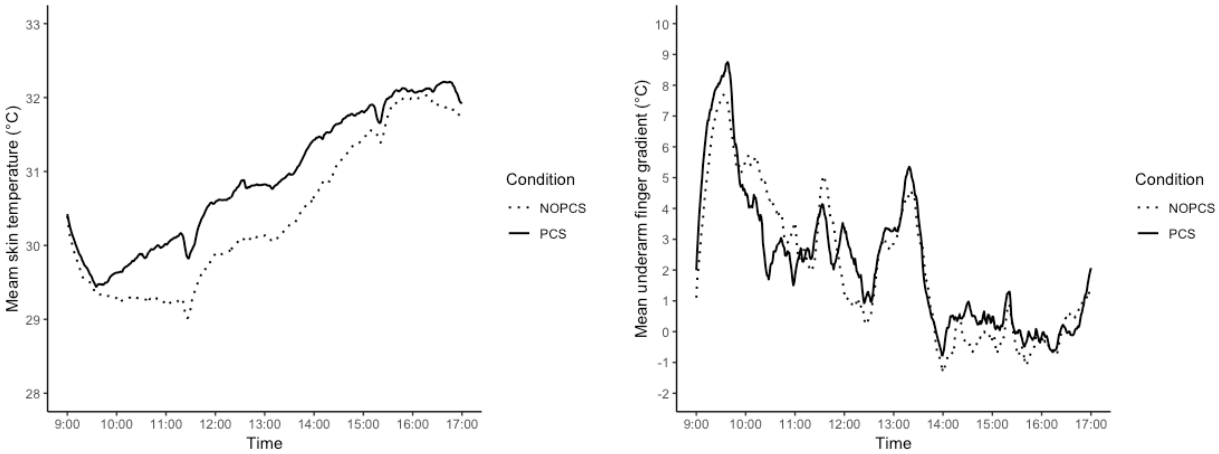
(b) Thermal comfort votes

3.3 Skin temperatures

Figure 4a presents the average of all participants of mean skin temperature over time. Mean skin temperature is an indicator of thermal sensation and an important input signal for thermoregulation. In the first half-hour, there is no obvious difference in the mean skin temperatures between the two conditions. It indicates that the habituation period makes the subjects achieve a similar thermal state in the two conditions. For the remainder of the test, the mean skin temperature in PCS condition is higher than in NOPCS condition.

Figure 4b demonstrates the gradient of skin temperature between underarm and finger, which is regarded as an index of vasomotion. There is no obvious difference between the two conditions. It seems likely that the effect of drifting temperatures on vasomotion remains when applying PCS.

Fig 4 Skin temperatures



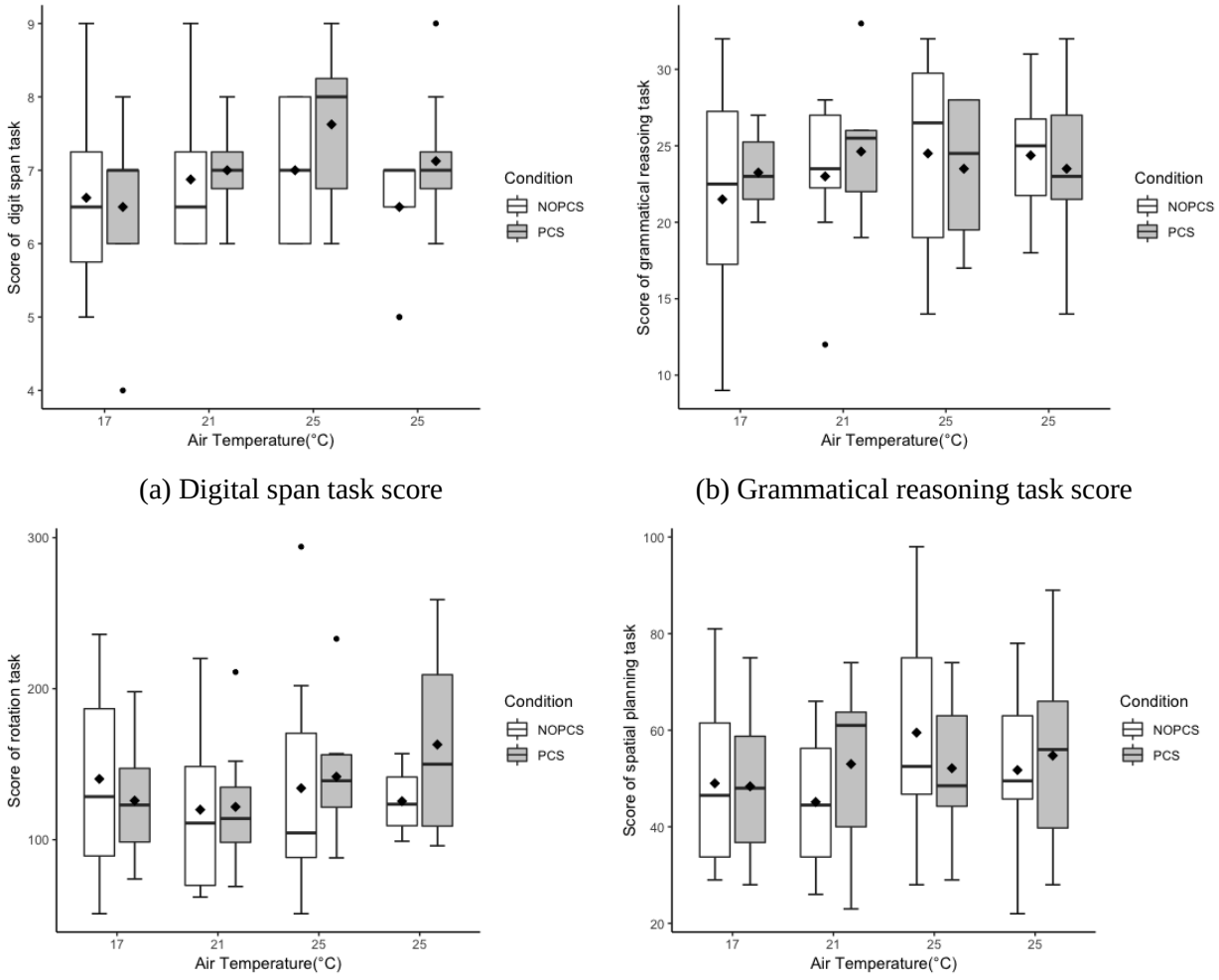
(a) Mean skin temperature

(b) Underarm-finger skin temperature gradient

3.4 Cognitive tasks

Figure 5 illustrates the results of the cognitive performance tests. Regarding the digit span task, the PCS improved performance in the warm temperature (25°C), but the improvement was limited in the cool temperatures (17–21°C). Regarding the grammatical reasoning task, a decreased score in the warm temperature (25°C) and increased score in cool temperatures were observed, moreover, the variation is smaller using PCS at most temperatures except at 25˚C at the end of the test. Regarding the rotation task, the result was similar to the digital span, no obvious difference in mild cold and improvement in warmth. Regarding the spatial planning task, the use of PCS enhanced the performance, especially in the temperature of 21°C. And no consistent conclusion can be made in the warm temperature as the performance was improved in one while impaired in another.

Fig 5. Cognitive tasks score



(a) Digital span task score

(b) Grammatical reasoning task score

(c) Rotation task score

(d) Spatial planning task score

4 DISCUSSION

This study tests a novel idea of PCS, which only targets the extremities: feet, hands and head. By investigating the PCS in drifting temperatures, we can see that the effect of the PCS on thermal perception is dependent on the environmental temperature. Veselý et al. [16] indicate that the thermal sensation is barely elevated by only using the heating desk or the heating mat at a temperature of 18℃. However, we found improvements in thermal sensation by warming the hands and feet together. The study of Zhang [17] complies with our finding, where thermal sensation shifts to the warm side by heating both hands and feet at a temperature of 18℃. However, the magnitude of thermal sensation change is smaller than our study, which may be due to different environmental settings imposed and equipment used. Moreover, the attenuated improvement of thermal sensation in 17℃ may indicate the limited effect of such PCS in more extreme cold environments. Surprisingly, the thermal sensation vote was lower in the PCS condition, but the mean skin temperature was higher at 25°C compared to NOPCS condition.

When leaving the paradigm of strict temperature control for a more dynamic indoor climate control in the built environment, a major concern rises whether it will decrease the daily productivity or performance. In this study, we found that the effects of PCS on cognitive performance vary among the tested temperatures and tasks. The PCS only improved the performance in warm environments when subjects were performing the digital span and rotation task. However, when performing the grammatical reasoning and spatial plan task, the PCS only enhanced performance in cool environments. This divergence may be due to the temperature affecting performance differently, depending on the task type, exposure duration and temperature [18].

So far, eight participants have been tested. Due to the small sample size, it is difficult to draw general conclusions at this moment. More participants will be tested in the near future.

5 CONCLUSIONS

This study focuses on a novel PCS, which targets only the extremities: feet, hands and the head to retain the health benefit from the dynamic environments (e.g. increased thermal resistance). The innovative insights from this study are that 1) The vasomotion reactions in terms of underarm-finger gradients were similar between the two conditions (with vs. without PCS), which indicate that the drifting temperature exercises the thermoregulatory system in a similar manner as if the PCS is in use; 2) Nevertheless, the PCS can improve thermal comfort, on average by 0.34±0.16 on a 6-point thermal comfort scale, and 84% of the comfort vote is higher or equal to ‘just comfortable’ in a dynamic environment with a moderately drifting scenario over a wide range of temperatures (17-25˚C); 3) Moreover, cognitive performance can be enhanced with PCS, but it depends on specific tasks and temperature ranges: the digital span and rotation tasks improved in a relatively warm environment (25˚C) while grammar reasoning was enhanced in a cold environment (17-21˚C). The results suggest that the tested PCS, in combination with drifting ambient temperatures, has the potential of creating a comfortable and healthy office environment, however, it is worth conducting further research to draw general conclusions.

ACKNOWLEDGMENTS

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Travel Concentration: The effects of attractor-bound movement on workplace activity

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ABSTRACT

Purpose: The purpose of this paper is to explore the effects of office attractors on workplace activity. First, it aims to describe how movement towards different attractors such as canteens and entrances can be approximated in a 2D spatial model, and second, to show how those simulated effects relate to actual observations of movement and interaction.

Theory: Human activity in physical workspace is typically examined from the perspective of the purely geometric properties of the space (i.e. in the field of space syntax), or by other properties of workspaces, such as barriers and distance between workers. Movement in offices however is an activity that is driven by both geometric and non-geometric properties. The non-geometric properties relate to the functional configuration of space (where seats/canteens/meeting rooms are) but the activity itself happens in the real space and it is thus bound by spatial configuration.

Furthermore, while the driver for movement is the need to travel to specific attractors, it is the actual space that allows for secondary effects such as serendipitous interactions to emerge. Thus, it can be expected that a successful approximation of workplace movement will also contribute to understanding interaction, especially that which happens away from spaces programmed for it such as meeting rooms.

This paper examines the two activities of movement and interaction under the hypothesis that a spatial model that properly simulates attractor-bound movement can successfully identify the locations where movement happens, but also provide relevant hints for serendipitous interaction.

Design/methodology/approach: To study this hypothesis, we constructed paths from each seat to a set of three types of attractors, specifically the building entrance, the closest canteen or kitchen and the closest WC. These paths were then transformed to zones of visibility to take into account the surrounding space as well as to allow for interaction to be examined as that activity is unlikely to happen directly on the path. The final result is a metric of travel concentration that measures how likely is it that a space will be seen from those generated paths. The metric is validated against actual observations of movement and interaction in a linear model, tested initially against a large sample of different workplaces (216 floors), but also against two sets of floors, one with high and one with low seat density.

Findings: The new metric fares well against both movement and interaction on the whole sample, but on the two sets of floors the effects are less robust. In high-density floors the main driver of attractor movement is the one generated from outside the floor and to a lesser extent the one that comes from within the floor. In low density floors only interaction is somewhat predictable albeit with a weak effect and only in relation to travel from within the floor. Travel concentration was found to be less effective than the existing Visual Mean Depth metric, however combinations of the two were found, in some cases to yield the best results.

Originality/value: The new metric presented here is a useful simulation of movement in office spaces which can be applied to the analysis of existing spaces, but also provide a way for designers to test against floor plans of new buildings.

Keywords

Workplace analysis, attractor-bound movement, spatial configuration, space syntax, human activity

1 INTRODUCTION

Evidence-based design of workplaces deals, at its core, with the physical properties of office environments as a vehicle to understanding human behaviour. More specifically, the aim of evidence-based design is to understand which properties of workspaces affect human behaviour and how; but also, how this knowledge can be used to design new spaces with potentials for different behaviours to emerge. The need for designing with evidence was highlighted in recent surveys (Outram, 2015; EBD, 2015) with architects and other related professionals noting in particular the lack of tools to carry out such tasks. New tools have indeed started appearing with the increase of computational power, along with analytical units in architectural offices (Denny, 2018), that allow firms to measure and understand organisations and how to design for them. Meanwhile the rise of co-working spaces has allowed companies to gather large datasets for architects to use when designing new spaces (Quito, 2019).

However little predictive power is currently offered by the existing analytical frameworks, especially those within the domain of space syntax. The published research has focused mainly on the development of various distinct methodologies in small samples and with contradictory results (Sailer, 2010). Despite larger samples slowly appearing in newer studies (see for example Hua et al., 2010), there is a systematic neglect to consider functional distributions of points of interest in the workplace, such as the various tea points, printers and watercoolers, which is arguably a reason for the lack of predictability in existing models.

The aim of this paper is to provide a way to measure the effects of these points of interest, by treating them as attractors that generate movement potential through travel towards them. The paper will also aim to link to previous research by comparing the new measurements with existing space syntax metrics and eventually validating the results by testing them against a large sample of activities in 41 workspaces.

2 LITERATURE REVIEW

Research that examined spatial configuration of office spaces as a proxy for understanding human activity can be traced back to the 1970s, with the first examples collating findings from various sources such as newspapers, articles and magazines (Steele, 1973; Sundstrom and Sundstrom, 1986). One of the first studies to rigorously measure properties of space and connect them to human behaviour was by Allen and Fustfeld (1975) where the authors showed that the distances between engineers in seven R&D laboratories significantly affected the communication between them. It was shown for example that a distance of more than 25 to 30 metres between engineers had a negative effect on the probability that those engineers would communicate once a week. A study that instead focused on the properties of surrounding workspace from the perspective of the individual staff member was by Hatch (1987), who tested whether barriers were a hinderance to face-to-face communication, i.e. as interactions which were, at the time, seen as distracting. Hatch found no evidence to support that claim and instead showed that employees in subdivided environments tended to attract more interactions.

Models of higher complexity appeared eventually, primarily within the field of space syntax. In multiple studies Hillier and Grajewski (1990; 1992; 1993) examined seven office spaces in the UK, Scandinavia and the US, employing techniques developed several years earlier for urban spaces and published in the book "The social logic of space" (Hillier and Hanson, 1984). For each of the seven offices the authors created axial maps i.e. linear maps denoting the fewest and longest lines of sight in an office space, but they also captured various activities through observations. The study considered a metric that was also developed for urban systems, 'integration' i.e. how integrated (shallow, easy to reach) or segregated (deep, hard to reach) parts of the system were in relation to the whole system. It was found that more integrated buildings as a whole tended to attract more movement, and in some cases interaction (Grajewski, 1992) but it was also shown that most interactions tended to happen at or near workspaces. Later workplace studies focused on different spatial models such as convex spaces (Wineman and Serrato, 1997), but also more detailed ones such as the grid-based Visibility Graph Analysis (Appel-Meulenbroek, 2009).

However, most of these models and techniques treated space as independent of function and did not examine workspace-specific parameters such as targeted movement, despite it being acknowledged as having potentially non-negligible effects on interaction by various researchers (Allen and Fustfeld, 1975; Fayard and Weeks, 2007). Some studies did look at the effects of attractors i.e. by measuring the distances to cellular offices (Serrato and Wineman, 1999) or entrances (Penn et al., 1999), but it wasn't until a study by Sailer (2007) when a more nuanced approach was undertaken. Sailer specifically simulated paths of staff members of two organisations from their office spaces to various attractors by asking the staff members to pinpoint the places they visited and how often they did so. The author thus demonstrated that when those paths were taken into account along with other existing metrics, predictions about the locations of movement became stronger. An even more detailed approach was attempted in a series of studies by a group of authors (Owen-Smith et al., 2012; Kabo et al., 2013; Kabo et al., 2015) examining two university buildings. In this case a set of paths was created simulating the potential trails of researchers from their cellular office space to various amenities such as toilets, stairs and elevators. When the paths from different researchers overlapped, the common 'zone' was treated as a potential for interaction, given that the researchers had a chance of bumping into

each other within that zone. The authors showed that path overlaps between researchers tended to create new collaborations in the form of new publications or grant applications.

While the studies by Sailer, Owen-Smith and Kabo introduced the missing ingredient of attractor-led movement and proved that movement and interaction were better predicted in this more nuanced way, they were done on small samples of two organisations each. The studies also used two different underlying spatial models: linear maps (Sailer) and networks of rooms (Owen-Smith, Kabo et al.). These representations allowed the authors to simplify the path generation, however they do not capture much detail of the spatial configuration and are thus more suitable in cases where workspace is clearly delineated in cellular office spaces instead of large open-plan areas.

3 DATA

This study will instead harness a large dataset of office spaces to validate results. This dataset was provided by Spacelab, an architecture and consultancy firm in London, UK, and contains 36 companies also located in the UK. The companies are spread over 41 sites (as some companies have sites in different parts of the country) and 60 buildings. They span 216 floors with a total office area of around 250,000 m^2. These companies belong to eight different industries (shown in figure 1) including retail, media, technology, public sector, and others. The total number of desks in the sample is 37,764.

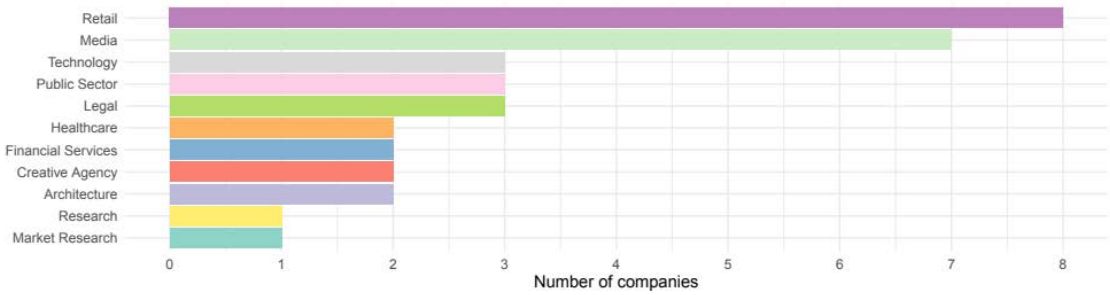


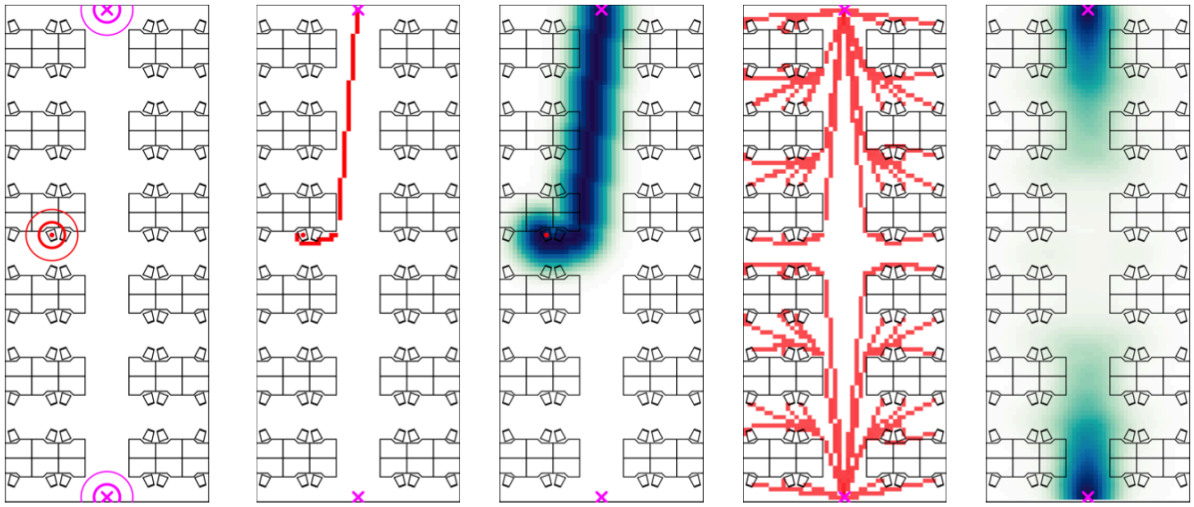
Figure 1: Number of companies per industry.

The dataset contains existing floor plans, Visibility Graph Analysis metrics but also observations of movement and interaction for all workspaces within each company over the period of one week, every hour for eight hours.

4 METHODOLOGY

The underlying representation used for this research was a grid, as this is provided in the context of Visibility Graph Analysis (VGA) a method of geometric spatial analysis within the field of space syntax introduced by Turner et al. (2001) and carried out using the software application depthmapX (Turner, 2001; Varoudis, 2012; depthmapX development team, 2019). While the measure of integration has been transferred from the urban-scale space-syntax analysis to VGA in previous studies, there is currently no equivalent metric capturing attractor-led movement potential for this grid-like representation. To adapt the ideas by Sailer, Owen-Smith and Kabo, three considerations had to be taken into account: origins and destinations, path-generation and path-overlap.

For the first consideration we chose to examine only paths from workspace seats to entrances, toilets and tea points (or canteens). Workspace seats can be thought of as the base for every employee from which most paths will start and end. The three attractor types chosen are the ones that are configurational i.e. their usage is more likely to be dependent on the need to reach them and thus the closest one is more likely to be selected. These are in contrast to other types of attractors such as meeting-rooms or other colleagues which require additional knowledge (i.e. which meeting room each employee attends at which time) for an accurate representation. Path-generation was rather more straightforward to adapt, given that within the field of space syntax various techniques exist for this task. The paths generated were the ones which required the shortest metric distance from seat to attractor. The final consideration, path-overlap required additional elements of the spatial model to adapt. Extant implementations relied on simpler spatial models covering large spaces and rooms but in the case of a grid-like structure the paths generated would be at-most single-cell wide (see for example figure 2b). To properly represent the potential for overlapping movement and co-presence (which allows for interactions to be triggered), a 'zone of visibility' was created around each path simulating all the space that a person travelling on that path could see. Under this assumption the existence of two common zones of visibility could trigger a new interaction, or pinpoint locations where movement is increased especially when those locations are close to the path.



(a) (b) (c) (d) (e)

Figure 2: Generating travel concentration for the same type of attractors (a - attractors marked with a magenta 'X'). From a seat (in red) the closest attractor is chosen and a shortest metric path created towards it from the seat (b). Then, the visible zone is created along that path (c). The zones of the paths from all seats to their closest attractors (d) are accumulated to create the metric Travel Concentration (e).

In technical terms, the process has four steps (shown in figure 2) and it is carried out from the perspective of the seat, not the grid cell itself. First, the closest attractor of a specific type is chosen by measuring the metric distance from that seat to all attractors of the same type (fig. 2a) and the shortest metric path on the grid is created from the seat to the attractor (fig. 2b). Obstacles such as furniture are taken into account. For the third step, all the area visible around the path is denoted as a zone of visibility (fig. 2c) that includes all the cells that can be seen when

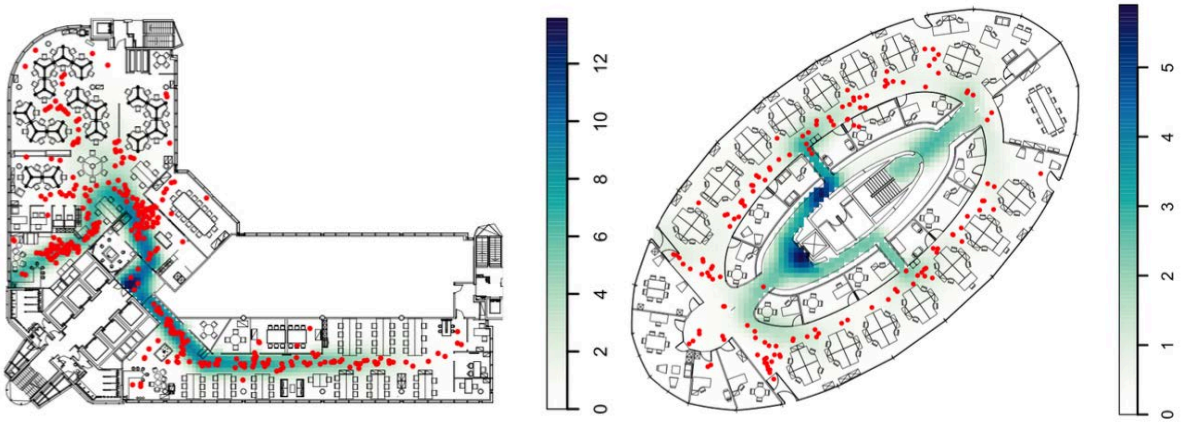
following that path. These cells are then assigned a value using a decay function i.e. one that decreases its value as the distance to the path increases. Finally, the process is carried out for every seat in the office space adding up the closest inverse distance to each path (fig. 2d). The result of this process is a new measurement for each cell, Travel Concentration (fig. 2e), a metric that is essentially a combination of the number of paths on which the cell was visible from, normalised by the distance from each path. Travel Concentration may be expressed using the formula:

$$TravelConcentration = \sum_{p=0}^{n} \frac{e^{\frac{-d(p,c)^2}{2\sigma^2}}}{2\sigma\pi}$$

where c is the cell for which the metric is calculated, p is a single path and d(p, c) the closest distance from the cell centre to the path, assuming they are inter-visible (0 otherwise). The formula is essentially the sum of a convolved gaussian of the path-cell minimum distance with window σ (as it appears in the formula) set to 1, taking into account all the paths from all the seats to the specified attractors.

5 ANALYSIS

Actual samples from the aforementioned dataset show that the method produces convincing results in some cases, but in others it is inadequate. Figure 3 shows two examples with (a) as a convincing case where movement (red dots) is mostly aligned with travel concentration (green/blue shades) and (b) as a non-convincing case where travel concentration appears unrelated to actual movement.



(a) (b)

Figure 3: Travel concentration (shades of green and blue) and movement (red dots) for the ground floor of case 61 (a) and the first floor of case 29 (b).

The new metric was tested against movement and interaction as aggregated for each floor in the whole sample, with the results shown in figure 4, and in comparison, to Visual Mean Depth (normalised for each site). In this and later analyses, floors where travel concentration was zero were removed from the analysis. As expected for travel concentration, movement (R^2 = 0.09) is

better predicted than interaction (R^2 = 0.05) with the results being highly significant in all cases. Effect sizes are small though, and even smaller than Visual Mean Depth as a metric on its own (movement R^2 = 0.17 and interaction R^2 = 0.10).

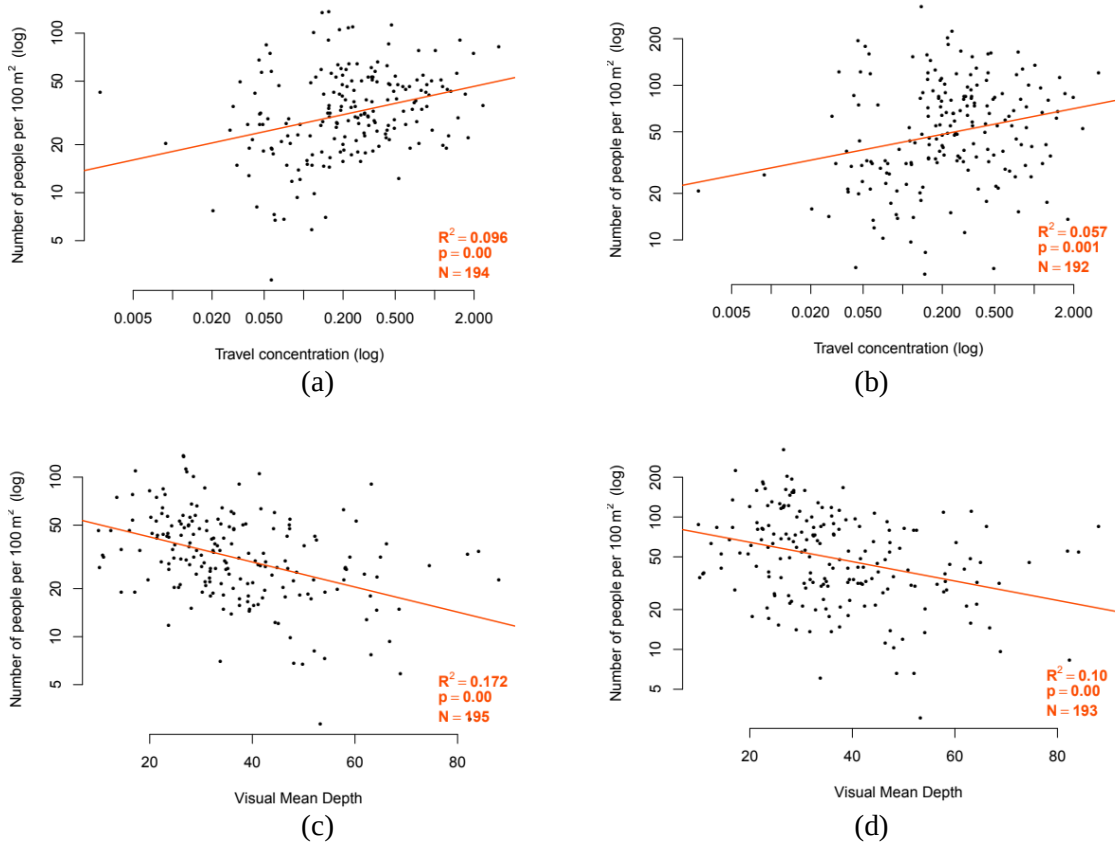
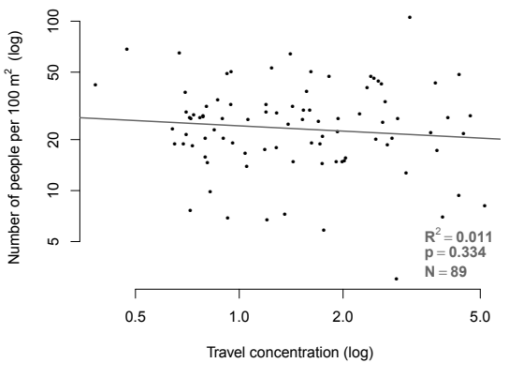
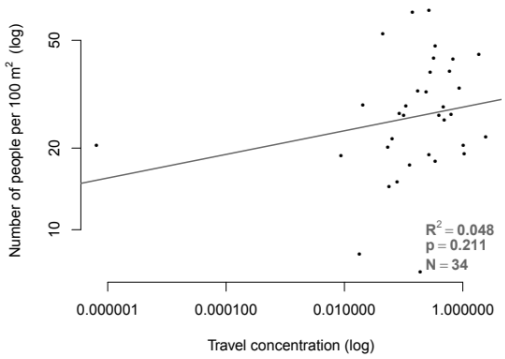


Figure 4: Mean travel concentration against movement density (a) and interaction density (b) for each floor in the sample. All scales except for Visual Mean Depth are logarithmic (base 10).

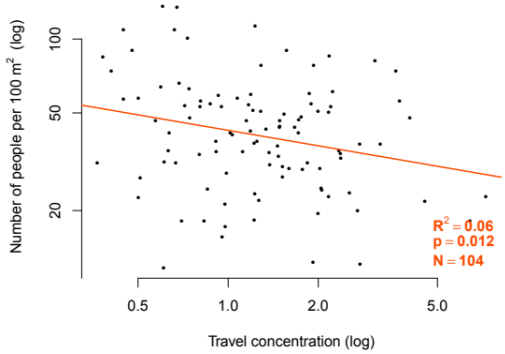
To further identify how travel concentration relates to movement, the sample of floors was split two ways. First, floors were split into two categories depending on whether they show high or low seat density (number of seats / total floor area) using the mean seat density (11 seats per 100 m^2). The second categorisation was done on each of the density splits, denoting whether the travel concentration came from within the floor or from outside. For example, all the paths of staff members that have a seat in a specific floor are collated to a separate in-floor travel concentration metric, while paths of staff members that came from a different floor were collated to an out-of-floor travel concentration metric. The aim with the second split was to separate trails towards attractors that are typically found on each floor (toilets, tea points) from the trails that lead to attractors that are sparse or unique to the building (canteens, entrances).



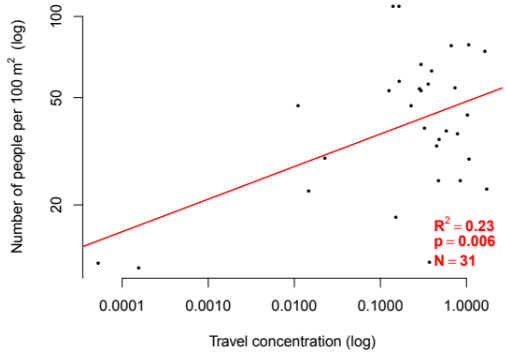
(a) Low seat density/within-floor



(b) Low seat density/out-of-floor



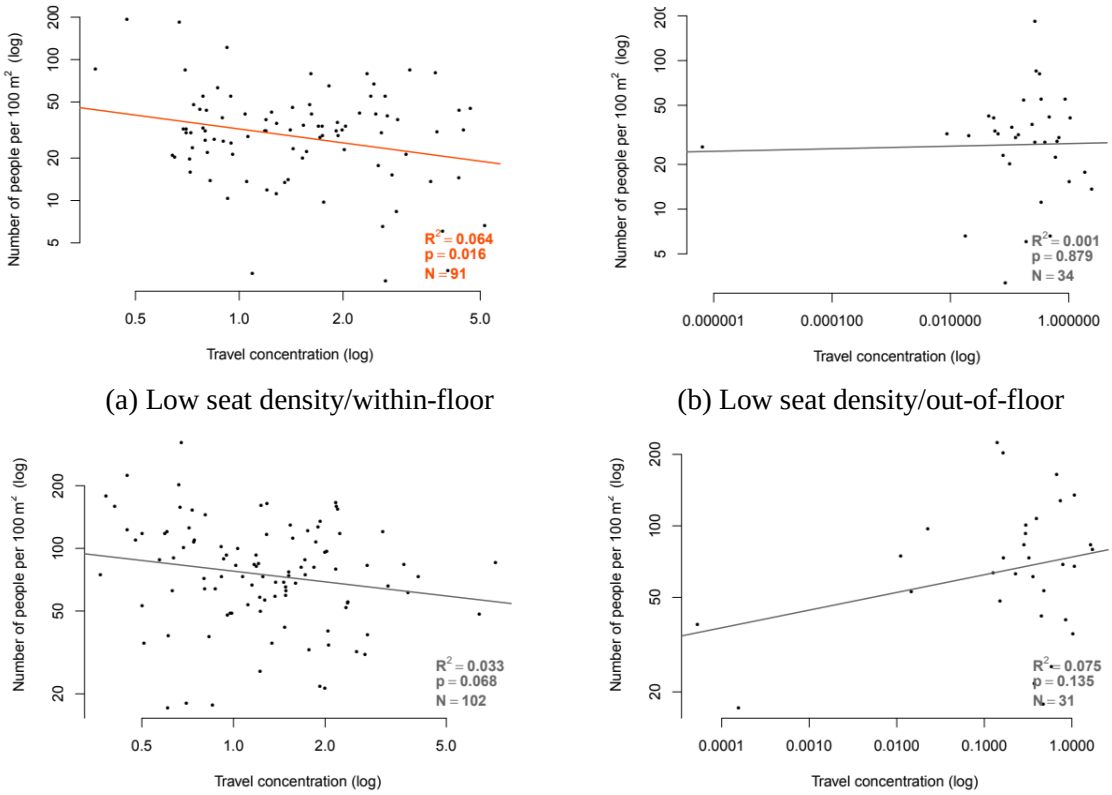
(c) High seat density/within-floor



(d) High seat density/out-of-floor

Figure 5: Mean travel concentration against movement density for each floor in the sample. Low seat density within-floor concentration (a) and out-of-floor concentration (b) and high seat density within floor (c) and out-of-floor (d). All scales are logarithmic (base 10).

The results from these splits are shown in figure 5. Generally, low seat-density floors (a, b) were harder to predict with insignificant results overall (p-value = 0.334 and 0.211 respectively), while high-density floors both have significant results either at the 0.05 significance level (c: p-value = 0.012) or the 0.01 level (d: p-value = 0.006 respectively). When it comes to high-density within-floor or out-of-floor travel concentration it appears that the latter more strongly predicts movement despite the smaller sample (N = 104 against 31 respectively). More specifically, high-density in-floor concentration (figure 5c) appears to be negative, i.e. floors with more common paths tended to attract fewer people moving. This is potentially due to confounding factors because the effect is not particularly strong (R^2 = 0.06). On the other hand, in high-density floors out-of-floor travel concentration (figure 5d) significantly predicts movement with a stronger effect (R^2 = 0.23). This is expected in floors that contain canteens and entrances because movement will follow specific common paths. For example, the paths of many staff members from other floors will include taking the stairs or elevator to the ground floor and going straight to the entrance thus creating a large concentration of paths from those stairs or elevators to that entrance. Given the strength of this effect it can be assumed that the earlier whole-sample results (figure 4) for movement are driven primarily from out-of-floor concentration.



(a) Low seat density/within-floor

(b) Low seat density/out-of-floor

(c) High seat density/within-floor

(d) High seat density/out-of-floor

Figure 6: Mean travel concentration against interaction density for each floor in the sample. Low seat density within-floor concentration (a) and out-of-floor concentration (b) and high seat density within floor (c) and out-of-floor (d). All scales are logarithmic (base 10).

The same splits were created for travel concentration against interaction, the results of which are presented in figure 6. In this case only the low-density in-floor concentration (figure 6a) was found to be a significant predictor of the activity density, though with a rather small effect (R^2 = 0.064). It is thus certain that other cofounding factors not taken into account are important for interaction. These results also agree with the general whole-sample results that interaction is a harder office-space activity to predict than movement purely using travel concentration.

Finally, table 1, shows all possible combinations of the four metrics (Travel Concentration total, in-floor and out-floor and Visual Mean Depth), for the full sample, only for high seat-density floors and only for low-density floors for movement and interaction. The results of the regression analyses show that by itself, the new metric does not perform better than Visual Mean Depth unless in highly specialised cases (movement and high seat-density out-of-floor concentration with R^2 = 0.23, also shown in figure 5d). However, in combination, the total Travel Concentration and Visual Mean Depth perform better at the level of the whole sample for both movement (R^2 = 0.22) and interaction (R^2 = 0.13) and best at the aforementioned highly specialised set of cases (R^2 = 0.32).

Behaviour	Movement						Interaction					
Sample	Full		High density		Low density		Full		High density		Low density	
	R^2	p	R^2	p	R^2	p	R^2	p	R^2	p	R^2	p
Travel concentration (log)	**0.10**	**0.00**	0.00	0.64	**0.10**	**0.00**	**0.06**	**0.00**	0.01	0.34	0.01	0.41
Travel concentration [In-floor] (log)	**0.04**	**0.00**	0.06	0.01	0.01	0.33	**0.07**	**0.00**	0.03	0.07	0.06	0.02
Travel concentration [Out-floor] (log)	0.04	0.11	**0.23**	**0.01**	0.05	0.21	0.03	0.18	0.08	0.13	0.00	0.88
Visual Mean Depth	**0.18**	**0.00**	**0.09**	**0.00**	**0.17**	**0.00**	**0.10**	**0.00**	0.04	0.04	0.05	0.04
Travel concentration (log) + Visual Mean Depth	**0.22**	**0.00**	0.07	0.01	**0.17**	**0.00**	**0.13**	**0.00**	0.06	0.02	0.05	0.04
Travel concentration [In-floor] (log) + Visual Mean Depth	**0.17**	**0.00**	**0.09**	**0.00**	**0.15**	**0.00**	**0.11**	**0.00**	0.05	0.04	0.07	0.02
Travel concentration [Out-floor] (log) + Visual Mean Depth	0.10	0.01	**0.32**	**0.00**	0.00	0.37	0.03	0.14	0.05	0.20	-0.05	0.81

Table 1: Multiple scenarios, showing the various combinations of using one of the Travel Concentration metrics or Visual Mean Depth, or a combination of those across the whole sample, for only high seat-density floors and for low seat-density floors, for movement and interaction. Models with high significance (p-value < 0.01) shown in red, while non-significant models (p-value > 0.05) shown in gray.

6 DISCUSSION AND CONCLUSION

This paper introduced a new spatial metric for the study of targeted movement in office spaces called Travel Concentration. It was shown that while similar endeavours were attempted, they were never tested on a large sample of workspaces and were applied to spatial models with low levels of detail. For this paper the metric was instead tested against a large sample of office spaces and in the grid-like representation typically used in the context of Visibility Graph Analysis. It was then shown that the metric is able to predict movement and interaction, albeit not particularly strongly throughout.

The few significant results from the splits according to seat density point at specific contexts the metric would work in, while in other cases provided future potential strategies for exploration. More specifically it was found that when there is a clear common travelling trajectory for most of the staff members (from their seat to the building entrance or a canteen) then the travel concentration provides a good approximation for movement. Weaker but still significant effects were found in cases of high-density floors and in-floor concentration and movement. The combinations with Visual Mean Depth proved successful in some cases indicating that the metric could be a useful addition to a larger set of metrics in regressions with multiple variables. In a similar vein, the relationship between the metric and interaction was only found significant at the low seat-density floor group also pointing to the need for more elements of spatial configuration to be taken into account.

Such additional elements of spatial configuration will be examined in future steps in this research allowing thus for more robust predictions of activity to emerge. To attain a more complete set of factors, building-wide metrics from the field of space syntax will be included such as metric depth, but also more metrics that measure local properties of space such as the distances to barriers and other potentials, many of which we have described in a recent publication (Koutsolampros et al., 2019). Beyond new metrics however, future research will aim to build robust spatial models that properly capture the nuances of spatial configuration, but also allow for understanding how that spatial configuration relates to human behaviour and how their combination can be employed to feed evidence back into the design process.

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SESSION 14: QUALITY OF OFFICE SPACES

Creating need-supply fit affordances in knowledge work environments through user-centred design processes

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ABSTRACT

Academical research on knowledge work environments often focuses on gathering knowledge on user-experiences and various measurable factors. Current research acknowledges the holistic and the complex nature of knowledge work environments, the employees' task-related needs, and the individuals' characteristics. Nevertheless, the link between knowledge work environment research and their design is still relatively weak. We explore workplace design through a participatory design process. The user-centred design approach revealed practical links between the environmental elements and employees' needs to support the design process. Participants explored three work situations, which varied on the level of interaction and task-complexity. The outcome of this exercise revealed distinctly different needs in explored situations in terms of privacy, exposure, mood and atmosphere. We used this information to generate design aims and affordances that support different task-related functional needs. The designed affordances are presented as a traditional floorplan, but also through affordance mapping. This descriptive analysis of implemented affordances reveals the designed entities of architectural and interior elements through instrumental, symbolic and aesthetic dimensions. In addition to the functionality of instrumental dimension, the symbolic and aesthetic dimensions may have a substantial impact on employees' decisions to actively re-locate in between the tasks and to experience improved satisfaction towards their work environment. We propose that the emerging data from design processes and affordance mapping of existing work environments could inform both workplace design and research on implicit ways in which to support the employees' need-supply fit and environmental satisfaction.

Keywords

Workplace design, participatory design, need-supply fit, user-centred design, affordance mapping

1 INTRODUCTION

Time- and location-independent working (Van Yperen et al., 2014) has created a shift from work environments with dedicated workstations and private offices into flexible and activity-based work environments, thus providing an opportunity for the employees to choose from different workstations and workspaces. These changes have set new challenges for workplace design processes. The new workplace typologies support different individual and collaborative tasks through implementing various available open or enclosed workspaces (Bodin Danielsson & Bodin, 2008; Boutellier et al., 2008; Appel-Meulenbroek et al., 2011; Wohlers & Hertel, 2017). Depending on the task complexity, different individual and collaborative tasks require different social dimensions that are supported by the physical work environment. The environmental structures, elements and layout can either protect, allow or even promote exposure to different distractions and stimuli (Heerwagen et al., 2004).

The office layout (e.g. single-cell office, shared office, open-plan office, combi-office and flexi/activity-based office) is a dominant factor when different outcomes, such as satisfaction, of work environments, are measured (Bodin Danielsson & Bodin, 2008; Bodin Danielsson, 2019). By definition, the employees' satisfaction towards their work environment is dependent on the extent to which the physical work environment meets the employees' needs (Van der Voordt, 2004). Also, the employees' tendency to switch between workstations and workspaces influences satisfaction towards their environment in a positive way (Hoendervanger et al., 2016). Comparative research focusing on the same office typologies, such as activity-based work environments, has revealed conflicting outcomes (Brunia et al., 2016; Colenberg et al., 2020). From a design perspective, a linking factor appears to be the level of openness of space and space division, which both affect the employees' sense of privacy and social interaction (Brunia et al., 2016; Hoendervanger et al., 2018). Moreover, the unique arrangements of architectural and interior design elements, and ambient factors create combinations, which support or hinder employees' satisfaction towards their environment in a complex manner (De Been et al., 2014; Brunia et al., 2016; Bodin Danielsson, 2019; Colenberg et al., 2020).

Our focus in this short paper is to show how employees can produce information for the design process through a participatory design approach. The recent knowledge work environment studies discuss person-environment fit theory (Edwards et al., 1998). Modification of this theory, the need-supply fit model (Kristof-Brown et al., 2005), describes the match between the needs of the person and the supplies of the environment. The different workspaces must provide the appropriate physical and functional conditions (such as privacy) that match the specific needs that different tasks require to create the fit. Through different workspaces, an activity-based flexible office may support the need-supply fit and, thus, increase employees' satisfaction towards their environment, decrease distractions and increase interaction (Gerdenitsch et al., 2008).

In this study, we describe the results of the design process through a three-part framework of instrumental, symbolic and aesthetic dimensions of the environment (Rafaeli & Vilnai-Yavetz, 2004; Vilnai-Yavetz et al., 2005; Elsbach & Pratt, 2007). Instrumentality refers to the extent to which the artefact or their arrangement contribute to performance or to promoting goals (Rafaeli & Vilnai-Yavetz, 2004; Elsbach & Pratt, 2007). This dimension is closely related to affordances, the ability of the environment to support the desired activities (Gibson, 2015; Maier et al., 2009). In the context of an office environment, a chair can be a single artefact, or it can create an affordance for sitting. The instrumental dimension extends into a workstation, an entity of a

chair, table and appropriate tools, that, together, form an affordance for working. Also, the work environment layout and its enclosed and open spaces belong to an instrumental dimension (Rafaeli & Vilnai-Yavetz, 2004; Elsbach & Stigliani, 2019). The aesthetic dimension consists of elements, such as colours, textures, forms, and complexity of their arrangement, which, together, create a sensory experience and influence the attractiveness of a space (Rafaeli & Vilnai-Yavetz, 2004; Sander et al., 2014). The third dimension, symbolic, elicits the meaning or associations (Rafaeli & Vilnai-Yavetz, 2004; Elsbach & Stigliani, 2019). Symbolic dimension is interesting, as it can convey how space could be used, for example, different furniture settings may convey a message of formality or playfulness, thus affecting the form of collaboration. Understanding the different environmental dimensions is essential, as research of activity-based flexible offices shows that employees prefer desirable and functional workstations over those that are undesirable, an attribute consisting of functional, social, emotional and symbolic features of the workspaces (Babapour Chafi et al., 2020).

Participation in design and decision processes enforces environmental comfort, and it can help users to cope with the environmental demands, and importantly, encourages the users to find new ways to solve environmental problems (Vischer, 2008). In this study, we explore the work environment through user-centred design processes, where participants of the study were encouraged to think of different work-related situations and the optimal surroundings. The generated information was used to guide the design process. The design outcomes are described through action supporting affordances in addition to their instrumental, symbolic, and aesthetic dimensions.

2 METHODS

Participatory design process consists of establishing a real-life problem situation, gathering information that will aid in understanding organizational practices, and identifying the needs and wishes of participants, with following testing and evaluation of new design (Bratteteig et al., 2013). When the future users of the design are given the "experience expert" positions, they can influence the idea generation, knowledge development, and the final design outcomes. Nevertheless, designers have an essential role in providing tools for ideation and expression in a co-design process. For the final design, the designers play a critical role in form-giving to the ideas and their implementation (Sanders & Stappers, 2008).

2.1 Study setup

The methods and results presented in this paper are part of a more extensive study. The methodological framework and parts of the study, such as lighting design, have been presented elsewhere (Markkanen et al., 2017; Markkanen & Herneoja, 2018). In this paper, the focus is on the user-centred participatory design process, its results and the generated design.

The study was organized in an ICT-startup-company located in Northern Finland. Company actively recruited new employees during the study. Therefore, the design area presented in this paper represents the overall area which the company discussed renting at the time of design. However, in the later phases of the study, the area available for intervention and its evaluation consisted of Room 1 with the informal meeting area and Room 2. This case study presents an example of a team office (Duffy & Powell, 1997; Bodin Danielsson & Bodin, 2008) with assigned workstations. However, there was a distinct need for task-appropriate spaces to support

concentration and collaboration, which are typical needs in work environments. Thus, the methods are applicable for larger contemporary work environments, such as activity-based offices.

2.2 Participatory design process

First, voluntary participants (n = 5) were invited to participate in a semi-structured interview. The interviews were held in the company's premises after a workday to support privacy and they lasted, on average, 60 min. The interview questions addressed the following themes: 1) job descriptions, daily tasks and habits, 2) current workspaces, their privacy and collaboration opportunities, 3) production of new knowledge in the organization, and 4) dream office. The interviews were audio-recorded and transcribed. The transcribes were iteratively read to identify different tasks, daily habits and situations, and the needs, to support the design process.

Second, the participants were invited to a participatory design workshop (n = 3). Participants explored different events and atmospheres in terms of activities, experiences and feelings. The workshop was structured as follows: First, as a warm-up exercise, the participants were asked individually to explore their "favourite place" outside work. Second, the participants were asked to describe their "perfect workday". Third, the results of the first two assignments were discussed, and different daily activities were collected on post-it notes. For the third assignment, the participants were asked to select three different often occurring situations and to explore them with the following prompts: *What is the space like? What is the atmosphere like? How do you feel in the situation?* Participants were also instructed to use the places, the atmospheres and the moods discovered in the previous tasks. After completing the third tasks, participants were asked to explore how their "dream office" would support these situations. Participants used different floorplans and print-out furniture to help the ideation process and describe their dream workspaces for explored situations. The workshop was audio- and video-recorded.

Third, the results of the workshop and the intervention space were analysed and documented. Based on the results, the design aims were formed and implemented in the design. Also, new affordances designed to the work environment were mapped and described.

3 RESULTS

The case organisation operates in the field of ICT services. The following task-groups emerged from the qualitative content analysis of interviews and the workshop: 1. Project work: teamwork consisting of individual work with collaborative planning and problem-solving. 2. Client communication: project development and different delivery processes. 3. Communication and marketing: collaborative ideation and planning processes followed by individual task completion. 4. Management: collaborative and individual tasks with high requirements for privacy. 5. Recruitment processes: contacting people, application management, interviewing recruits, and initiation guidance.

3.1 User-centred understanding of task-related needs through the participatory design process

Workshop participants identified the following situations concerning individual work: 1) "Concentration intensive work and demanding problem solving" that requires distraction-free environment. 2) "Together alone", during which occasional help in problem-solving or knowledge sharing was necessary for efficient work. 3) "Task completion", during which

participants finished their tasks. The collaborative work situations varied in terms of how many people participated and the length: 1) Ad hoc problem solving, (see "Together alone"), where two participants briefly collaborate to find a solution to an emerging problem. 2) Collaborative work, during which participants work together on a predetermined problem or task. 3) Team meetings and daily morning meetings for general knowledge sharing. The client communication situations typically occurred through virtual connections, either phone or video conference calls. Also, different recovery situations, such as lunch and coffee breaks, were brought up.

Table 1 Results from the participatory design workshop

Situation	*Collaboration and privacy*	*Atmosphere and mood*	*Description of "dream office"*
Demanding problem solving alone	Individual work High need for privacy and distraction-free environment	The atmosphere is peaceful, calm and light. Focus is effortless to attain and maintain.	The space has a sense of spaciousness of a mountain or a sea. Spaciousness can be achieved with a glass wall. Workstations have outdoor views, preferably of nature. They are separated by acoustic partitions and partitions walls. The space is easy to access, and there is a sense of control of the space and the use of time. The colours are neutral and light. Lighting can be controlled: options for dim and bright light.
Brainstorming and collaborative problem solving	Collaborative work Low need for privacy and distraction-free environment Participants can join the discussion and leave whenever they feel like it	The atmosphere is free, relaxed, playful, and joyous. There is a sense of togetherness, achieving together, and trust. There is a freedom to present "flying ideas and stupid ideas". There is no schedule or goal.	The space is loud and informal; it is free-form and multifunctional. The view behind the glass wall is that of a big lively city. There is a lounge-style sofa corner with a screen, game console and fireplace. There is a high table with bar chairs and a whiteboard to visualise ideas. Space should have an option to exercise. The space is easily accessible, and people can come and go as they please. The environment is visually rich and stimulating. The lighting is controllable by different areas in the space.
Remote client meeting with a set schedule and goal	One or more participants High need for privacy and a distraction-free environment. Conversation through the conference- or video-call	The focus level is intense. The situation requires problem-solving "on the go". The mood ranges from "despair to satisfaction". There is a schedule and a goal.	The space is calm and gives a positive impression of the organization for the client and can be used as a meeting room. The space is enclosed and distraction-free to create a suitable environment for discussion with clients. The tools include videoconference facilities, computer and headphones. The functionality of the equipment is essential. There are single-person workstations with suitable privacy for videoconferences.

Next, the workshop participants were asked to choose three situations to discuss in terms of mood and atmosphere in space. Finally, participants were encouraged to ideate the work environment for these situations. The selected situations and analysed participant discussions during the workshop are presented in Table 1.

3.2 Designing new affordances to support need-supply fit formation

The workshop generated a rich material for the design process with distinct elements applicable to the three-part framework of instrumental, symbolic, and aesthetic dimensions. For the design process, the interviews and workshop results were iteratively studied and derived into design aims: 1) Support individual work through increased auditory and visual privacy and create an option to withdraw to different space. 2) Support *ad hoc* problem solving and collaboration through a face-to-face seating arrangement and additional workstations with visualization tools. 3) Support collaboration and brainstorming through a space that supports freeform discussions and idea visualisation. 4) Support client communication through a space suitable for on-site and virtual meetings. Also, we aimed to 5) improve lighting and 6) acoustic properties of the environment.

The aims were implemented in the design presented in Figure 1. Each space was designed to support a different level of privacy and collaboration to support different needs. The workspaces were given names to communicate different spaces with the participants, the Forest, the Park, the City and the Mountain Cabin. The different affordances generated during the design process are listed in Table 2, and their instrumental, symbolic and aesthetic dimensions are described.

Table 2: Designed environmental features and affordance mapping

	Affordances	**Instrumental dimension**	**Symbolic dimension**	**Aesthetic dimension**
Room 1	Face-to-face seating arrangement to promote awareness and ad hoc problem solving (1) Visualisation tools and furniture to promote collaboration (2)	The face-to-face seating arrangement of workstations with high visibility Separate workstation set up for brief problem-solving events Visualisation board Separated from informal meeting area with a curtain	"Forest" Casual and home-like	Rich to support a comfortable and home-like atmosphere Curtains with autumnal colours (greys, green, orange, purple) Colourful carpets
Room 2	Multitenant workspace supporting focused work (3) Increased visual privacy for confidential tasks (4) Visualisation tools (2)	The face-to-face seating arrangement of workstations with high partitions for increased privacy Visualisation board	"Park" Peaceful, calm and light	Lean-to support the calm atmosphere Soft green wall and plywood tree Partitions different shades of green and blue
Room 3	Workstations for high focus work (5) Workspace for meetings and collaboration (6) Workspace for individual and group phone meetings and videoconference meetings (7)	Enclosed and distraction-free space Workstations with high partitions for focused individual work High meeting table for collaboration Tools for videoconference meetings Wall-mounted drawing board	"City" Formal and calm	Lean to support formal atmosphere Muted colours Wall-mounted drawing board with city view
Informal meeting area	Workspace for group meetings (8) Recovery area (9)	Separated from Room 1 with a curtain Couch, chairs and rocking chairs	"Mountain cabin" Playful and	Rich and colourful to support a playful atmosphere

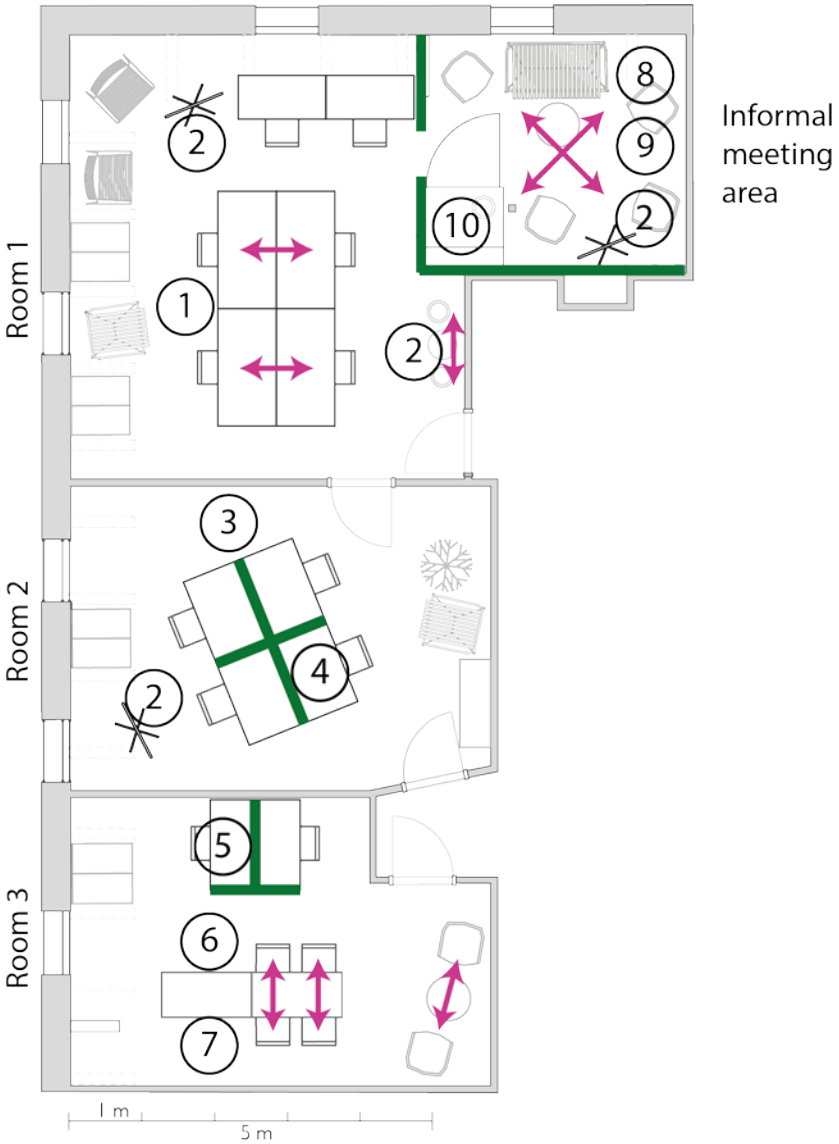
	Phonebooth for phone meetings (10) Visualisation tools (2)	with side tables Wall-mounted drawing board for problem-solving Phonebooth for individual phone meetings	relaxed	Wall-mounted drawing board with nature visualisation

4 DISCUSSION

To respond to needs and emerging problems in knowledge work environments, more information is needed on how the need-supply fit is formed in relation to employees' activities. There appears to be a gap in knowledge concerning the design processes, but also in the detailed analysis of studied office environments (Brunia et al., 2016; Gjerland et al., 2019; Colenberg et al., 2020). It has been shown that employees perceive their fit in a particular environment through a combination of their activity, work setting and personal need for privacy (Hoendervanger et al., 2019). For need-supply fit to occur, for example, in activity-based work environments, employees need to actively switch between the different work settings to find and utilize the right fit (Hoendervanger et al., 2016). Approaching the need-supply fit formation from participatory design and workplace design perspectives may improve our understanding of workspaces that support employees to find the right fit and, thus, improving employees' environmental satisfaction.

The needs described by the participants of this study were distinctively different in terms of privacy, interaction, exposure, mood, and atmosphere for situations of concentration intensive work, brainstorming, and virtual communication with the clients. Different needs regarding the level of privacy, collaboration, and atmosphere were used to guide the design on an instrumental, symbolic, and aesthetic level. On an instrumental level, the sense of privacy and the level of exposure set important limits for the design. Although the spaces described in the workshop were not implemented as such to the design due to the limitations of existing premises, the key features and dimensions were included in the different affordances. The model presented in Figure 2 shows the roles of users and designers in creating need-supply fit forming affordances. Users inform the design process of their task-related needs, which designers interpret and implement into the design.

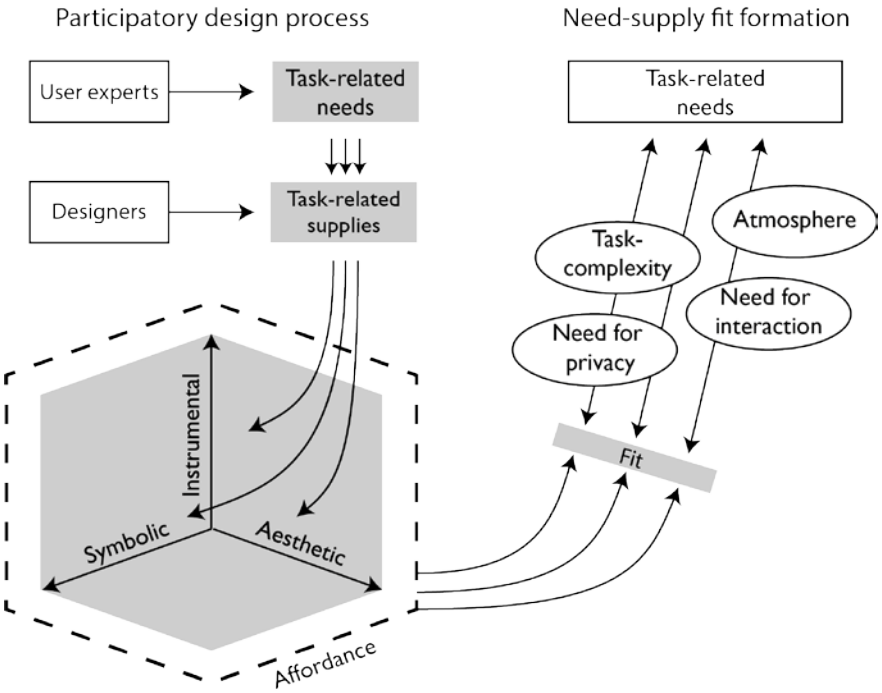
Figure 1. The floorplan and mapping of the participatory design process motivated affordances. The increased awareness and collaboration supporting settings are indicated with pink arrows and increased visual privacy supporting settings with green lines. The descriptions of numbered affordances are presented in Table 2.



In addition to presenting the results of the design phase of this study as a detailed floorplan (Figure 1), the affordances and their instrumental, symbolic and aesthetic dimensions are described (Table 2). The affordance mapping (Koutamanis, 2006) with descriptive analysis can also be applied to existing work environments. Linking the environment to its activities in a contextual manner might improve our understanding of which affordances support or hinder different activities and what features are integral for need-supply fit formation. Although the small number of the participants sets limitations on the participatory design phase of this study and its results, the presented process of designing, describing, and analysing affordances is an important addition to the ways how researchers and practitioners can study and discuss knowledge work environments. A similar approach of artefact analysis (functional, emotional, symbolic, aesthetic, physical structure and stimuli) was used in a study of activity-based flexible

offices to understand workstation preferences (Babapour Chafi et al., 2020). While the instrumental dimension supports the functional requirements of different activities, the symbolic and aesthetic dimension may influence users to switch more actively and enable them to find affordances that support their personal and instrumental needs. Furthermore, the symbolic dimension may convey the information for which activities are supported by the affordances implemented in the space. Future research is recommended to investigate task-related needs beyond the instrumental level. Understanding the impact of symbolic and aesthetic dimensions in workplace design may reveal tools with which to promote employee well-being and need-supply fit formation.

Figure 2. User-informed design of task-supporting affordances supports task-related need-supply fit formation.



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Cultural values and its influence on future workplaces. An analysis of religious values in working environments

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ABSTRACT

The internationalisation in many companies and projects requires a better understanding of working conditions in different cultures to enable an enhanced integration of employees in foreign working environments. Nevertheless, there are boundary conditions in each country, which leads to different workplace strategies and workplace conditions. This will be analysed through the comparison of cultural values, particularly religion, which is one relevant characteristic of cultures across the globe. Therefore, relevant literature and existing legal frameworks in Europe and the United States of America for employee rights protection regarding religious discrimination are examined and appropriate measures for an internationally accepted working approach are deducted. The imprint of cultural values is a very strong frame for employees and their working habits. Especially the working conditions in Western countries are highly influenced by Christian standards. Although there are many clear traditional limitations, most countries can develop their individual and original "open space" experimental fields, which differ substantially from country to country. Therefore, workplace strategies need to be designed according to cultural characteristics and uniform working terms are necessary to create equal working conditions for employees from all cultural backgrounds. The line of discussion is focused on the balance or imbalance between convergence to an internationally accepted and equalised way of working and workplaces to promote the well-being of foreigners in multinational companies.

Keywords

Equality, workplace, multinational, culture, religion.

1 INTRODUCTION

In times of globalisation, migration, low birth rates, and the shortage of specialists, industry faces new challenges. Europe`s growing demand for highly skilled professionals and the increase of

young European professionals who emigrate to Asian countries put at risk the future of the European economies. Despite language barriers, wealthy countries like Singapore and Japan as well as countries on western continents attract career-orientated experts from all over the world (Helena, 2017). Apart from that, the continued immigration of people with different backgrounds in terms of culture and religion may be a solution to meet the European labour needs and to counteract the issue of population decline. Due to the inevitable further globalisation of human activities in diverse areas, younger generations will have to consider immigration strategies more carefully to meet the increasing demands of mobility between countries and continents (Avramov, 2016).

Therefore, understanding employee integration into different cultural environments becomes more and more essential, and cross-cultural competence is becoming a requirement. In this context, maintaining an engaging international workforce as well as protecting and improving the well-being and job satisfaction of foreign employees requires the transformation and accommodation of the working environment (Avramov, 2016). Consequently, more attention needs to be paid to how workplace designs can engage international employees and how to create a sense of well-being in the working environments for them. Workplace strategies need to be designed according to different cultures and their working conditions (Francis, 2013).

Existing studies are dealing with the creation of equal workplace conditions and the integration of individuals in working environments by focusing on the agreement of cultural values and corporate identities on a management level. An implicit element within this literature represents an adjustment to the work environment upon migration, which can contribute to overcoming barriers and avoid conflicts between different cultural affiliations. While there is available literature on the adjustment of individuals to avoid discrimination (Hirt, 2017), the literature on workplace designs that reflects the culture of their occupants to promote well-being in multinational companies has not been fully investigated.

This paper aims to define existing potentials for including cultural identities in workplace strategies and workplace design processes to create a basis for discussion of multicultural working environments, which encourages the integration and well-being of highly skilled foreigners. The author defines cultural values based on religion and analyses the correlation between religious and occupational identities within legal frameworks. Therefore, relevant literature and general laws in Europe and the United States of America for employee rights protection regarding equality and religious discrimination are examined. As a result, feasible workplace strategy approaches to support the expression of religious identities at the office are deducted and possibilities for further researches to generate new knowledge about different cultural perspectives are outlined.

2 CULTURE, RELIGION, AND WORKPLACE

Different interpretations of the term culture have been given in the existing literature. However, the majority defines culture as a result of “values” and “practices” (Hofstede, 2010). Therefore, people can be clustered according to different aspects, such as nationality, region, gender, generation, social class, and organisational level (Hofstede, 2010). Furthermore, religion, linguistic, and other characteristics regarding culture exist and are defined in the common literature.

In the context of the workplace, organisational cultural models take culture into account. One example of these approaches is the layer model, which divides the organisational culture into three superimposed layers (Schein, 2004). Here, the first and lowest layer, known as "assumption", describes the inner feelings and interactions of peoples. The second level represents the "values" and describes the strategies, goals, philosophy, and justification of a company. The "artefacts" layer includes all the visible external influences like clothing, language, layout, and design as well as the location of a building. In terms of an international workplace approach, the latter layer has a special significance as it can differ from country to country.

Following, both above-mentioned approaches explain religion as a factor to define different cultures. While Hofstede describes religion as an important characteristic to cluster culture, Schein uses the term in the description of the "artefact" layer of visible external elements, which can be seen in a religious context, e.g. concerning the appropriate or inappropriate religious dress codes. Thus, the role and position of religion and religious identity can be assumed as an important factor to define cultures and therefore derive potential needs for future workplace strategies, not least because religious claims are often in line with other rights and interests.

The necessity of an updated workplace concept with cultures in mind is illustrated by the increase of religious diversity in Europe and the fast-growing societies where Hinduism, Islam, and Buddhism form the majority. Today three of the top five economies are Christian influenced, whereas only one is predicted to remain in the ranking of the strongest economies in 2050 (Pew Research Center, 2015). This change of the global marketplace implies the need for workplace adjustments according to the expected cultural changes it involves.

In addition to the integration aspect, recent studies concluded that religious beliefs can affect the working practice and the mental health of the employee. Several investigations conducted in the service industry showed that employees of companies that promote the expression of religious practice enhance occupational identity and productivity. Conversely, it means that identity disruption and conflicts can occur when values are not aligned (Héliot, 2019). Other researchers found a negative relation between the religious practice at work and mental stress but a positive relation to job satisfaction, organisational citizenship behaviour, and commitment (Kutcher, 2010).

According to a survey that was carried out among young Europeans in 2013, the majority of those questioned considered cross-cultural intelligence and the ability to work in a multicultural environment as main skills in the labour market (Francis, 2013). Another survey confirms the openness of the upcoming generations to people from other cultures. Thus, 64% of those questioned have close friends with other religious backgrounds. The results of the questionnaire indicate additional discrepancies between countries of immigration and emigration. In average around 76% of the surveyed 15-21-year-olds from growing or developing countries like Indonesia, Nigeria, Turkey, China, India, Brazil claimed that religious faith is important to their happiness compared to about 26% of the classical immigration countries such as Japan, South Korea, Canada, USA, Australia, Germany, France, and the UK (Broadbent, 2017). Therefore, it can be concluded that the expression of religious identity at the workplace contributes to a sense of well-being, especially for immigrants from emigration countries.

This highlights the relevance of cultural identity and religious expression at workplaces; why a homogeneous balance between various company and cultural values, factors, and perspectives

needs to be found (Katalayou, Foblets, Vrielink, 2012). Hence, the challenge is how to bring several religions into a multinational workplace as a factor of promoting integration and well-being of every employee equally as they differ in their daily religious practices, concerning the outer appearance, behavior toward third parties, prayer rituals and times as well as eating and drinking habits. To assess religion as a representative coefficient of culture, the following section focuses on existing legal frameworks in Europe and the United States of America to estimate the current situation of employees, who face conflicts between professional and religious obligations.

3 LEGAL FRAMEWORKS AS A FACTORS FOR EQUALITY IN MULTICULTURAL WORKING ENVIRONMENTS

The chapter describes the issue of religious diversity and its impact on workplaces. This presents questions on, e.g. how religious dress should be accommodated in the office, and the extent to which organisations with a religious ethos should be allowed to require religious adherence from those they employ (Katalayou, Foblets, Vrielink, 2012). The freedom of religion is a fundamental human right, which unites cultures across the globe and represents the basis for a democratic system. So the question arises of how this is considered in legal frameworks and today's workplace designs?

Cultural identity embodied the diversity in workplaces and displays not only visible external signifiers on the "artefact" layer, such as the wearing of a hijab, kippah, or turban by Muslims, Jews or Sikhs. Visible features were debated publicly in the 1980s and have lost none of its importance to date (Héliot, 2019). Another factor of the impact of religion in the workplace shows the working times and holidays. The traditional working year in Western countries includes holidays on Sundays, Christmas, and Easter, which enables Christian believers to take time off for religious purposes. Therefore, in the given working environment, Christian employees can comply easily with religious accommodations in terms of dress codes as well as daily prayer and fasting times while other religious groups need to adopt certain behaviours or deal with renouncement. (Katalayou, Foblets, Vrielink, 2012). Consequently, the formal equality of rules does not achieve equality in daily practice. The Home Office Research Study from the year 2001 shows that there were relations between certain religions and disadvantages in the labour market. Further, the research indicates that before the implementation of employment protection against religious discrimination, the labour market has suffered unfair treatment (Weller, 2001).

Current frameworks like the EU Directive or the permanently updated Title VII of the Civil Rights Act of 1964 focus more on invisible identities or religious accommodation, like religious holidays, prayer times, and rooms to eliminate conflicts between religious practice and work requirements and does not cause undue hardship for the employer. The employer does not have to provide specific accommodation for an employee, as long as they have reasonably accommodated the religious needs of the employee. This effort would exceed ordinary administrative workplace costs. The Federal law in the U. S. applies only to companies with more than 15 employees, while many state laws ensure the protection of employees in smaller enterprises. Although the number of Americans who do not identify with any religion raised from 8% in 1990 up to 21% in 2014 the number of acts under Title VII of the 1964 Civil Rights Act increased in the same period from 1.709 to 3.549 (www.wharton.upenn.edu, 2015).

In Europe, two different legal frameworks exist that deal with equality cases. On one hand, the European Court of Justice (ECJ) determines cases of religious discrimination at workplaces under the EU Directive 2000/78. On the other, the ECHR (European Court of Human Rights) determines cases involving religious human rights claims (Katalayou, Foblets, Vrielink, 2012).

Any case regarding religious discrimination will be determined under one of these legal systems, which makes dealing with religious beliefs or practices at work more complex and non-transparent.

Furthermore, there are various other regulations regarding the protection for religious rights, like The International Covenant on Civil and Political Rights (ICCPR) or the European Social Chapter but none of them refers directly to a workplace context (Katalayou, Foblets, Vrielink, 2012).

The impact of the EU Directive is analysed by using some appropriate cases. In the UK, a classroom assistant wanted to wear a face veil when she was in the classroom with a male teacher. After she refused to remove the veil, she was suspended. The Employment Appeal Tribunal (EAT) decided that the treatment could have been indirect discrimination and that Muslims face a disadvantage compared to others due to the need of showing the face (Kirklees, 2007). Another example occurred in the Netherlands, where a female Muslim teacher was suspended for refusing to shake hands on religious grounds. The Equal Treatment Commission (ETC) decided that this cannot be seen as indirect discrimination (Civil Court Utrecht, 2007). In 2013, the ECHR held that employers need not accommodate individual requests to pray at work. The current legislation frequently reacts too sensitively to the disadvantages one group incurs relatively to others (Héliot, 2019). Already, the heterogeneous outcomes of these samples of legal cases in the aforementioned European countries show the ongoing difficulties courts face in dealing with religious diversity in the workplace.

By translating religious needs into legal frameworks, the multicultural work environment and the expression of cultural values at workplaces are promoted in Western countries (Katalayou, Foblets, Vrielink, 2012). However, the comparison of the legal cases shows the uncertainty in the execution of the legal requirements and leaves space for interpretations.

4 CONCLUSION

This work shows that religion can be seen as a factor of cultural identity and should be taken more into account in future workplace approaches to promote a cross-cultural work environment. Adjustments to multicultural workplace concepts in terms of promoting cultural values will become an important factor for facing the new challenges of globalisation and growing diversity. This would engage the integration process and therefore the well-being of foreigners in a globalised world of employment.

Nowadays, legal frameworks are in place to protect the individual from religious and cultural discrimination at the workplace and engage the employer to provide religious accommodation for his employees. The reviewed literature shows, on one hand, strong evidence that integration of religious values tends to be beneficial for the mental health as well as the well-being of the individual and strengthening their bond to the organisation (Héliot, 2019). Further, new

generations are already aware of the importance of cross-cultural competences and are open-minded towards cultural exchange. Consequently, it can be assumed that the integration of cultural values in workplace strategies or design processes can engage an international workforce and improve the well-being of all employees in multicultural companies, especially of immigrants from emigration countries.

On the other, the literature illustrates negative effects caused by non-harmonised corporate and religious identities as well as a lack of clarity or complexity of the existing legal provisions. Nevertheless, the paper displays the existence of a discrepancy between the demand for equality and the current working conditions of the Western countries, which are highly influenced by Christian standards. The need for multicultural workplaces is evident in the light of the above-mentioned factors, such as the increasing religious diversity in Europe as well as the rapidly growing population of non-Christian key economic countries and the ongoing globalisation.

Therefore, it is needful to think about the implementation of cultural values in the workplace strategy process within legal frameworks to create equal work conditions and encourage the integration of foreigners. Approaches for simple implementation in existing workplace designs could be the providing of a common meditation space as well as flexible time and holiday policies. This could be achieved by the integration of flexible workplace concepts such as home-office/telework or trust-based-working hours. Flexible conditions can be interpreted as basis approach for a multicultural workplace design where everyone derives equal benefit in terms of workplace location and schedules. However, with the increase of flexibility, the levels of self-organisation and responsibility are growing as well and could lead to mental stress or isolation. An alternative is job-sharing concepts, where one position is divided between several employees. Therefore, mutual agreements on working hours and close coordination between the employees regarding working processes are necessary and can enhance flexibility and engaging the integration of immigrants by intercultural exchange (Gawlik, 2018). As many religious minorities practising fasting or are subject to other dietary restrictions the offer of suitable dishes can build bridges and avoid feelings of discomfort (ENAR, 2015). Another measure within a religious-identity-supporting workplace design could be a separate storage room for ceremonial objects and a suitable restroom for washing. Further potential is to be found in terms of smart solutions. For instance, large companies with irregularly used conference rooms could implement applications to check availabilities and give religious employees the possibility to book and use the spaces for religious purposes. Further, they can communicate with colleagues through the app to discuss job assignments and working schedules. As a result, a religious extension of existing building applications could enhance the cultural identity of multinational companies. It is important to mention that the human resource department and change management has an important role in balancing religious accommodation and job demands during the implementation of such measures but have not been in the focus of the presented work.

This paper aimed to find potentials of the implementation of culture in form of religious values in the workplace strategy and design process to increase the well-being of high skilled foreigners to stay competitive in an international labour market. Nonetheless, significant research gaps remain and the paper shows great potential for further analysis. As the majority of literature is dealing with leadership methods and the management of religious conflicts, the integration of religion in workplace strategy and design processes needs closer consideration. An appropriate method to gain knowledge regarding the different cultural perspectives and needs could be a

qualitative assessment by questioning young professionals who migrated into Western countries about their job satisfaction or well-being before and after the immigration and what kind of workplace designs and strategies appealing to them. Besides, a comprehensive comparison of the data gained by interviews or case studies before and after the integration of cultural identities will deliver insights into the impacts of physical multicultural workplace designs on different performance parameters. Research of existing laws in different countries would be important to create a basis for a clear and uniform legal frame, which promotes equality in a global context.

Taken together, flexible workplace concepts can be interpreted as the first approach for a multicultural workplace design where everyone derives equal benefits in terms of workplace location and schedules. Nevertheless, uniform laws with workplace management, strategy and design content need to be implemented to support equality in multicultural working environments.

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SESSION 15: SUSTAINABILITY AND WORKING CONDITIONS

The importance of location for services office in vacant real estate

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ABSTRACT

Purpose: the research in the thesis aims to explore the alignment of vacant office properties to real estate preferences of serviced office concepts.

Theory: in the aftermath of the recession in 2008, structural vacancy levels of Dutch office real estate were high. In reaction, vacant office space has been used to accommodate a rising market phenomenon, the serviced office concept (SOC). In hosting a SOC, selecting a suitable location requires consideration of settlement criteria, furthermore, parties have to account for the benefits SOC-users seek: outsourcing, flexibility, and cost effectiveness.

Design, methodology & approach: the research approach encompassed conducting semi-structured interviews. 5 realtors and 5 CEO's of serviced office concepts in the greater Rotterdam-the Hague area, and the province of Gelderland participated. Open- and axial coding was utilised in order to uncover characteristics of vacant properties, and required real estate traits necessary to run serviced offices.

Findings: based on the interviews it was found that market segmentation had a tremendous impact on the required real estate characteristics. Primary traits of properties revolved around good accessibility of the property, and accounting for agglomeration dynamics. Secondary traits encompassed, ambiance and amenities.

Research limitations & implications: the cross-sectional study focussed on a metropolitan area and a segment of the periphery of the Randstad. Furthermore, the study focussed on a particular business centre archetype, the "serviced office".

Originality & value: the research explores the required real estate, and location characteristics, while seeking for potential variations in requirements for different SOC service providers.

Keywords

Serviced office centre, workplace, location.

1 INTRODUCTION

While the economy is booming, the office real estate market appears to be in a dichotomy. In favourable locations shortages of quality office space are noted, while the vacancy rates in

unfavourable locations are expected to remain unhealthy indefinitely (Koppels, Remøy, & el Messlaki, 2011; van der Voordt, 2007; PBL & ASRE, 2013; Dynamis, 2019; Bouwinvest, 2019).

The reasons for the pressure on the office real estate market lies in demographic and technologic developments. Firstly, the demand for office space is declining due to an aging workforce (PBL & ASRE, 2013; Buitelaar, 2017; NVM Business, 2017), while new ways of working reduces the required surface area per office worker (NVM Business, 2017; Savills, 2017). The dichotomy on the market is further exacerbated as a result of inhabitants relocating to urbanised areas, leaving rural environments behind (PWC, 2017).

To cope with vacancy levels in the Netherlands, firms are transforming single tenant offices into multi-tenant business centres (Hartog, Weijs-Perrée, & Appel-Meulenbroek, 2018; Weijs-Perrée, Appel-Meulenbroek, de Vries, & Romme, 2016; NVM Business, 2017). Drivers fuelling this development are the technologies that made it possible for many office workers to work time, space, and device independent (NVM Business, 2017; Savills, 2017). Secondly, the number of self-employed professionals in the Netherlands has increased (NVM Business, 2017), creating a demand for affordable flexible office solutions. Lastly the traditional long-term lease contract is under pressure (Haynes & Nunnington, 2014; NVM Business, 2017; Savills, 2017). Organisations require more flexibility in real estate options, due to the increasing pace of change in the world (Bernardes & Hanna, 2009; Lin, Chiu, & Tseng, 2006).

For property owners, utilising business centre concepts leads to a higher potential occupancy, maximising returns on investment (NVM Business, 2017). The selling point of the concept for office workers is that they provide flexible lease solutions in a serviced office environment. As business centres are beneficial to both sides of supply and demand, the market presence of these concepts is expected to increase annually (NVM Business, 2017; Savills, 2017; CBRE, 2019; Bouwinvest, 2019).

In light of the developments on the Dutch office real estate market, the alignment of office space location to host a serviced office concept (SOC) becomes an interesting notion. This paper presents the results of a qualitative study into the property preferences of CEO's of serviced office providers.

Table 1. Types of business centres according to Weijs-Perrée et al. (2016) and NVM Business (2017).

Type of business centre	Characteristics
Business centre	Customers rent small-scale office space for a fixed fee in a flexible term. Facilities are shared
Services office	Serviced offices are fully outfitted office spaces, including facility staff and services. Purchasing supplementary services is optional and will cost subsequent additions to the fee. The focus is businessmen
Coworking space	Coworking space is a communal environment of workplace independent professionals. In coworking spaces shared and stand-alone workplaces can be rented. The concept focusses on meeting. Focus groups encompass informal organisations seeking for inspiring workplaces. The concepts are frequently settled in lively areas.
Incubator	An incubator concept is comparable to a serviced office/coworking environment, its unique selling point revolves around offering guidance and support to tenants. Training services and financial services are therefore provided, as an incubator supports an inspiring environment for start-ups.

2 THEORETICAL BACKGROUND

2.1 Classification of business centre concepts

According to Weijs-Perrée et al. (2016) and NVM Business (2017), four types of business centre concepts are distinguished (See Table 1). This paper will focus on serviced office workspaces, defined by Van der Kar (2016) as a "fully furnished office space within a building that is commercially let, sub-let or licensed to third parties on a serviced basis. The services will tend to comprise all of the building services and a menu of business support services". Even though literature makes a distinction between several types of flexible office concepts, it would appear that most enterprises exploit a hybrid form (van der Kar, 2016; Weijs-Perrée et al., 2016; NVM Business, 2017). As a result, Van der Kar (2016) and Weijs-Perreé et al. (2016) expect similar preferences for real estate requirements among providers of serviced office concepts.

Table 2. Added value of flexible office concepts for end users

Benefit	Sources
Outsourcing	
Focus on core process	Weijs-Perrée et al., 2016; NVM Business, 2017
Outsourcing full office concept	Van der Kar, 2016; NVM Business, 2017
Access to supporting services	Van der Kar, 2016; Weijs-Perrée et al., 2016
Flexibility	
Flexibility for growing organisations	NVM Business, 2017
Flexibility	Van der Kar, 2016; Gibson & Lizieri, 1999; Weijs-Perrée et al., 2016; NVM Business, 2017
Work concept	
Activity based working	NVM Business, 2017
Sharing services with others	NVM Business, 2017
Creativity and innovation	Colliers International, 2015
Meeting professionals	
Access to a community for the exchange of knowledge and ideas	NVM Business, 2017; Colliers International, 2015; Weijs-Perrée et al., 2019
Professional network	Van der Kar, 2016; NVM Business, 2017; Weijs-Perrée et al., 2019; Hartog et al., 2018
Social network	Weijs-Perrée et al., 2019; NVM Business, 2017
Financial advantages	
Cost effectiveness	NVM Business, 2017; Weijs-Perrée et al., 2019; Hartog et al., 2018
Turns fixed cost into variable cost	Van der Kar, 2016
Short term leasing is not show on the balance sheet	NVM Business, 2017; Savills, 2017
Optimise use or real estate	NVM Business, 2017
Productivity	Weijs-Perrée et al., 2016, 2019
Quality of life	
Balance work and private life	Weijs-Perrée et al., 2019; Hartog et al., 2018

2.2 Added values for of users utilising serviced office concepts

Utilising business centres can be beneficial in various manners. Prior studies suggest numerous added values, which have been displayed in Table 2.

Firstly, general advantages apply. By using serviced office concepts organisations can focus on their core processes, leading to conventional outsourcing advantages (Weijs-Perrée et al., 2016; NVM Business, 2017; van der Kar, 2016). Furthermore, the often shorter lease contracts can increase organisational flexibility, and reduce organisational risk (van der Kar, 2016; Gibson & Lizieri, 1999; Weijs-Perrée et al., 2016; NVM Business, 2017).

Other perceived advantages differ based on profession, organisation, or industry. According to Van der Kar (2016) the serviced office users are quite heterogeneous. As the business centre occupant is active across different industries in both the public and private sector (Gibson & Lizieri, 1999; NVM Business, 2017), different concepts targeting uniqueness, social advantages or financial benefits may appeal to specific office users (Weijs-Perrée et al., 2016; Colliers International, 2015; NVM Business, 2017; van der Kar, 2016). The heterogeneity of business centre customers may therefore form a basis of market segmentation.

2.3 Segmentation of Serviced office concepts

Market segmentation of office space may have an impact on the requirements of office locations. Literature shows however that the segmentation of the market is difficult to assess, due to significant market hybridisation (van der Kar, 2016). There are some ambiguous signs of market division however. On one end Weijs-Perrée et al. (2016) mentions the focus on the creation of communities by the majority of business centres. NVM Business (2017) however states that co-working spaces are concentrated in the Randstad, suggesting the existence of a geographical market division. Savills (2017) in turn recognised that serviced office providers are shifting their focus from small organisations to large corporations. Where local creative organisations select a specific concept within their region, large organisations consider utilising flexible office providers that have a global presence (NVM Business, 2017). This development should lead to differentiation between flexible office concepts, as large corporations are expected to have different demands compared to small-scale office users.

2.4 Location selection factors

In selecting a location of settlement, organisations impact their future financial performance, throughput, and solidity (Ho, Lee, & Ho, 2008). According to Rymarzak and Sieminska (2012) settlement criteria differ per trade, and reflect firm preferences. Furthermore, local factors, including the natural, economic, technical, social, political landscape, and the regional role, have an impact on this consideration (Rymarzak & Sieminska, 2012), as displayed in Table 3. Even though the financial factors appear to be the most dominant in office organisations (Adnan & Razali, 2015), factors other than the costs of real estate were considered in literature. Karakaya and Canel (1998) elaborate on this by stating that in selecting a site, aspects should focus on ensuring alignment with the organisational objectives. Factors like accessibility, presence of resources, stakeholders, and markets appear to be of interest in considering a region.

In the case of office buildings, the location appears to have a tremendous impact on its financial performance. For that matter, poorly occupied office structures share similar locational traits. Remøy and van der Voordt (2014) explained that vacant properties are especially found in monocultural office- and business parks. These parks share a lack of connections with public transportation, have few facilities, and possess limited parking potential (Brown & Teernstra, 2008; van der Voordt & Remøy, 2014; Hek, Kamstra, & Geraedts, 2004). Furthermore, a report by Dynamis (2019) elaborates on the preference of office users, selecting city centres of neighbouring municipalities over settling in the periphery of a large town. It therefore seems that

successful office properties would be located in well accessible sites situated near the heart of cities.

Table 3. Settlement criteria for organisations.

Criteria	Sources
Transportation, traffic, accessibility	Rymarzak & Sieminska, 2012; Karakaya & Canel, 1998; Özdağoğlu, 2012
Property aspects	Rymarzak & Sieminska, 2012; Özdağoğlu, 2012; Ho et al., 2008
Maintenance	Rymarzak & Sieminska, 2012; Özdağoğlu, 2012
Market potential	Rymarzak & Sieminska, 2012; Özdağoğlu, 2012
Presence of competition	Özdağoğlu, 2012; Karakaya & Canel, 1998
Existence of complmentary products	Özdağoğlu, 2012
Accessibility to markets	Rymarzak & Sieminska, 2012; Karakaya & Canel, 1998; Ertugrul, 2011
Labour market conditions	Rymarzak & Sieminska, 2012; Karakaya & Canel, 1998; Ertugrul, 2011; Ho et al., 2008
Distance to resources, stakeholders and suppliers	Rymarzak & Sieminska, 2012; Karakaya & Canel, 1998; Özdağoğlu, 2012; Ertugrul, 2011
Local environment, availability of land, utilities	Rymarzak & Sieminska, 2012; Karakaya & Canel, 1998
Quality of life for employees	Rymarzak & Sieminska, 2012; Karakaya & Canel, 1998; Ertugrul, 2011; Ho et al., 2008
Community considerations (e.g. local legislation)	Karakaya & Canel, 1998; Ertugrul, 2011
Risks	Ho et al., 2008

3 RESEARCH METHODS

This study employed a qualitative approach to contribute to a deeper understanding of the industry and complement research based on quantitative methods (van der Kar, 2016; Hartog et al., 2018; Weijs-Perrée et al., 2019). Semi-structured interviews were conducted among five realtors and five CEO's of serviced offices (SOC's). The realtors were interviewed to gain a thorough understanding of the real estate market in relation to serviced office concepts, whereas interviews with the CEO's of serviced offices uncovered their clients' preferences for real estate.

Realtors and CEO's were located in two geographical areas to determine potential differences between central business districts (CBD) and secondary hubs: the metropolitan Rotterdam-the Hague, and the province of Gelderland that harbours three urbanised areas of more than 150,000 inhabitants. By conducting five interviews per profession group data saturation could be attained (Saunders et al., 2012; Tracy, 2013).

3.1 Study group realtors

Realtors were selected based on their activities in the chosen geographical areas, specialisation in business real estate, and proficiency level, substantiated by their presence in the Vastgoedcert register (Vastgoedcert, 2019), see Table 4.

Table 4. Characteristics of participating realtors

Participating organisation	Realtor Gelderland 1	Realtor Gelderland 2	Realtor Suburbs	Realtor Rotterdam 1	Realtor Rotterdam 2
Active region of	Greater Arnhem	Greater	Suburbs	Greater	Greater

participating department	area	Nijmegen area	Rotterdam area	Rotterdam Area	Rotterdam Area
Geographical segmentation	Nation wide	Local area	Local area	Local area	Nation wide

3.2 Study group serviced office concepts

The chosen business centres were selected from a web-based inventory, and offer facility services but do not centre around communities. Participating SOC's are described in Table 5.

Table 5. Characteristics of Serviced Offices

Participating organisation	SOC Arnhem	SOC Provinces	SOC National	SOC Rotterdam	SOC Rotterdam
Active Region	Greater Arnhem area	Overijssel, Gelderland, Utrecht.	National	Metropolitan area Rotterdam, The Hague	Metropolitan area Rotterdam, the Hague
Number of locations	2	6	35	4	16
Property acquirement	Freehold	Cooperative	Leasehold	Freehold	Leasehold
Primary activity focus	- Serviced offices - Conference hub	- Serviced offices - Conference hub	- Serviced offices	- Serviced offices	- Serviced offices
Primary focus group	Office users	Coaches	Healthcare	Multiple users	Multiple users
Strategy	Differentiation	Differentiation	Differentiation	Focussed cost leadership	Focussed cost leadership
Minimally required size per location to be profitable	+/- 5000 sqm	< 1000 sqm	< 1000 sqm	2000 sqm	1000 sqm

3.3 Data analysis

Interviews were recorded and transcribed. Primary open coding was based on a literature review and was used to break down the interviews into elements (Cooper & Schindler, 2014; Saunders et al., 2012). After all interviews had been coded, the codebook was revisited to reassess the position of elements in order to ensure mutual exclusivity (Cooper & Schindler, 2014). Finally, axial coding was utilised to allow categorisation of uncovered elements (Saunders, Lewis, & Thornhill, 2012).

4 RESULTS

In considering preferable location aspects CEO's of serviced office concepts claim the importance of market research: market potential, presence of competitors, unique selling points

and market saturation should be assessed. Furthermore, a location has to align with the property and concept. Realtors additionally stated that office users prefer to settle between other office users. Therefore, diverse business parks and solitary office properties were judged unappealing, while central business districts were seen as attractive.

A geographical difference was noted in the services of office providers. The SOC's residing in the provinces seemed to include cross selling additional services to neighbouring organisations, while their peers in the metropolitan area focussed solely on their serviced office concept. This may be due to the significantly smaller office masses present in non-metropolitan areas, resulting in less feasible business cases for supplementary services in the area. Therefore, it may be more lucrative for SOC's outside of central business districts to act as a hub by providing these additional services in their location.

Besides these general considerations, participants elaborated on the topics of accessibility, ambiance, and amenities.

4.1 Accessibility

The most important trait of a location appeared to be accessibility: of the 71 registered remarks on location, 54 were related to accessibility. The means of transportation could be divided into two main subjects, public transportation and travelling by car.

> *"You have a company that comes from there and the employees come mainly by car. Those will often not settle in the centre. They will choose to be closer to the (city)ring." (*SOC Rotterdam 2)

Realtors agreed that both the accessibility via public transportation, and car, are critical. Public forms of travelling are becoming the more dominant settlement factor however, due to the preference of office users to settle in centres. As these areas contain a large office mass they form a potentially profitable location for serviced offices.

> *"It's trendy to be in the middle of the city and that plays a part in the consideration to settle in the centre" (*Realtor Rotterdam 1)

The serviced offices, however, had more diversified views. This resulted from their focus on customer groups. Three providers, one in the metropolitan area, one national and one in the province, seem to prefer locations in the periphery of a city. Accessibility by car appeared to be one of the major drivers in this decision, as this was preferred by their target customer. Two SOC's mentioned free parking to be a prerequisite, while public transportation could be sacrificed. For the third concept it was a matter of balance; the location has to be accessible for the clients of his customers, by car, and public transportation. These service providers considered that the location follows the concept. For the two remaining serviced office concepts the approach was somewhat different. Both view a location and consider what would align, thus the concept followed the location.

4.2 Ambiance

A last location aspect that was considered by participants appeared to revolve around the ambiance of the area. The look and feel of the location were mentioned several times by serviced office participants. Additionally, remarks on safety were related to the reputation of the area. On the representation factor of real estate both realtors and serviced office concepts are in agreement with its criticalness. On elements, opinions differed however. Realtors indicated that the

aesthetics of the property were critical. The serviced offices were more divided on the subject, as three concepts indicated that aesthetics is of lesser importance. More vital topics for the service providers were representable space, and ambiance.

4.3 Amenities

In selecting a location, the perceived importance of amenities in the area appeared to be ambiguous. Even though four realtors suggested that local amenities were critical for SOC's, three of the serviced office providers stated that they did not consider amenities in selecting a location. One of the participants attributed this reasoning to the lack of interest of his customer. Even though amenities were not considered to be critical by these SOC participants, lunchrooms and supermarkets were mentioned as a preferable factor in an environment. Furthermore, one of the remaining serviced office providers stated he housed a corporate restaurant. As the catering service was open to the public, the concept created its own amenity within the environment. Delving deeper into the amenities, only a realtor and serviced office provider responded on the topic of quality of life facilities by stating there was no demand for it.

> "*With a more attractive location, including the building, with own amenities for lunch, you will be able to occupy the property faster*." (Realtor Rotterdam 2)
> *"This is a working building, so what the environment provides in catering, in… what there is to do, is… not very important I believe."* (SOC Rotterdam 1)

The reason for the different views on the importance of amenities may lie in market segmentation. The realtors mediate a bulk in office square meters on the market. Therefore, they are expected to have a general overview of market requirements. The participating serviced offices however have a clear vision of price to quality ratios for their target group, with the majority running a cost leadership focus. For their concepts, the amenities had little perceived value.

> *"And it's nice when people in the building feel positive because of the presence of e.g. a sports club, or a restaurant that provides biological meals." (SOC Arnhem)*

5 DISCUSSION

Based on the literature study it was suggested that the real estate requirements for serviced office concepts would be similar across the market (van der Kar, 2016; Weijs-Perrée et al., 2016; NVM Business, 2017). In addition, SOC's were expected to focus on central business districts near city centres (Dynamis, 2019). This picture was confirmed by the participating realtors, whom attributed this preference to the present amenities in CDB's, and the appealing quantity of office mass. As realtors mediate the bulk in office mass on the market, it would appear that serviced office concepts would best thrive in central business districts.

Despite the general picture of the SOC market, the subtility in market segmentation appeared to have a significant impact on the location preferences of serviced offices. Allthough market segmentation appeared to be difficult to assess (van der Kar, 2016), NVM Business (2017) suggested the presence of a geographical segmentation, while Savills (2017) hinted at a different preferences for organisational sizes. Through the interviews it became clear that participating SOC operators executed differentiation- and focussed costleadership strategies.This meant the operators targeted a specific type of audience, albeit by offering a different facility fit-out, branding, etc. Through focussing on a specific market section, other type of office users

appeared to be repelled. SOC providers therefore seemed very counscious of the type of property and location they were seeking for.

As a result, the alignment of an office property with the market segment was crucial, as was mentioned by Karakaya and Canel (1998). For instance, the accessibility of the site was deemed critical according to the research participants and literature (Brown & Teernstra, 2008; Hek et al., 2004; Özdağoğlu, 2012; Rymarzak & Sieminska, 2012). Where realtors suggested the increasing importance of public transportation, participating serviced office providers showed how the different forms of accessibility influenced the type of customers it would appeal to, and thus determine the location the concept required. This strengthens the notion that user advantages of serviced offices depend on the type and preference of the user (Weijs-Perrée et al., 2016; Colliers International, 2015; NVM Business, 2017; van der Kar, 2016), and the heterogeneity of the SOC customer base (van der Kar, 2016; NVM Business, 2017; Gibson & Lizieri, 1999).

6 CONCLUSION

This paper has described the results obtained from a qualitative study into the location preferences for serviced office suppliers. In evaluating a location, it appears to be sensible to select a property in an area containing more office mass. Central business districts form good locations due to the present office market and the appeal for office users to remain among office users.

Locating a serviced office outside of the central business districts appears to be a viable strategy. Of critical consideration is the alignment of the concept with real estate, location, and the target customer. Accessibility appeared to be the most critical aspect. A serviced office concept requires a good reachability potential for minimally one type of transportation to be successful, either by car or by public transportation. In addition to aligning accessibility potential, the importance of other factors depends on preferences of the targeted market segment: Amenities, ambiance, and safety.

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Why indoor air quality matters – creating sustainable future working environments

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ABSTRACT

The purpose of the paper is to raise awareness about the quality of indoor air with hands-on information for project owners and designers on how to create a healthy indoor environment.

Light and noise are well known to impair our work-productivity if they are not carefully designed. As research shows, air quality has a great impact on health and productivity of a building's occupants, but they're still not regulated with norms, as light and noise are. Indoor air quality is the next intangible material which must be addressed in the interior design process.

Solutions for well-known pollutants such as mould and CO2 are already good practice in building construction. PM (particle matters) and harmful VOCs (volatile organic compounds) are formally labelled as toxic when they are inhaled in a certain quantity and during an extensive time, but these are mostly not considered.

PM come mainly from outdoor air through windows, or the mechanical ventilation system, into indoor spaces. Filters in the ventilation system purify the outdoor air before coming into the space. Depending on the filter, the energy consumption of the building system can increase dramatically and pollute the outdoor air more than which needs to be cleaned in the first place.

Harmful VOCs are very common in building materials, and indoor air tests show that the quantity exceeds the recommended limits. Greenery is a solution to provide oxygen and it is proven that plants also decontaminate indoor air regarding VOCs. Nevertheless, the best solution is not bringing in building materials and products such as furniture, which give off harmful chemicals.

The issue is the immense amount of time needed to vet healthy building materials. Screening materials is a long process, since the manufactures don't have to indicate the ingredients of their products and there are still no regulations which prohibit the use of harmful chemicals. Sustainability certifications of materials and internet platforms of sustainable building materials are a great help for choosing healthy materials. Furthermore, the choice of healthy materials is still very small, and it is difficult for designers and project owners to follow through the design intention. The battle for clean indoor air starts with raising awareness. Project owners and designers need to request the market to provide healthy materials.

Keywords

Indoor environment quality, indoor air quality, occupants' health & productivity, green building certifications.

1 INTRODUCTION

Norms are in place for protecting the occupant's health regarding physical space, such as the minimum space needs per person, distances of corridors for safety, etc. Also, intangible items like light and noise are regulated, since it is proven that it impacts on our health and productivity. Regarding indoor air quality, there are guidelines of CO2 quantity, but the chemical cleanliness of the air is not regulated, while substances are classified as carcinogenic, mutagenic or dangerous for reproductive health, based on verified scientific evidence. Now green building certifications include indoor environment quality in one part, but the main intention is on energy and resource saving matters. It is true that the construction and real estate industry is responsible for 60% of the waste and 30-40% of energy according to the UNEP, Federal Statistical Office, however the occupant's health should have the same or even more importance. It should become the third intangible item of building construction norms.

2 THE PROBLEM AND THE IMPACT

What are the pollutants and where do they come from?

Carbon Dioxide (CO2) is the first issue of indoor air quality, since we build air-tight buildings. CO2 can significantly impact productivity and decision-making capabilities. The research of the state university of New York proves that the decision-making performance decrements in six of nice scales by a rate of 600 ppm CO2 content in the air (1). It becomes best practice to install CO2 sensors in spaces to control the mechanical ventilation or indicate manual ventilation.

Dampness and mould grow indoors when enough moisture is available. They are associated with respiratory symptoms, allergies and asthma, and can affect the immunological system. This issue is well-known, good architecture practice, and the correct use of spaces and its ventilation is of public awareness.

Particle Matter is one indicator of the air quality and known for outdoor air quality measurements caused by combustion of fuel and driving on the street. The building ventilation system brings them into the buildings, and they are produced in the space simply by walking on the floor or rubbing on chairs with toxic chemical ingredients. Particle Matter gets into the lungs through the air and is small enough to get into our blood system or stay within the lung. Particles within the lung may cause cancer and lung disease. The review of the Soochow University, Suzhou, China concludes that PM damages the human respiratory system based on epidemiological, experimental and mechanism studies. (2)

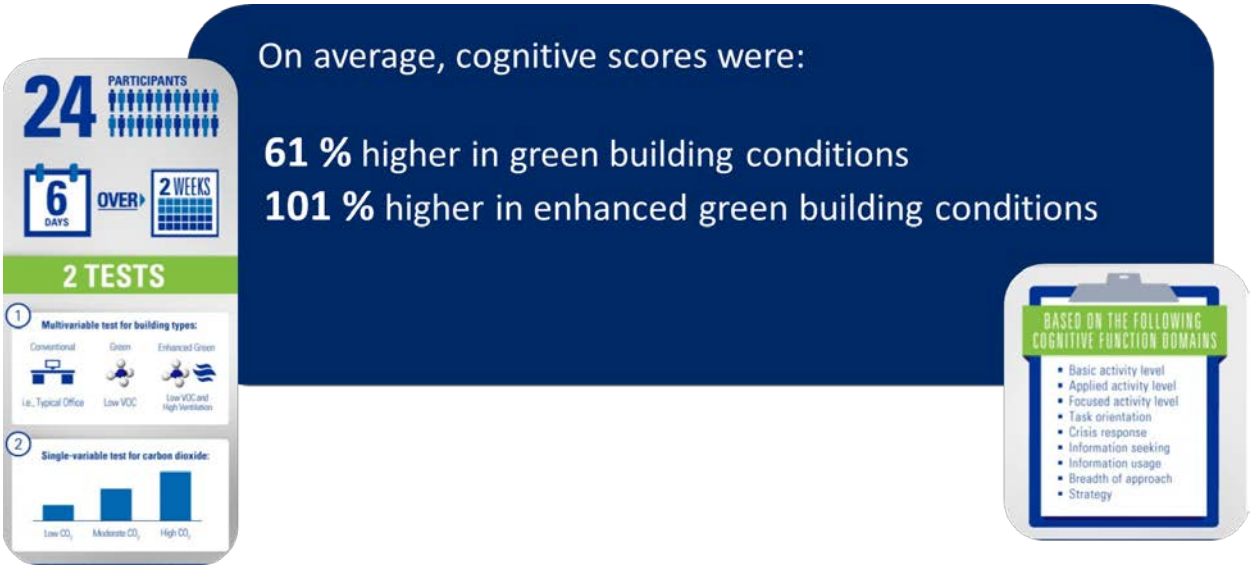
The focus is now on the not yet well-known area of chemical pollution. It is a class of organic chemicals called Volatile Organic Compounds (VOC) that emit at room temperature, so called off-gassing. There are benign and harmful VOCs. Out of the 900 recognised ones, the most known harmful ones are formaldehyde, toluene, and benzene. Harmful VOCs have been formally labelled as toxic and can cause headaches, rashes, nausea, eye, nose and throat irritation. Depending on the exposure time and quantity, they can be carcinogenic, mutagenic and reproductive toxicant. They are extremely common in building materials such as paints, solvents of glues (e.g. carpet glues), particle boards (furniture) and carpet backing. Also, common indoor source of VOCs includes detergents, pesticides and dry-cleaning solvents.

Many VOCs cannot be detected by smell or colour and the effects of extended/extensive exposure can occur years later. It is an understudied class of indoor air pollutant and public awareness is not there yet, as it is with tobacco smoke and outdoor air pollution by vehicles.

Although common sense tells us that healthier interior air quality yields a better indoor environment and makes us feel better, resulting in increased performance, proving this nevertheless has been very difficult in the past.

A double-blind study conducted by researchers at the Harvard University T.H. Chan shows the impact on cognitive functions in conventional and green buildings, as well as green buildings with enhanced ventilation. The researchers measured cognitive function for nine functional domains, including applied and focus activity levels, task orientation, crisis response, information seeking, information usage, breadth of approach and strategy. Information usage scores for green and enhanced green environments with low VOC levels and high ventilation were 172 and 299 percent higher than in the conventional environment, respectively. Also, crisis response scores were 97 percent higher for the green environment (3).

Figure a) Study Results of “A controlled Exposure Study of Green and Conventional Office Environments.”



"When it comes to the decision-making ability of green building occupants, intelligence is in the air," said John Mandyck, Chief Sustainability Officer for United Technologies Corporation, “and we know green buildings conserve natural resources, minimise environmental impacts and improve the indoor environment, but these results show they can also become important human resource tools for all indoor environments where cognitive abilities are critical to productivity, learning and safety.”

3 SOLUTIONS

3.1 Mechanical Ventilation

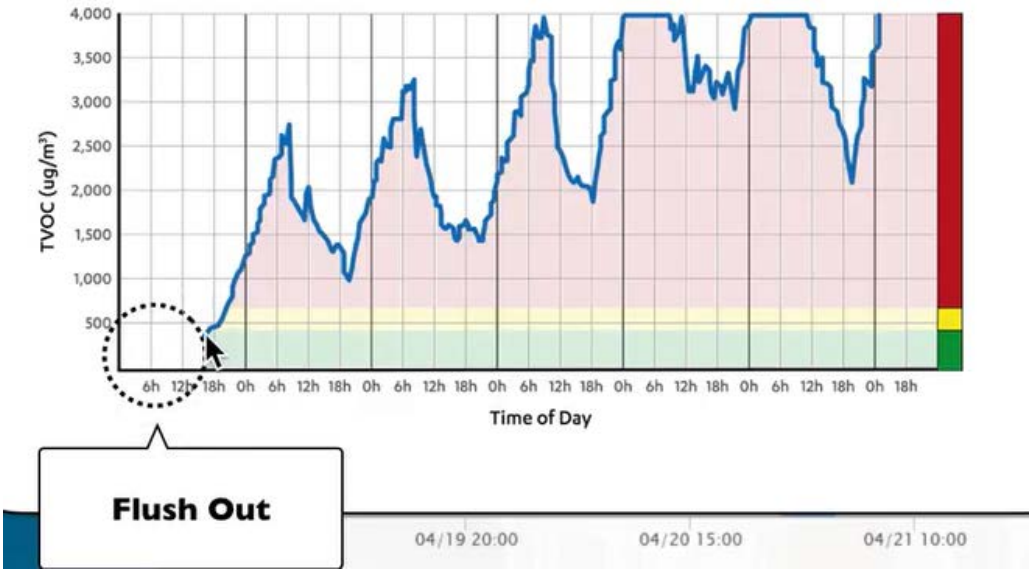
Fresh-air intake systems are common practice in air-tight building in order to constantly provide the right amount of oxygen to occupants. In terms of air pollutants, this ventilation system also provides the solution to dilute the indoor air with outdoor air. Air-tight buildings have the indoor air problem since the 1980s, when the sick-building syndrome (SBS) was officially recognised by World Health Organization. SBS describes a medical condition where people in a building suffer from symptoms of illness or feel unwell for no apparent reason. (4)

Mechanical ventilation is a good means, but it comes into the conflict with green building targets /C02 footprint for their increased energy usage. Depending on the quality of the outdoor air, it is necessary to install a filtration system into the ventilation to clean the outdoor air (reduction of PM 2.5) before coming into the spaces. Installing filtration increases energy use and brings back the air pollution, which are to take out at the first place.

An interesting study was conducted by GIGA, an international organisation assessing the health performance of buildings.

After the construction phase, flush-outs are prescribed by building certifications to blow out air pollutant of the construction and freshly installed materials. Following the flush-out, the project immediately performed a spot test and passed their indoor air quality assessment. On the request of the client they put in place indoor air quality monitors in order to continuously measure the air quality.

Figure b) Result chart of the study with a continuously air monitoring after flush-out



During the flush-out period, no Total Volatile Organic Compounds (TVOC) were detected. The continuous monitoring after the flush-out period instead measures peaks and valleys of TVOC quantity in the air, which results in the ventilation system turning off and on. The TVOCs are climbing up when the system is off, and they disappear when the system is on. The problem is that the TVOCs are building up over time. Even in 6 days the TVOC level is so high that it can't even been tracked. (5)

The mechanical ventilation system is a solution during building operation hours, but the hours when it is off are critical, and people are still in the building during overtime etc.

3.2 Greenery

Another solution to purify the air is by using plants. They need water and good maintenance in order to control mould, but no energy. The leaves transform CO2 to oxygen, but studies show that also they absorb VOCs and PMs. Ahu Aydogan, the assistant professor of the city college of New York proofs in her researches that the entire plant reduces the concentration of formaldehyde. Further, her studies show that the roots remove formaldehyde more rapid than the aerial plant parts. (6)

Already in 1989, the NASA did an investigation on purifying air with plants. Low-light requiring houseplants, along with activated carbon plant filters, have demonstrated the potential for improving indoor air quality. This plant system is one of the most promising means of alleviating the sick building-syndrome associated with many new, energy-efficient buildings. (7)

New innovations which pass the polluted air by the roots for a faster removal of air pollution are coming on the market now. For example, hydroponic technologies use embedded fans, activated carbon filters, micro-organism filters but no soil.

3.3 Source control

The third solution is source control. It is the most effective and easiest way to prevent indoor air difficulties. This is easier said than done as it takes significant effort, time and diligence to select building materials which prove that their ingredients are not harmful. One reason is that producers are not used to show what is in their products and seldom know because of the long supply chain. For planners and project owners it takes a tremendous amount of time to vet the products and it narrows the choice down extremely. Subsequently, designers have difficulties to get their design concept followed through.

3.3.1 Product certification

Product certifications are a helpful tool for selecting healthy materials and products. In the last years the product certifications increased immensely, and each country has their own testing regulations. Thus, it became difficult to understand what each certification stands for and to compare them to each other. The manufacturers on the other side have difficulties to find the right choice of certification for their product and market. Further small manufactures can't afford the certification process which needs to be recertified periodically.

The list below shows a selection of product certifications which focus and/or include indoor air quality assessment:

- **Cradle to Cradle®** (C2C) The product certification is a globally recognised measure of safer, more sustainable products made for the circular economy. https://www.c2ccertified.org/

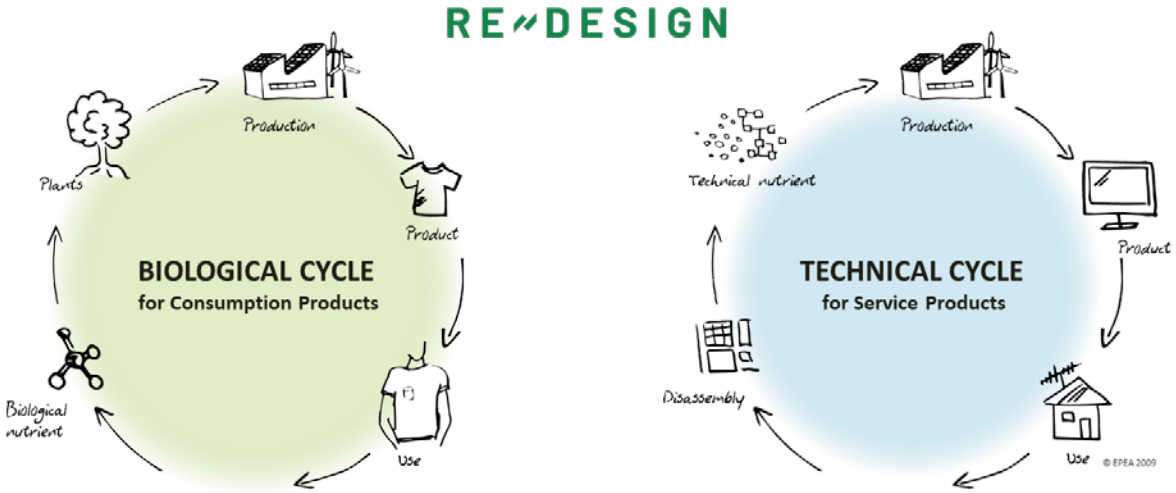
- **EU Ecolabel** is recognised across Europe, awarded to products and services meeting high environmental standards throughout their life-cycle. www.ecolabel.eu
- **Blauer Engel**, a German Ecolable, is the ecolabel of the federal government of Germany and sets high standards for environmentally friendly product design. https://www.blauer-engel.de/en,
- **Indoor Air Comfort** is a pan-European product certification (IAC). It is an innovative tool to show compliance of a product with low VOC emissions criteria set out in Europe. https://www.eurofins.com/consumer-product-testing/
- **Level,** evaluating environmental and social impacts for commercial furniture. https://www.levelcertified.org/
- **Floorscore**, recognised indoor air quality (IAQ) certification standard for hard surface flooring materials, adhesives, and underlayment.https://www.scsglobalservices.com/services/floorscore
- **GUT**, Carpets tested for a better living environment. https://www.pro-dis.info/gut.html?&no_cache=1&L=0
- **CRI,** Green Label +Plus, Indoor Air Quality Testing Program, Carpet-rug.org, USA, low chemical emission of carpets, adhesives and cushion products. https://carpet-rug.org/testing/green-label-plus/
- **Greenguard** is a product certified for Low Chemical Emissions, UL COM/CG. http://greenguard.org/en/index.aspx
- **Declare** is a transparency platform and product database that is changing the materials marketplace, set up by the international Living future institute. https://living-future.org/declare/.
- **Health Product Declaration**® (HPD) for the accurate, reliable and consistent reporting of product contents and associated health information, for products used in the built environment. https://www.hpd-collaborative.org/stands

All of them have listed the products they certified on their website and are a good source for sustainable products. Each label can be also valuable for achieving building or indoor environment certifications butneeds to be checked carefully.

A special focus is to take at the Cradle to Cradle (C2C) approach which was developed during the 1990s by Prof. Dr. Michael Braungart, William McDonough and the scientists of EPEA in Hamburg. The concept is to design products inspired by nature, in which they are created according to the principles of an ideal circular economy.

Cradle to Cradle certified assessment categories represent rigorous achievement across five critical performance categories: Material Health, Material Reutilisation, Renewable Energy and Carbon Management, Water Stewardship, and Social Fairness. The material health category helps to ensure products are made using chemicals that are as safe as possible for humans and the environment by leading designers and product developers through a process of inventorying, assessing and optimising material chemistries.

Figure c) The two Cradle to Cradle nutrient cycles



The two nutrient cycles: The Cradle to Cradle® design concept distinguishes between the biological and the technological cycles for materials. Waste materials in an old product become the "food" for a new product. In the biological cycle, materials are returned to the biosphere in the form of compost or other nutrients, from which new materials can be created.

In the technical cycle materials that are not used up during use in the product can be reprocessed to allow them to be used in a new product. (8)

This differentiates Cradle to Cradle® from conventional recycling and the concept of eco-efficiency. It is about eco-effectiveness and goes beyond conventional sustainability tools and approaches, which primarily show the negative influence of humans on the environment.

3.3.2 Sustainable Product Libraries

Online tools such as product libraries are very useful for finding healthy materials and products. Following is a short list for sustainable and healthy building materials:

European based:

- **www.building-material-scout.com/en-us/**
  represented by Drees & Sommer SE, an international consulting company working in the building and real estate sector and Hoinka GmbH.
- **https://bettermaterials.gbci.org/**
  launched by the Green Business Certification Inc. (GBCI), an organisation independently recognising excellence in green business industry performance and practice globally.
- **https://epd-online.com/**
  The EPD online tool of the Institute Bauen und Umwelt (IBU), an industry-wide association provides detailed environmental- and health information of building products, raw materials and primary products.

U.S. based:

- **www.spot.ul.com/**,
  created by UL LLC, a global safety certification company.

- **www.mindfulmaterials.com**
  The mindful MATERIALS Library is an agnostic product certification library, enabling manufacturers to showcase product transparency and optimisation information and industry professionals to search for a multitude of relevant products. Powered by Origin.
- **www.greenscreenchemicals.org/**
  GreenScreen for Safer Chemicals is a method of comparative Chemical Hazard Assessment (CHA) that can be used for identifying chemicals of high concern and safer alternatives. GreenScreen was developed by and is a project of Clean Production Action, a tax-exempt, nonprofit corporation.
- **www.hpd-collaborative.org**
  The HPD Open Standard is a standard specification for the accurate, reliable and consistent reporting of product contents and associated health information, for products used in the built environment. Health Product Declaration® (HPD) Collaborative is a not-for-profit.
- **https://www.scsglobalservices.com/certified-green-products-guide**
  SCS Global Services is a trusted leader in third-party environmental, sustainability and food quality certification, auditing, testing and standards development.
- **https://www.bifma.org/page/about**
  BIFMA is the not-for-profit trade association for business and institutional furniture manufacturers. They created the label LEVEL for office furniture and it are coming up in the European manufactures market.
- **www.origin.build.org**
  Origin is a material database that allows for all materials, all varieties from all around the world. Developed by GIGA, an international organisation assessing the health performance of buildings.

3.3.3 Indoor environment certifications

Project owners can peruse a green building certification, which are well established on the green building market, but mainly focus on energy and resource saving. The most commonly used certification systems BREEAM (Building Research Establishment Ltd, Great Britain, https://www.breeam.com/), LEED (Leadership in Energy and Environmental Design, administrated by U.S. Green Building council USGBC, https://new.usgbc.org/leed) and DGNB (German sustainable Building Council, https://www.dgnb-system.de/) also have their certification system only for indoor spaces with attention on the occupant, and include all assessment of the indoor air quality.

- LEED version 4 for interior design and construction
- BREEAM In-Use and Refurbishment & Fi-Out
- DGNB Innenräume (interior spaces)

Supplementary certification systems of interiors only are also coming up, such as WELL building standard (administrated by International Well building institute U.S. https://www.wellcertified.com/), Fitwel (trademark of the U.S. Department of Health & Human Services, https://www.fitwel.org) and RESET (administrated by GIGA, an international organisation assessing health performance of buildings, https://www.reset.build/).

The requirements are checked on documents and on side after the completion. It is a one-time check and only a few requests a renewal of the certification periodically. Nevertheless, the indoor environment quality changes continuously as buildings are pressurised and depressurised by mechanical systems, as ventilation, heating, and cooling power up and down and as occupant activity impacts CO2, CO, Particulate Matter and VOCs.

To point out is the RESET™ certification, which is a sensor-based and performance-driven certification. It prioritises on-going results and long-term occupant health by continuously monitoring indoor air quality. It requires data to be live-streamed to the cloud via multi-parameter monitors that can be accessed from any device.

4 REFERENCE PROJECTS

The International Olympic Committee (IOC) opened their new headquarters “Maison Olympique” in Lausanne in June 2019. Apart from bringing their 500 employees under one roof, the main purpose was to invest in sustainability, one of the three pillars of the Olympic Agenda 2020. Features included reusing 95% of the concrete of their old building until the interior planning, getting people to move via a prominent interior staircase and a special focus on the interior air quality. During the furniture selection they requested the manufactures to prove that they go beyond the requests of LEED credit indoor environment quality. The manufactures of the last selection round didn’t have any sustainable product certification and therefore tested their products for off-gassing hazardous chemicals. Surprisingly for them the test results were not positive and thus they started to change the product to make it healthier. It clearly shows that the awareness of off-gassing is not there yet and only strong requests by the market (project owners, occupants and designers) can change it.

As explained earlier, designers and planners struggle with the request of sustainable products, since it reduces the choice and needs tremendous effort in vetting them. It needs to be turned around. The designers select the products because of functionality and design fit and request that the manufacture proof that it is healthy and sustainable. It surely needs a certain amount of this and clients name that it is feasible but already asking for it would push the awareness.

5 CONCLUSIONS

Indoor air quality is a health issue to be seriously considered for all kind of buildings we spend an extended period of time in. Mechanical ventilation systems are one solution, but in conflict with the target of energy-efficient buildings. Greenery is a good solution which is not only a decoration and should be recognised as a method to purifying indoor air. The best way is to carefully select the materials that are brought into the indoor space. The selection of healthy building materials must become as “easy” as selecting food in the supermarket with ingredients listed on the package. Planners and project owners need to push the market until regulations are in place for full material transparency and avoiding harmful chemicals. A must have is the continuous monitoring of indoor air quality, including TVOCs, to make the indoor air quality visible throughout the building life.

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SESSION 16: LEARNING AND COMMUNITY@WORK

Relation between working environment and learning outcomes in agile student projects

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ABSTRACT

Agile methods in academic teaching seems to be pioneering work by now but could rapidly establish themselves. Since two years at Hochschule Mittweida - University of Applied Sciences (HSMW) a subject is offered, where students manage a transdisciplinary project using the agile method SCRUM. Originally created to manage software development projects (1), SCRUM has been adapted to solve practical problems in the topic of sustainable city development together with experts of local city administrations.

The theory claims that agile project teams are more engaged, intrinsically motivated and gain better results because they get the freedom and space they need (2). Furthermore, agile methods can improve the learning process (in appropriate subjects) and be especially useful facing complex problems (3). Practical experience shows that these effects do not appear on a naturally basis. To take full advantage of those benefits several conditions must be met. The current literature focuses on the method itself or when discussing the work environment do not mention special requirements for academic issues. As the author experienced, the didactical concept with SCRUM turns the way students are used to solve problems upside down and requires mental flexibility. It seems to be important to give students a comprehensive and sophisticated introduction to this method and practical insights. At HSMW this recently takes place in a specific room with an agile work environment which students can also use to work on their projects. Since then the process of learning as well as the motivation and commitment of the students and even the willingness to face challenges improved significantly. Therefore, the work environment in this context seemed to be worth analysed.

As a result of this experience a small study was started to analyse the following research question: What impact has the learning and working environment for learning outcomes in agile student projects? Based on a semi-qualitative survey a normal classroom and the agile working environment were compared regarding student's satisfaction and their self-assessed performance. Moreover, work conditions were classified using the Kano method. The results indicate an impact of the work environment, especially on team interaction and establishing constructive review meetings.

This contribution is supposed to support lectures to improve learning outcomes when working with agile methods as well as universities to prepare themselves to future requirements.

Keywords

Agile, SCRUM, agile working environment, learning outcome

1 INTRODUCTION

1.1 Agile projects with SCRUM

Agile methods (namely SCRUM, Kanban, Design Thinking, etc.) were essentially originated for adaptive software development. They are described in the "Agile Manifesto" (5) which was thought of as an attempt to shape the process of development in a more flexible and transparent way (6). SCRUM as an agile project management method, represents the core values of the Agile Manifesto (7) and was developed by Sutherland and Schwaber (9), (10). In SCRUM projects an **interdisciplinary development team** works in close collaboration with (potential) customers and organizes itself.

SCRUM is particularly suitable for **complex problems** with **frequently changing conditions**. To simplify complexity, the project goal is broken down into single increments. These increments represent for e.g. product features and are fully completed in **fixed timeframes, so-called sprints**. The work status of the whole project as well as pending tasks and results are always transparent for the whole team. Current feedback to the interim results, to the collaboration as well as to working atmosphere are key factors of successful SCRUM projects. This ensures to meet the client's expectations and the possibility to adapt to changes faster and more easily. From the viewpoint of SCRUM, changing the plan is part of the process – an attitude that helps to manage frequent uncertainties (2), (4).

To no surprise, an increasing number of companies are implementing parts of agile methods to their workflows, especially in their research and development departments (11). An empirical study about agile methods with over 1000 participants has shown that agile methods in general can receive better outcomes compared to classic project management (12). To encourage the application of agile methods, "agile spaces" are provided. "**Agile work spaces**" are purposefully designed rooms with a lot of free (writable) wall space, movable furniture and enough freedom of movement for everybody participating. Providing a space, which supports agile working, can be a great benefit to the work. (13).

1.2 Agile student projects at HSMW

In a more and more dynamic world, the increasing complexity of interactions already changed the way projects are managed. In the future, the constant change of conditions will probably speed up. Therefore, flexibility in a team's workflow, open communication will be key factors for successful projects. Those "agile" abilities gain importance and therefore should be integrated in academic teaching. Examples for implementation in schools are EduSCRUM (2) and agile education[16] (6). A pioneering project in using the project management method SCRUM at the academic level of teaching is currently realised at the HSMW. After learning about the SCRUM method, the participants have to develop a project in the topic of sustainable city development (7). The project is funded by the LiT+ Project in Saxony through the Federal Ministry of Education and Research (BMBF) and was first started in 2019.

Students from the bachelors' programs "Real Estate- and Facilities Management" (HSMW) and the master's program "Industrial Management" (HSMW) collaborate with students from "Industrial Engineering" of a local university. They participate in the one-semester inter- and transdisciplinary course, which was offered as an optional course.

[16] http://agile-education.de and https://eduscrum.nl/en/

All participants worked with agile methods in general as well as SCRUM in particular for the first time. Students designed solutions for a sustainable urban development by using agile methods like SCRUM. Ecological, economic and social questions enriched the practical challenges to a complex task, which has to be resolved in the process. Working closely together with the decision-makers of local administrations, the developed ideas are presented and assessed regularly and concepts have to be adjusted by every team independently. The overall goal for each team is to develop a sustainable concept for a specific urban area chosen by the team. Only a large frame is prescribed for the concepts, not the expected results itself. This open-ended outcome allows every team to be actually creative in their work and may find unusual solutions. The fact that teams are interdisciplinary supports the diversity of student approaches.

As the experience shows, agile projects in academic teaching supports the shift from teaching to learning. That means the responsibility of the learning outcome is partly transferred from the teacher to the students (2), (3). To accomplish this, the focus has to be shifted from the maximum target achievement to proper customer benefits and the working process itself (3). Supporting this with an appropriate work environment seems to play an important role. Project requirements may change during project and therefore the working process itself must stay flexible and needs to be supported by a supportive work environment. So far, it can be observed that the **work environment has an impact on agile projects in academic teaching**. The question is, what features determine this impact and how. Current literature focuses on the method itself combined with didactical approaches. Whenever agile work environment is discussed, scientific sources refer to office situations and special requirements for academic issues remain unmentioned.

1.3 Accompanying research to analyse the role of agile work environment

Agile project teams are supposed to be more engaged, intrinsically motivated and gain better results because of the constructive learning- and working atmosphere (2). Practical experience show that these effects do not appear on a naturally basis. Since there is a specific room with an agile work environment available at HSMW, the student projects as well as their motivation and commitment improved significantly. The work environment provides a lot of free (writable) wall space, movable furniture and enough freedom of movement for everybody participating. To analyse the impact of this work environment, a small study was started. The goal was to find and evaluate the reasons for this change. The **research question** is: What impact has the working environment for learning outcomes in agile student projects? Therefore, the former normal classroom in one semester and the current agile working environment in the following semester were compared. A semi-qualitative survey was conducted to investigate the student's satisfaction with the project, the work environment and further work conditions as well as the self-assessed performance.

2 METHODS

Two different learning situations and work environments within two student groups were compared and analysed. Both groups worked with the SCRUM method, but an agile work environment was only available for the second group. The course structure and the didactical concept were the same in both groups and contained of three sequential stages. In the first stage classic knowledge transfer in topics of sustainable city development as well as workshops to apply SRUM took place. After that partners from local city administration explained their current problems and students were encouraged to find possible solution ideas. Out of this students

defined their own projects for the rest of the semester and worked independently. Frequent review meetings accompanied the second stage. Project teams contained of 2 to 4 people. Only a framework regarding to the project output was given to ensure maximum freedom and creativity. The only condition was to work in diverse teams and with the agile project management method SCRUM. This included to work on the project during exactly six sprint periods with fixed time slots. Finally, during the last stage students evaluated their own project results in terms of their potential contribution to sustainable development.

Group one started the student project in March 2019. The group contained of 6 students, whereas 5 students were from HSMW and 1 student from the partner university. Besides 5 of the 6 students were female. All students were in the first semester of their master course and aged between 22 and 27. Group one did not have a special agile environment to work in during the project. A typical academic workplace like a seminar room and **workshop equipment** for moderation, presentation and visualization of ideas were provided (fig.1&2).

Figur 1 – regular seminar room at HSMW

Figure 2 – SCRUM workshop in regular seminar room (HSMW)

The same room was redesigned to an agile room with a lot of free writable wall space, movable furniture and enough freedom to work in dynamic sequences (fig.3). Next to workshop equipment **group two** was provided this **agile work environment**, where the SCRUM workshop took place and which they could use at any time afterwards. Fig. 4 shows a work situation during one of the SCRUM workshops with interactive and self-regulated learning sequences.

Figure 3 – "agile room" HSMW

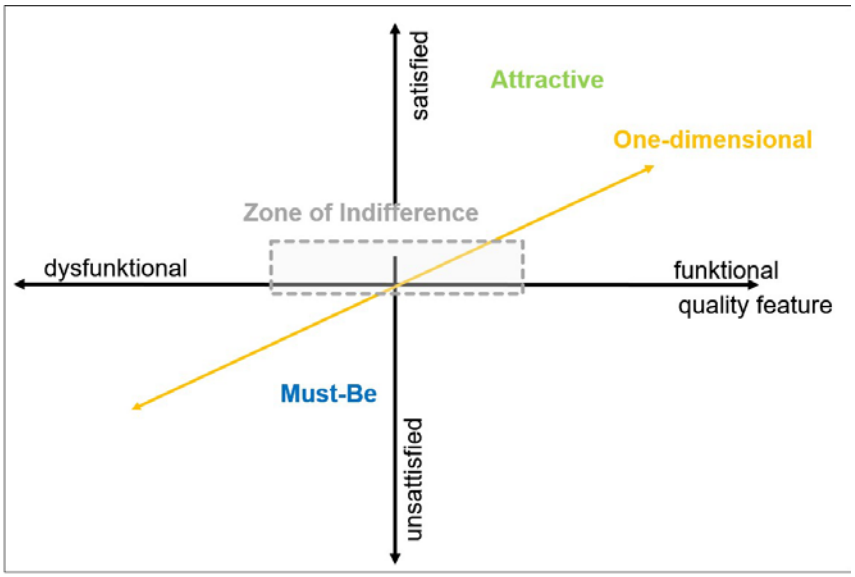
Figure 4 – SCRUM workshop in agile room HSMW

This group contained of 51 students: 45 were from HSMW and 6 from the partner university. Furthermore, students from bachelor's and master's programme were combined to collaborate in interdisciplinary teams. They were aged between 21 and 32 and female (52%), male (42%) as well as diverse (6%).

The **research methods** contained of two surveys, which were conducted after the courses. Regarding to the research question the overall goal was to analyse the impact of the work environment to satisfaction and learning outcome. Each survey contains three parts: **A)** work conditions, **B)** gaining expertise of SCRUM method, **C)** outcome and learning effect. The survey methodology includes three questioning methods: 1) Kano-method, 2) a 5-stage satisfaction scale, 3) questions about the level of agreement on given statements as well as several open questions.

The **KANO model** was developed to gain a better understanding about the customer satisfaction towards a product or a service (14). Out of this inspiration, the "theory of attractive quality" was developed (15) as shown in fig. 5.

Figure 5 – KANO model (own representation based on KANO (14))



To gain a descriptive statement the **KANO method** asks two contrary questions regarding the same feature. The first question asks about the impact of the physical existence of a quality feature (**functional**). The second question asks about the impact of the theoretical absence of the same quality feature (**dysfunctional**). Depending on the combination of the answers of every participant a feature can be classified in one of the 4 categories of the KANO model (table 1). The double question allows also to identify questionable replies (Q), that can be sorted out easily.

Table 1: feature classification via answer combination according to KANO

Feature		Dysfunctional				
		I like it	I expect it	I'm neutral	I can accept it	I dislike it
Functional	I like it	Q	A	A	A	O
	I expect it	R	I	I	I	M
	I'm neutral	R	I	I	I	M
	I can accept it	R	I	I	I	M
	I dislike it	R	R	R	R	Q

According to tab.1 every feature can be classified - for each person individual - as: (16)

Must-be features (**M**): are basics, which lead to dissatisfaction if they are not available or the quality is not fulfilled. Those features are required or expected and cannot improve the satisfaction level, for e.g. space heating.

Attractive features (**A**) cause a not expected benefit and therefore will most likely improve the level of satisfaction, for e.g. a roof terrace.

One-dimensional features (**O**) can improve satisfaction, if their quality is above average, and can also lead to dissatisfaction, if minimal quality requirements are not met, for e.g. in case of daylight availability.

Zone of indifference (**I**): features that have little effect on satisfaction at all.

Reverse features (**R**) indicates a reverse relation between functionality and satisfaction, when for e.g. a dysfunctional feature leads to satisfaction. In most cases this can be avoided by logical survey design.

The main survey was online based and was conducted in December 2019 as well as on February 2020. In group one only 2 students (33%) and in group two 18 students (35%) replied to the main survey, while 15 students answered all questions. One whole questionnaire had to be sorted out because it was identified as questionable (Q).

3 RESULTS

3.1 Work environment

The first part of the survey contained of questions about work conditions using the KANO method. The following tables show the frequency distribution of how participants classified the features “agile room” and “provided materials”. Group one classified the theoretical availability of an agile room, which was absent during their project, as attractive (A) and the provided material as must-be (M). Replies to the open question “Where did you work during your sprints?” were: “in seminar rooms”, “at cafés” and “at home”. In addition, students of group 1

wrote that the material was used “permanent” or “in every sprint”. To confirm the KANO categories of course a much greater sample size is necessary. Therefore, further findings concentrate on group 2.

Table 2 – frequency distribution of classification of features regarding KANO model / group 1

agile workshop room, n = 2		Dysfunctional				
		I like it	I expect it	I'm neutral	I can accept it	I dislike it
Functional	I like it	0%	**50%**	**50%**	0%	0%
	I expect it	0%	0%	0%	0%	0%
	I'm neutral	0%	0%	0%	0%	0%
	I can accept it	0%	0%	0%	0%	0%
	I dislike it	0%	0%	0%	0%	0%

provided workshop material, n = 2		Dysfunctional				
		I like it	I expect it	I'm neutral	I can accept it	I dislike it
Functional	I like it	0%	0%	0%	0%	0%
	I expect it	0%	0%	0%	0%	**100%**
	I'm neutral	0%	0%	0%	0%	0%
	I can accept it	0%	0%	0%	0%	0%
	I dislike it	0%	0%	0%	0%	0%

Most students of group 2 classified both features as attractive (A) while the second largest group in both cases remains indifferent (tab. 3). A KANO classification can be considered as significant with a confidence level of 90%, if the difference between the highest frequency distribution and the second highest frequency is greater than 6% (20). In both cases this requirement is not fulfilled. This bimodal distribution states, that no clear category allocation is possible.

Table 3 – frequency distribution of classified features regarding KANO model / group 2

agile workshop room, n = 18		Dysfunctional				
		I like it	I expect it	I'm neutral	I can accept it	I dislike it
Functional	I like it	**6%**	**6%**	**11%**	**28%**	**11%**
	I expect it	0%	0%	**11%**	**17%**	0%
	I'm neutral	0%	0%	**6%**	**6%**	0%
	I can accept it	0%	0%	0%	0%	0%
	I dislike it	0%	0%	0%	0%	0%

provided workshop material, n = 17		Dysfunctional				
		I like it	I expect it	I'm neutral	I can accept it	I dislike it
Functional	I like it	**6%**	0%	0%	**35%**	**24%**
	I expect it	0%	0%	**12%**	0%	**6%**
	I'm neutral	0%	0%	0%	**18%**	0%
	I can accept it	0%	0%	0%	0%	0%
	I dislike it	0%	0%	0%	0%	0%

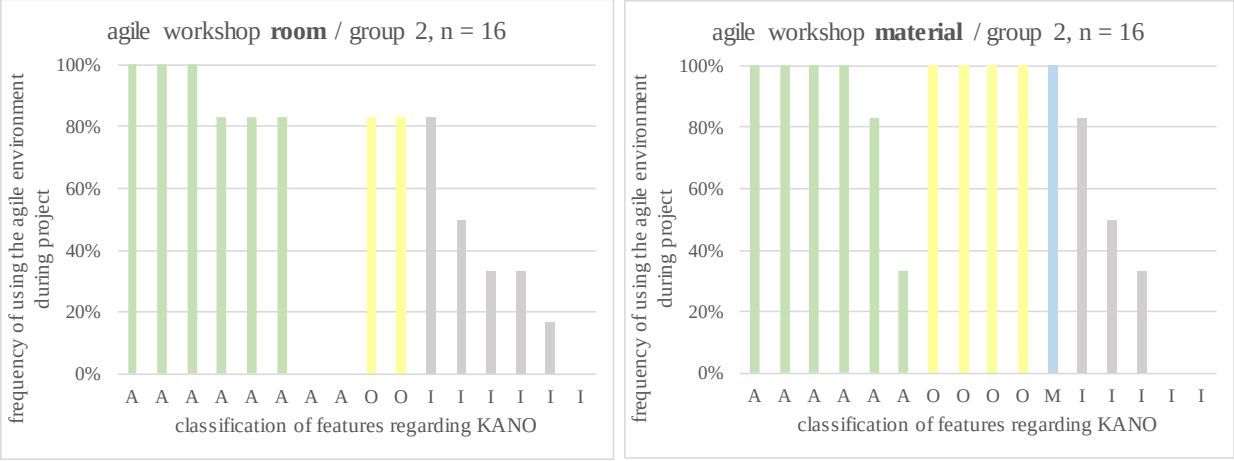
To verify the KANO method in this specific situation the relation between individual KANO categories and the satisfaction with work environment were compared. Fig. 6 shows a certain

degree of consistency regarding the categories and provides an interesting insight regarding the one-dimensional category (O) here.

Figure 6 – KANO category and satisfaction with work environment, group 2 / n = 16

All students, divided in small groups, worked in the agile room during three SCRUM workshops at the beginning of the semester. Fig.7 shows the using frequency of the agile room / provided materials afterwards - during the individual student projects – and takes the individual KANO classifications into account. As the results show, students who categorised the work environment as (A) or (O) used it more often. This leads to the question whether the environment was used because it was evaluated attractive or whether it was evaluated attractive because it was available.

Figure 7 – using frequency and KANO classification

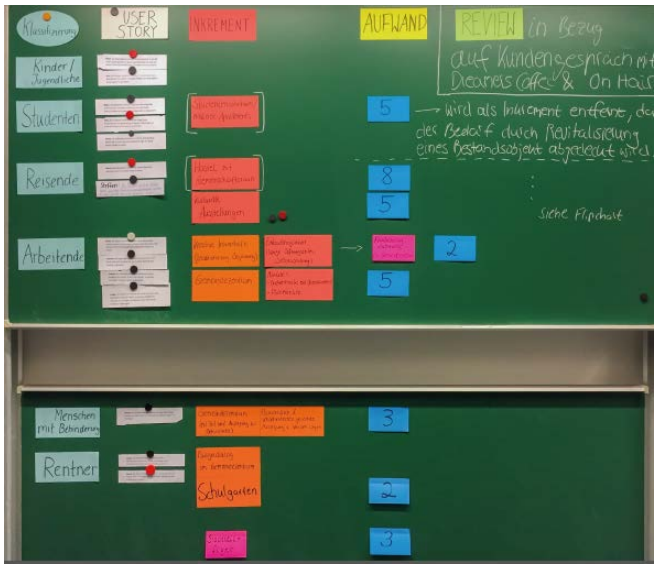


It is need to be mentioned, that every team had an easy access to the agile environment to work there individual, but not at the same time. Group 2 contained of 51 students, that shared one agile room with a maximum capacity of 15 people and shared the same schedule. Therefore, the presumption is close, that the **evaluation is related to the actual availability** of the agile room. According to the answers the agile room was quite popular to work in but students did not want to wait until it is available. In open questions, participants specified as main reason for not working in the room: “already occupied” (3 mentions) and “too small for more than three teams”

(2 mentions). Students also mentioned, that the agile environment helped them working more creatively and more freely (4 mentions).

So far, the results can be interpreted as an indication that **easy access to an agile environment** and to working materials are considered as potentially attractive and therefore can increase satisfaction (see category (A)). Furthermore, the temporal unavailability of an agile room was evaluated neutral.

Figure 8 – impression of an agile work sequence



Additionally, the author observed on a random base, while the agile room was not available, teams occupied nearby regular rooms and rearranged them to **work agile** with available boards or wall space. Fig 8 gives an impression on that. The workshop material supported this procedure or may even be the critical factor here. This observation leads to the question whether the agile environment is a fundamental need for successful agile projects or in particular important when learning about and using agile methods for the first time. It seems that once the agile way of working has been fully understood it can be transferred.

3.2 Method competence regarding SCRUM

The next part of the survey concerned the gained SCRUM competence. Regarding the question whether and how the agile room influenced the learning outcome, the relation between individual KANO categories and self-assessed SCRUM expertise was analysed. As fig.9 shows, a clear determination is not derivable. It is more like a tendency towards the argument that providing an agile environment supports the understanding of agile concepts. On the other hand, the agile environment was nether a mandatory requirement for a growth of competence nor a guarantor for it. Fig. 10 takes additionally the using frequency in account and confirms these indications partly.

Figure 9 - KANO category and gained SCRUM competence, group 2 / n = 16

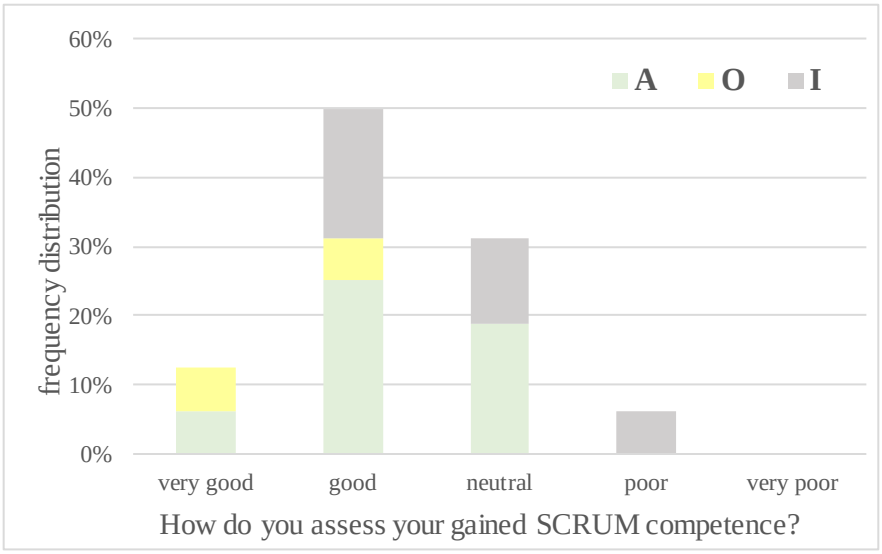
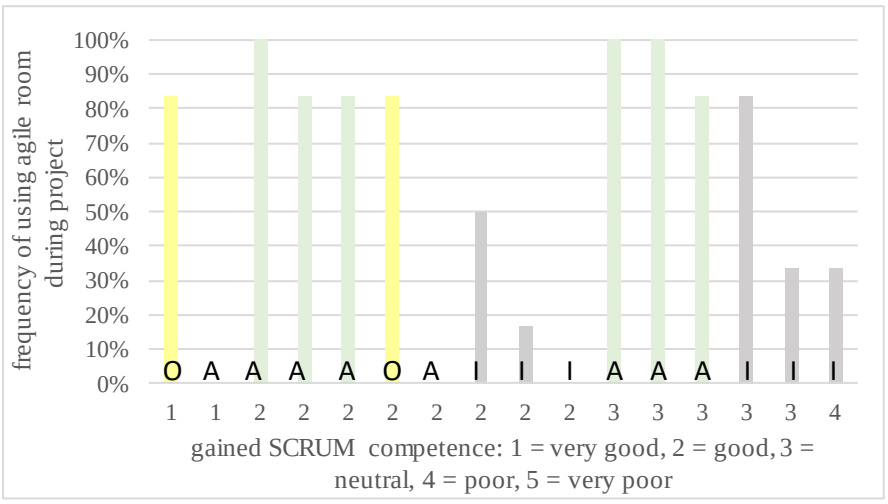


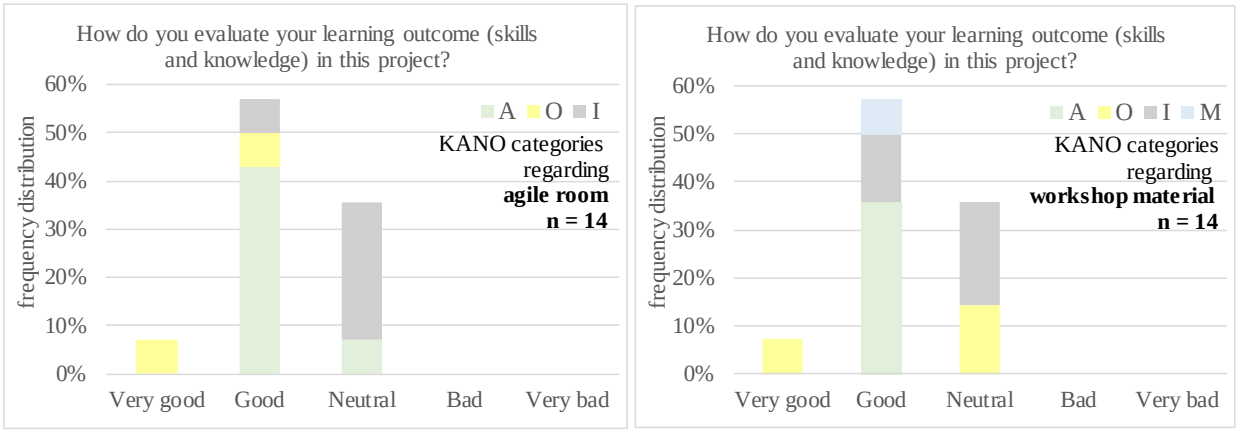
Figure 10 - KANO category / frequency of using the agile room / gained SCRUM competence, group 2 / n = 16



3.3 Project and learning outcomes

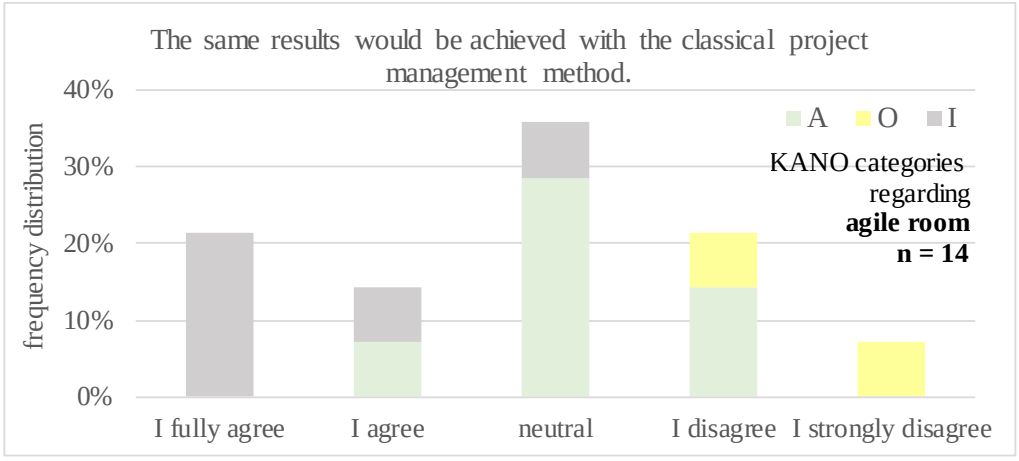
In the last part of the survey participants were asked to evaluate their own learning outcome and their own satisfaction with the project. As fig.11 shows, the self-assessed learning outcome was evaluated more often as “good” or “very good”, when the agile room or the provided material were evaluated positive.

Figure 11 - self-assessed learning outcome compared with KANO category of agile room & material, group 2



Last questions asked for a final evaluation of the SCRUM method and the project. Fig.12 shows the results of the level of agreement for a statement compared with the KANO categories regarding the agile room. Of course the didactical concept was designed for an agile project. However, students that appreciate the method here also evaluated the agile working environment positively.

Figure 12 – evaluation of the agile method compared with KANO category of agile room, group 2



Finally, there were some open questions about, what students appreciated while working with an agile method for the first time and what was unsupportive or difficult. The working environment wasn't mentioned here. Students of both groups stated the "freedom to work creatively" as well as the focused and in particular "*agile*" way of working positive. On the other hand, the "lack of clarity" as well as the "time boxing" was challenging for some participants. One suspicious difference of group two was, that they pointed out, that they were able to solve content-related issues ore challenges which occurred during the project by themselves, while participants of group one answered, that they had difficulties but without mentioning further details.

4 DISCUSSION

Even though the sample size is not representative, the results indicate a relation between work environment and learning outcomes in agile student projects. Nevertheless, the specific impact of the work environment is very difficult to determine. The KANO method can help to classify single features of the work environment.

The data indicates, that providing an agile environment can support the understanding of agile concepts in academic teaching. Furthermore, it is more likely that self-assessed learning outcomes are evaluated positive, when an agile work environment is provided. But it is important to enable an easy access and provide adequate capacities. However, the agile room was nether a fundamental requirement for a growth of competence nor a guarantor for it here. The agile environment seems to be especially important to gain method competence regarding SCRUM. The agile work environment can be a critical factor here. It seems that once students truly experience and understand agile working procedures they can adapt them to wherever they want to work. To confirm the findings further data needs to be collected. Some conflicts regarding the results suggests that the design of the study needs to be improved before collecting more data and in greater detail, especially regarding working procedures and supportive room features.

What the author observed was, that there are differences between group one (regular work environment) and group two (agile environment), especially regarding motivation, productivity and the learning progress. Surprisingly the second group was overall less satisfied during the project (according to the informal feedback meetings) but was finally more satisfied with the project results and their learning outcome (according to the survey). In fact, critical thinking is part of the agile concept. Therefore, it is presumed that group two internalized and demonstrated the cognitive process here. On the other hand, group one appeared to be totally satisfied with the work conditions (according to the informal feedback meetings) but more often problems occurred in late project stages and caused dissatisfaction. The data confirmed this observation only partly.

As a closing remark, key beneficial aspects of agile methods such as SCRUM like being self-organized, working creatively and with constant feedback can add value on the academic level. An agile work environment can truly support certain aspects here. The key aspects as well as the impact of single features of an agile work environment on learning outcomes are worth of further research.

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Co-working and Co-learning Environment at the cross-roads of the North and the South - Case Future Tech Lab in Namibia

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ABSTRACT

Purpose: Future places for learning and working are digitally and physically integrated immersive environments. The purpose of this paper is to analyse the co-creation process of remote-presence based digital and physical co-learning and co-working place. The context is cross-cultural when Nordic space approach is applied and further developed in Namibia.

Theory: The analysis is based on Action Design Research (ADR) process model by Mullarkey & Hevner (2019), which integrates the process of designing an artefact, shared space with its technology and process of continuous improvement.

Design/Methodology/Approach: The qualitative case study is conducted. The case study Future Tech Lab is about 200sqm space with three different zones in the University of Namibia main campus. The physical solution encourages collaboration and technical solutions interlink the place overseas by using remote presence. The data is gathered by document analysis, observations and interviews including structured survey.

Findings: The findings indicate that the co-design of immersive learning environment sets requirements for the physical solution, which need to be taken into account by co-creation from the shared vision to realization of the space. The co-creation involves many stakeholders and cultural differences effect differently to various stages of the co-creation.

Originality/value: The cultural context in the case study provides an interesting setting between Nordic and Namibian approaches. The remote presence and its requirements provide new knowledge and recommendations for co-creation of immersive environments.

Keywords

digital, learning environment, co-creation, culture, Global South

1 INTRODUCTION

Culture is the hidden dimension of human space, states Hall (1966). Our culture molds our experience and directs our behaviour toward it. Having this in mind this paper will describe both the co-creation of the learning environment in Finnish-Namibian collaboration focusing both on the co-creation process and user experiences of the place.

Finnish University of Turku (UTU) established their satellite campus inside the University of Namibia campus, Africa in April 2019. The concept includes a state-of-the-art remote presence learning and working environment for international collaboration in the creation of future technologies with industry and through distance education. It is a homebase for software engineering education and research as well as for university-industry collaboration. The purpose of this paper is to analyse the co-creation process of remote-presence based digital and physical co-learning and co-working place and understand the iterative process of it.

2 CULTURAL CONTEXT

The identified two major factors that influence the success of technology transfer are 1. cultural variations across nations and 2. organizational culture-based differences (Kedia and Bhagat 1988). When building up a common digital and physical platform for developing future technologies in collaboration with Finnish and Namibian students, researchers and practitioners, it is important to understand the cultural differences and similarities. Hofstede defines culture as the collective mental programming, (beliefs and values) of the mind which distinguishes one group or category of people from another. (Hofstede 1983). One can also see cultural differences within nations (or even tribes and clans, which is an essential fabric in the Namibian society. Additionally, the different generational cultures exist: digital natives, children and adolescents, who have, from the beginning of their lives, been socialized to use socio-digital technologies (Hakkarainen et al. 2015).

Finnish and Namibian culture have similarities by being both feminine and normative. Both cultures value equality, solidarity and quality. Traditional African values, although in congruence with many universal values, place more emphasis upon collectivism, collaboration, caring, dignity and respect (Poovan et al. 2006). Normative culture includes great respect for traditions. Finland and Namibia have exceptionally good and long relations (150 years in 2020). Namibia is the only country in Africa with whom Finland has such a special bond (Kaartinen et al. 2020).

However, there are also differences. Namibia is a relatively hierarchical society, while Finland is more using hierarchy for convenience only. In Finland control is disliked, communication is direct and participative. Namibia is considered as a collectivist society while Finland is an individualist society in which individuals are expected to take care of themselves and their immediate families only. All this might have consequences to experience spatial experiences.

3 PHYSICAL AND DIGITAL PLACES FOR CO-LEARNING AND CO-WORKING

The pedagogic performance of the spaces, physical and virtual, accommodate the experience of learning (Harrison and Hutton 2014). They state that the rise of distributed space set challenges for the creation and design of learning-centred communities. Co-learning, also known as

collaborative learning, is a method of learning and teaching, where learning carried out as a team exploring a significant question or co-creating a project. Co-learning can be physically learning in the same place or through the internet (Aramo-Immonen et al. 2015). Everett and Hummell (2013) noted about 'shared workspace' of inter-cultural interaction and learning that engage students' imaginations, encourage dissonant voices and generate narratives. An inter-cultural encounter creates new possibilities for reflexivity, and opportunities for co-learning.

Universities and higher education institutions old and new pay increasing attention to the need to design facilities that are activity-based and flexible (den Heijer, 2011). According to Sankari et al. (2018) the benefits of co-working spaces for academic space users are in attractiveness and community appreciation. Ondia et al. (2018) pointed out the users attach a symbolic value to physical characteristics of co-working spaces.

Li and Fu (2014) structured a basic framework for a co-working platform, which can be divided into four levels: physical workspace, basic collaboration, management, and resource environment levels. Remote presence technology allows for an experience of a shared working or learning space in a physically distributed setting. Remote presence technology is based on modelling the activities in all the participating physical environments by 20 to 30 cameras plus sensors for different senses. Thus, remote presence technology significantly outperforms the affordances of conventional videoconferencing facilities, for example, by allowing participants of the shared session to mingle freely in another physical context, for example behind, not only in front of the peers in another context. The elements of place experience, atmosphere, time rhythm, functionality, ease of use, narrative and meaning are present both in physical and digital environment (Nenonen & Kojo, 2013; Tähtinen et al.,2013). This paper aims to understand the physical and digital integration of immersive environments in co-creation processes.

4 FUTURE TECH LAB CONCEPT

Future Tech Lab is 200sqm space, which consists of three zones, welcoming zone, co-learning zone and co-working zone. While all zones will eventually have technical solutions to support each zone's purposes, co-learning zone have also been designed for novel technology that is still under development. Remote presence technique allows virtual participation to another location in the way that virtual environment is a live 3D video feed and one can see, hear and feel the situation and presence almost the similar way as participants were locally present. This is possible by setting up a certain amount of camera pairs around the room, which will gather video feed from every direction. When these video feeds are merged together, one can get a 3D constructed room, with objects, people and anything you have in that environment. While participants use head mounted displays on both ends, they can see each other in the same environment. This will enrich the co-learning experience. The same technology also allows other ways to see the other end, for example participants could look through the "window" while they are looking at the video wall and see the participants from the other side. This is only a scratched surface. In addition, one can have a sense of presence with remotely participating fellow learners by immersive connection.

The realization of the concept is completed in terms of physical place during 2019, but the final settings of technology will be completed during year 2020. However, the collaborative activities have begun and it provides the possibility to investigate both the co-creation process of immersive collaboration environments and the very first user experiences.

5 METHODS

The case study method as a qualitative approach was chosen, because it involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence (Yin, 2009). The data is gathered by interviews, participatory workshops and retrospective document analysis.

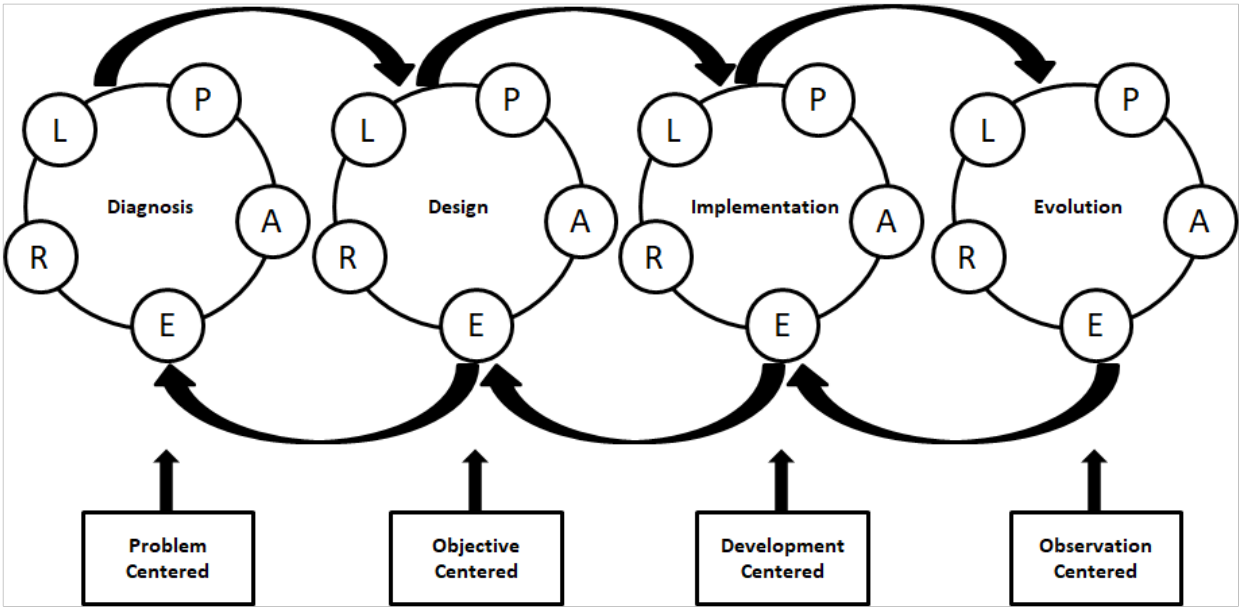
Sein et al. (2011) presented paper of Action Design Research (ADR) that provides an insightful structured process model that combines both action research (AR) (Susman and Evered, 1978) and design science research (DSR) (Hevner et al. 2004). They described seven guidelines for DSR. Guidelines are listed in Table 1.

Table 1 Design-Science Research Guidelines (Hevner et al. 2004)

Guideline	**Description**
Guideline 1: Design as an Artifact	Design-Science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desires ends while satisfying laws in the problem environment.
Guideline 7: Communication of Reseach	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

The selected framework is Action Design Research (ADR) process model by Mullarkey and Hevner (2019). The ADR approach was selected, because it encapsulates the two processes: process of designing an artefact, shared space with its technology and process of continuous improvement into an iterative and integrated whole. The model is described in Figure 1.

Figure 1. Action Design Research process model with research entry points (Mullarkey & Hevner 2019)



The model illustrates multiple iterations in ADR intervention cycles in every ADR stage. The four stages are 1.Diagnosis, 2. Design, 3. Implementation and 4. Evolution. Each phase includes iterations, which are Planning (P), Artifact Creation (A), Evaluation (E), Reflection (R) and Formalisation of Learning (L) (Mullarkey & Hevner 2019). Table 2 presents elaborated ADR entrypoints, which are part of the ADR-process model.

Table 2 Elaborated ADR-entry points (Mullarkey & Hevner 2019).

Entry Points	**Descriptions**	**Activities**	**Questions**
Problem-centered	Understand and define the specific research problem Understand and define the solution space	Problem Identification; Motivations and goals for ADR Project ADR Project	What is the problem to be solved in practice? What are the research goals of the project? Why do existing solution fall short?
Objective-centered	Explore the design options based project objectives; Generate design knowledge of what is feasible in the solution space	Solution Design; Development of Design Principles	What would a better artefact accomplish? What are its critical design principles and features? What is possible? What is feasible?

Development-centered	Develop an ensemble instantiated artefact e.g., system to address research problem; Demonstrate satisfactory solution	Solution implementation; Demonstration of Solution	How does the instantiated artefact solve the problem? How to evaluate the goodness of the solution?
Observation-centered	Observe existing system in context; Identify possible evolution opportunities for system improvements	Improvement Goals; Evolution possibilities for existing System	How has the solution continued to solve the problem? How has the problem changed and demanded changes/ improvements to the solution?

6 RESULTS

The results are presented based on the analysis of different phases of the Action Design Research process stage by stage. The focus is on the development of the physical and digital environments, in collaboration in different phases by co-creation methods.

Table 3 Action Design Research process Stage 1

Stage 1. Diagnosis **Vision of satellite campus in the Global South**				
		Physical environment	**Co-creation methods**	**Digital environment**
Iteration	**Planning**	Sharing the vision of remote presence platform	Co-creation workshops between university representatives	Sharing the vision of remote presence platform
	Artifact Creation	Identifying the physical locations in both campus in Namibia and Finland	Local representatives visiting campus	Identifying the ICT-architecture and infrastructure to equipment and tools

	Evaluation	Understanding real estate markets in Namibia	Formal meetings for institutional agreements	Understanding academic year for realizing the software engineering education
	Reflection	More specified requirements	Formal meetings for Industry collaboration	More specified requirements
	Formalisation of Learning	Understanding e.g. the differences of built infrastructure in both countries e.g. indoor environment, energy	Understanding the maturity of physical and digital infrastructure and markets	Understanding the different cultural orientations for technology

Stage one aimed to shared vision about campus in the Global South. The location of the Future Tech lab was elaborated out from the existing empty building. This made the design process focusing on retrofitting. The decision of location has turned out to be a success factor due to the fact that traditionally foreign campuses are located outside the local university campus. In this phase managerial issues to establish the agreements between different stakeholders played a key role and the shared vision was brought to the management level in both universities. The cultural differences in basic structures both in built environment, markets and action environment in the University were important to understand in this phase. The use of technology for collaboration is more typical to individual Finnish culture than in more community-based culture in Namibia.

Table 4 Action Design Research Process Stage 2

Stage 2. Design **Concept of Future Tech Lab**				
		Physical environment	**Co-creation methods**	**Digital environment**
Iteration	**Planning**	Identifying the structural elements of the place	In-Space Design with users	Identifying the current knowledge of telepresence, potential and

				challenges of the technology while using state-of-the-art technology. Identifying remote presence technology for multipurpose collaboration
	Artifact Creation	Drafting the concept with three zones: Co-learning zone, Co-working zone and Welcoming zone - Drafting the first layout solutions	Co-creation workshop with users and concept developers	Identifying most suitable hardware and setup for enabling remote presence technology Specifying the passive variables for digital environment like acoustic
	Evaluation	Stakeholders evaluate drafted layout	Co-creation workshop with users and concept developers	Evaluating a hardware setup for supporting remote collaboration and suitability to the physical environment
	Reflection	Specifying the layout solutions	Design Dialogues with professionals	Noted its impacts to physical environment
	Formalisation of Learning	Sharing the physical transcripts of with digital design experts	Sharing the Nordic design thinking with local stakeholders	Sharing the requirements of use cases with physical design experts

Stage two aimed to co-create a vision of the Future tech Lab. This was made by understanding the collaborative activities enhanced with remote presence technology. The process for defining the use cases and transcripting them to functional zones in existing buildings was a rewarding learning process for all stakeholders. The use cases require movable furniture, which supports the use of co-learning zone for multiple purposes. In an acoustic environment the overlapping

sound between local groups might affect the circumventing sound. This had to be considered by locating groups far enough from each other as well as in sound absorbing materials. At the end of this stage the local facility managers pointed out that they like the way Nordic approach is describing the places.

Table 5 Action Design Research Process Stage 3

Stage 3. Implementation **Realization of Future Tech Lab**				
		Physical environment	**Co-creation methods**	**Digital environment**
Iteration		Sharing the design brief with the chosen local partners		
	Planning		In-Space Design with local planning team in Namibia	
	Artifact Creation	Renovation of the space and decoration	Renovation process collaboration	Specifying the requirements for physical infrastructure supporting fixed technical solutions and implementing technical solutions
	Evaluation	Following the process	Collection of photo gallery Continuous updating communication	Testing current technical setup with remote presence software
	Reflection	Visiting the place	Walkthroughs and meetings	Technical infrastructure adjustment
	Formalisation of Learning	Starting to use the place	Learning to use the space in local context	Guidelines to modify technical solutions more suitable for sense of presence

The third stage aimed to realize the physical renovation in the place. The remote presence technology pilots conducted indicate that the experience of presence by technology is possible. The limitations of minor visual quality issues and missing 3D audio need to be fixed to enhance the feeling of presence. The place is supporting the remote presence experience by dividing the group areas correctly and enabling multiple uses for the remote presence technology used. Already at this stage in technological development, the space implemented allows for high quality 3D video capture. In order to get more data about user experience, we need to fix remaining issues and get more head mounted displays to test it in multiple locations simultaneously.

The cultural similarities in project management made the process smooth however there were some differences too. The trust between different actors in the renovation project is different in Finnish and Namibian culture and that needs to be considered e.g. in selection of the project group and flow of invoices during the process.

Table 6 Action Design Research Process Stage 4

Stage 4 Evolution ***Using the Future Tech Lab***				
		Physical environment	**Co-creation methods**	**Digital environment**
Iteration	**Planning**	Creating the house rules for the use of place	Workshop with the main users	Preparing ready-to-use settings for different uses
	Artifact Creation	Using the place for different kind of events	Meetings, seminars, workshops, individual working	Bringing in the technology
	Evaluation	Collecting user experience feedback	Interviews, surveys	Collecting user experience feedback
	Reflection	Identifying the needs for fixing the place	Meetings with local services providers	Ensuring the useability
	Formalisation of Learning	Sharing the cross-cultural experiences of place as a collaborative affordance	Learning to maintain the place in local context	Strengthening the experience with remote presence connectivity

This stage 4 aims to use the Future Technology Lab and due to delay in technology setting, the results about user experiences are based on the evaluation of the physical solution. Structured interviews were conducted to six users who had organised an event in the Future Tech Lab by using a survey template to gather experiences.

Based on results, the Future Tech Lab´s atmosphere is comfortable for co-working and co-learning. The current space is usable and functional for different kinds of activities. People feel current space like a home. It supports different identities and it is democratic. They wish to share the meaning of the place for others: "The room engages participants to collaborate somehow naturally". It affords soul matchmaking. Interviewed people identified the hindrances and enablers for the collaboration, the positive factors were based on the structure of the co-working zone with different levels of the floor formulating group work areas. However, the solution has some functional weaknesses: the danger of falling from different levels and the lack of space for back bags. The cultural differences were not identified in the interview results even though the sample represented both Finnish and Namibians. The observations in space have indicated that the Nordic approach to daylight differs from the local approach. Before retrofitting the large windows were dedicated for the storage space - now they are opening up the view to the mountains for all users of space and the curtains can be used to protect the room from hot sun when needed.

7 CONCLUSIONS

To sum up the results the following recommendations for co-creation of immersive environments in cross-cultural context can be proposed

1. The use of technology for collaboration sets the requirements for space and increases the collaboration intensity in space design.
2. The iterative process approach is suitable for understanding the integration of digital and physical elements of the environments.
3. The cross-cultural understanding from action environment, project management practices and finally maintenance of space need to be understood in order to develop a good user-experience for different users.

The limitation of the study is still the lack of remote presence experiences. Additionally, future studies focusing on learning outcomes is needed to indicate the success of the environment.

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SESSION 17: OPTIMIZING WORKPLACES

Change Management by Building Information Modeling and its impact on organisational optimisation and digital success in small- and medium-sized enterprises of the construction sector

An analysis of BIM-application cases and critical success factors

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ABSTRACT

The ongoing digitalisation in the construction sector is breaking up new issues of collaboration, in-house and with external partners. The research focusses on determining the success factors for change management in small- and medium-sized companies in the construction industry. Purpose of this research is guide, design and shape the change for Industry 4.0 in relevant companies. The construction industry represents a scattered market of very small, small and medium companies. The structure of construction projects require cooperation of many participants on the same project and with an alignment of common objectives. The switch to digitalisation stresses many participants in the construction industry in view of inexperience and missing risk assessment for the commitment of Building Information Modeling (BIM).[17] It is the leading digital working-method, vision and project management procedure in the construction sector. During the last year, different building research projects were analysed with regard to BIM-application cases and the effect of critical success factors in organisational structures, culture and competences. With this knowledge, the risks can be alleviated and moderated with the use of a whole set of critical success factors (CSF) along the BIM-workflow. Additional construction projects will be included in the evaluation prospectively with the objective to transfer risk-free BIM-knowledge to the entrepreneurial applicators.

Keywords

change management, construction industry, organisational optimisation, critical success factors.

[17] Note of author: uniform spelling for recurring term: *Building Information Modeling*.

1 PROBLEM STATEMENT AND BACKGROUND

1.1 Building information modeling

The working method BIM represents a digital appliance, with the goal of creating an intelligent, 3D building data model, which is usable for all stakeholders of the building process. They are going to have the access to a central model during all phases of the construction planning, execution and utilization process. The model is aware of physical data, used amounts and material, technical constructions and it is applicable on the lines of lifecycle sections of civil works as figure 1 summarizes.[18]

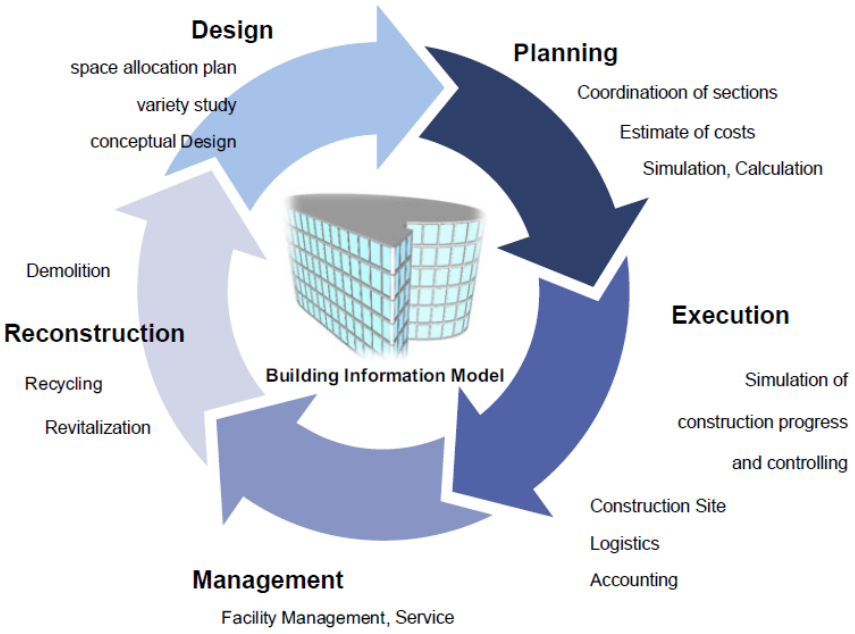


Figure 1: Building Information Modeling as integrated working method
(Source: Borrmann *et al.* (2015), p.4.)

In comparison to other economic branches, the construction sector is falling behind in view of digital transformation processes. Research in secondary data shows the imbalance.[19]

BIM is going to provide advantages for entrepreneurial and project-related structure. The necessity of in-company BIM-usage as digital working method is economically justified by competitive benefits, in comparison to analog planning and executing construction work. During the planning phase, the advantages are the model-based coordination between the individual object and expert planners. Consequently, the BIM-application establishes a cooperative problem solution tool in construction project teams. The main communication among all stakeholders within the project team will be done by different types of data output based on BIM-Software.[20]

The possibilities of work sharing on the same digital model go along with the avoidance of retrospective correction of defects and follow-up costs. It arises from increasing the model

[18] cf. Borrmann *et al.* (2015), p. 44; cf. Federal Ministry of Traffic, Construction and Urban Development/Federal Institute of Construction, City and Space Research (ed.) (2013), p. 18 – 23.
[19] cf. Best/Hinz/Leinhos (2018), p. 104; techconsult GmbH (2018), p. 6.; Schmid (2019), p. 6.
[20] cf. Treeck *et al.* (2016), p. 17f.

dimensioning by integration of cost, time and construction sequence models in the basic coordination model.[21] In this regard, the BIM-application affects organisational structures of enterprises and construction project teams and represents a change management process. A strategic implementation may lead to optimisation of individual entrepreneurial working processes.

From 2020, BIM is obligatory within the framework of public contracts in german infrastructure projects.[22] Companies without BIM-experience and internal BIM-workflow will be disadvantaged, especially in public tendering. BIM-application experiences show that unacquainted users meet challenges concerning BIM before taking advantages. For supporting the sustainable practice of BIM, an evaluation of CSF shall minimize the corporate and construction project-related risks of digital transformation by BIM.[23]

1.2 Structural characteristics of the German construction sector

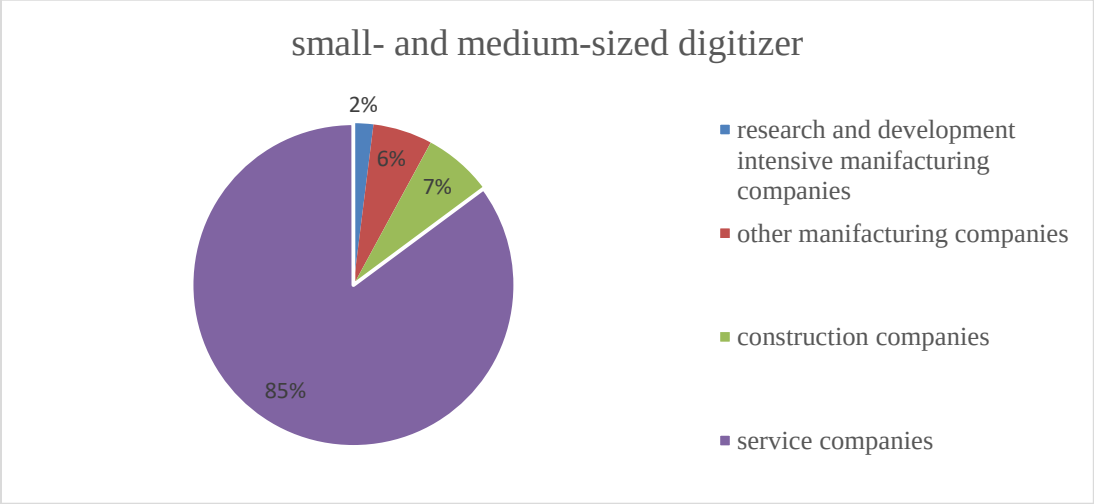
A need of change occurred in a so far analogue acting branch. The german construction industry consists of approximately 80 % small- and medium-sized companies. Those are generating about 50 % of the whole turnover.[24] In this regard, the meaning of smaller enterprises is enormous for the whole branch.[25] The reality of digitalisation in german construction enterprises turns out to be backward, regarding:

- renewing necessary IT-infrastructures,
- the development of technology-related competences and
- the reorganisation of workflows.

The construction industry is located substandard in relation to other industrial sectors in Germany.[26] A continuous BIM-application is currently missing.[27]

[21] cf. Albrecht (2014), p. 26.
[22] cf. Federal Ministry of Traffic and digital Infrastructure (ed.) (2015), p. 5.
[23] cf. PwC GmbH (ed.) (2019), Digitalization of the german construction branch; BauInfo Consult GmbH (ed.) (2019), p. 4.
[24] cf. Association of the German Construction Industry e.V. (ed.) (2019), enterprises and turnover within the german main contract work.
[25] Note of author: The definition of small- and medium-sized companies goes along with the EU Directive 2003/361/EG: microenterprises consists of less than ten employees and a yearly turnover of max. 2 Mio. Euro, small enterprises with less than 50 employees and a yearly turnover of max. 10 Mio. Euro and medium-sized enterprises with less than 250 employees and a yearly turnover of max. 43 Mio. Euro.
[26] cf. KfW Group (ed.) (2019), KfW- Digitalisation report small- and medium-sized businesses.
[27] cf. PwC GmbH (ed.) (2019), Digitalization of the German Construction Industry; BauInfo Consult GmbH (ed.) (2019), p. 3.

Figure 2: small- and medium-sized Companies: Digitizer



(Source: based on KfW Group (ed.) (2019), KfW- Digitalisation report small- and medium-sized businesses.)

Figure 2 shows the backwardness of the construction sector (7 %) towards especially skill-intensive service companies. This business panel represents the small- and medium-sized companies significantly with about 10.222 participating enterprises, by evaluating the investments in digitalisation indicators. Those are the:

- amount of invest in digitalization,
- innovation activity and
- finance structure for digital working methods.

Criteria of being a digitizer are renewing of IT-structures in hard- and software, enlarging of knowledge concerning digital application cases and enabling of in-company multidimensional workflows (data drops, conventions, working tasks).[28]

2 EXECUTION

2.1 Objectives

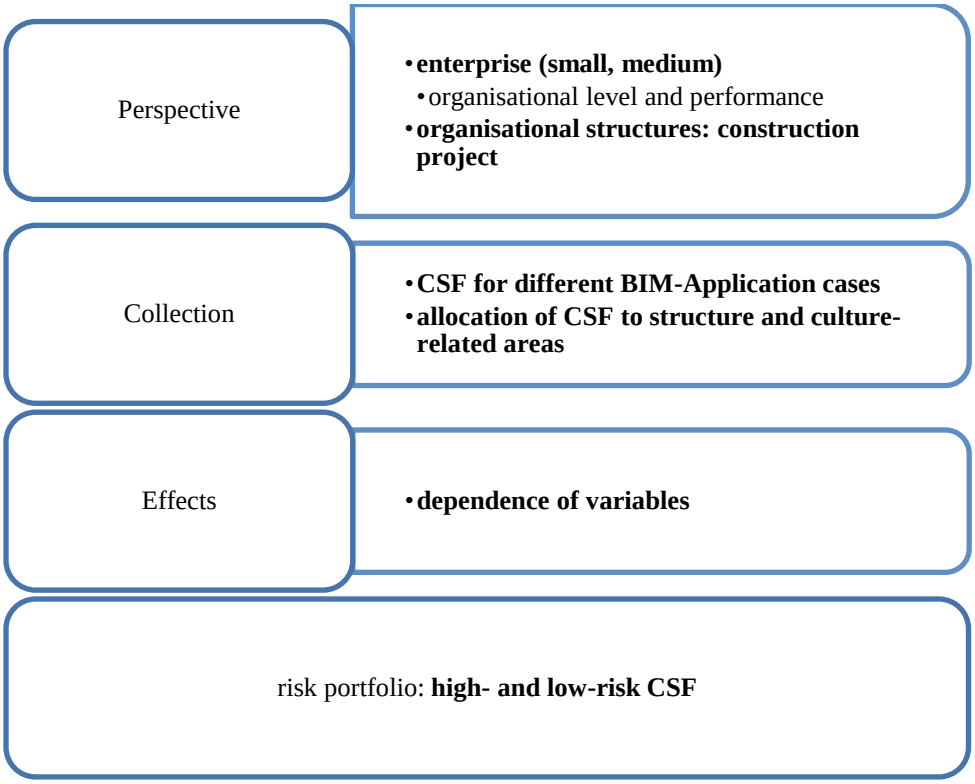
This work shall support a low-threshold connection to work successfully with BIM. Further, it is the first step of improving the competitive situation for enterprises, while getting a fast overview of the typical CSF in BIM-application. Those factors determine the effectiveness of change processes. The evaluated CSF are going to be structured as a detailed set of factors for supporting competitive empowerment and further the area-wide application of BIM as an interdisciplinary and cross-linked working method.

A theoretical framework forms a standardized category system as link between BIM as a technological application and digital working method on one side and entrepreneurial implementation necessities on the other. This research supports the increase of work

[28] cf. KfW Group (ed.) (2019), KfW- Digitalsationreport small- and medium-sized businesses.

performance in construction project teams in small- and medium-sized companies. Figure 3 shows the dimensions.

Figure 3: key dimensions



(Source: own representation.)

The purposes of the key dimensions lead to the creation of a multidimensional instrument, which is usable for risk estimation. The risk appraisal includes the entrepreneurial layer enterprise structure, enterprise culture and individual. The resulting standardized category system, which contains those business layers, is going to define essential requirements for cross-linked and interdisciplinary work during and after changing processes. The same procedure occurs concerning the construction project layer. The collection of all factors will show dependences and relations to framed digitalisation goals for companies and employees with the BIM-use. Further, it will be possible to define which kind of critical success factors appear in different BIM-application. This approach provides the awareness for individual risks in view of different BIM-user. Parts of discriminant analysis can combine and visualize cases of BIM-application with risks in various stakeholder groups and business layers and create a portfolio map.

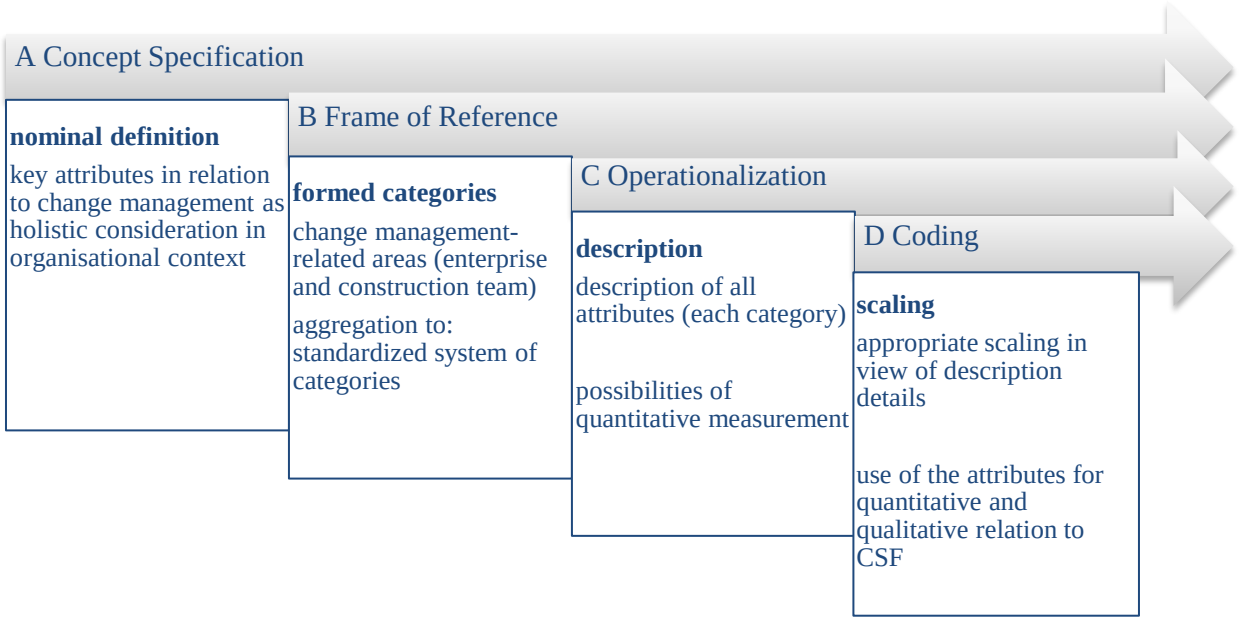
2.2 Methodology

2.2.1 Frame of reference

Figure 4 illuminates the single stages of development. The concept specification defines the criteria of entrepreneurial and construction project-related environment (A). The result is a standardized system of categories, which enables the structural assignment of evaluated CSF from BIM-related construction projects. Detailed description of all values supports the

subsequent allocation of factors (B).[29] This stage shows the relation between change management and organisational categories of enterprises and project contexts in connection to BIM-application. The variety of chosen attributes confirm to the definition of change management. Subsequently, the description of all attributes takes place (C). A definite assignment of CSF to the appropriate category eliminates interpretative scopes. The coding of the attributes contains the allocation of scale level for further quantitative or qualitative research methods (D).[30]

Figure 4: stages of frame development



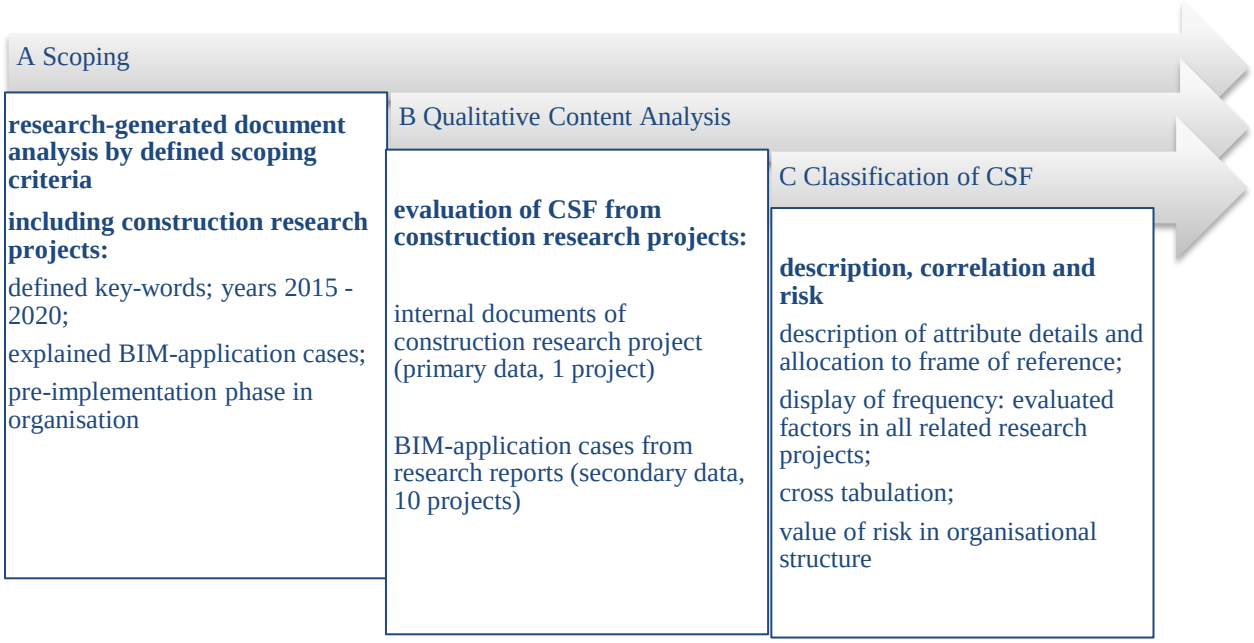
(Source: own representation based on Döring/Bortz (2016), p. 225; Cooper (2010), p. 40; Mayring (2000), passage 1-28.)

2.2.2 Analysis of critical success factors

By analysing BIM-application cases in different construction projects, it is possible to filter out CSF. A qualitative content analysis will detect the CSF, based on research reports within a defined scope. Therefore, the frame of reference builds up specific success definitions, formulated as BIM-goals for each analysis-included project. The definition of success represents the set of dependent variables, while the evaluated CSF are the independent variables, which affect the performance of success. Figure 5 illustrates the stages of analysis. Finally, the classification of high-risk and low-risk factors for organisational performance pictures a tool for risk estimation.

[29] cf. Heyvaert/Hannes/Onghena (2017), p. 53.
[30] cf. Döring /Bortz (2016), p. 225.

Figure 5: stages of evaluation and agglomeration of CSF in BIM-application cases



(Source: own representation based on Booth/Sutton/Papaioannou (2016), p. 69, 84 ff.; cf. Pham *et al.* (2014), p. 372; Mayring (2000), passage 1-28.)

The scoping procedure, done by SALSA-Method, leads to a differentiated result in database research (A). It contains the key word definition [Search], further the selection of context-related projects within the data base [Appraisal] and finally the quality evaluation of detected research reports, based on the formulated problem of CSF in BIM-application cases [Synthesis and Analysis].[31] Applied key words on Fraunhofer IRB (database) provide research projects between 2015 and 2020 to capture the current state of technology and workflow in BIM-application cases.

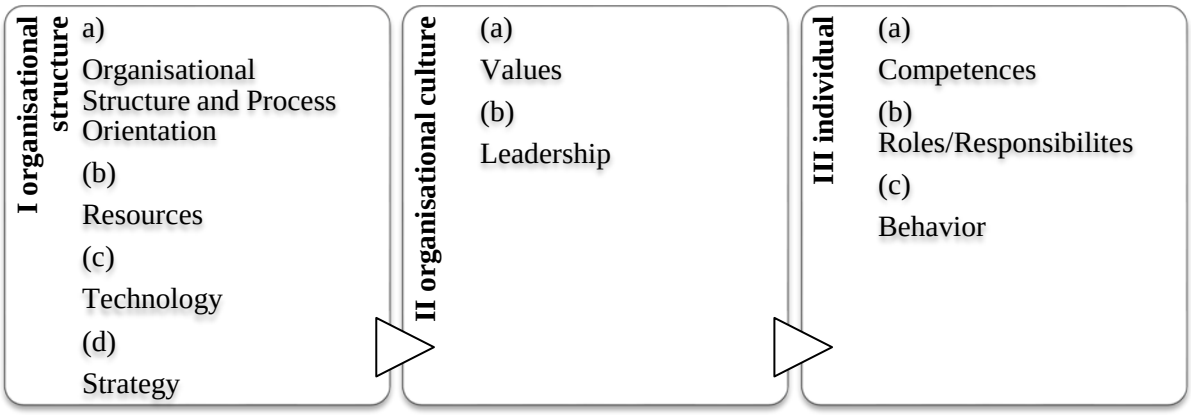
The research generated document analysis contents internal documents (primary data) and located reports (secondary data) (B). The entrepreneurial and construction project fields (figure 4) shape the conceptual framework, evaluated by literature. Theoretical founded aspects apply on factors from practical application cases along the lifecycle of buildings. The classification occurs methodical secured this way.[32]

The classification of evaluated CSF describes the attribute details and influences on the dependent variables of digital success (C). Cross tabulation leads to the connection of analysed factors and market specific criteria of enterprises and construction project levels e.g. size of enterprise or range of operational processes. Finally, a risk assessment shows which organisational areas in enterprises and construction projects with higher or lower risk. The following chapter exemplifies change management related categories of organisational interest.

[31] cf. Booth/Sutton/Papaioannou (2016), p. 69, 84 ff.; cf. Pham *et al.* (2014), p. 372.
[32] cf. Mayring (2000), passage 1-28.

3 DIMENSIONS OF CHANGE MANAGEMENT IN ORGANISATIONAL CONTEXT

Figure 6: dimensions of change management



(Source: based on Lauer (2014), p. 8; Staehle *et al.* (1999), p. 934; Kraus *et al.* (2010), p. 16.)

The described areas in figure 6 prepare the frame of reference for the content analysis. It displays change management-related context in organisations. As well the structure of enterprises as the structure of construction projects, go along with the terminology of organisation. The term stands out for coordination of processes and actions.[33] In this relation, segmented actions reach an organisational goal, which follows a system of formalities.[34] Those formalities contain distinct allocation of tasks and authorities to decide for domination and subordination. It leads to the conclusion, that organisation is an institutional facility. Following the definition of *Schreyögg and Geiger*, the participating members of the organisation are responsible for achievements within the prevalent structure.[35]

The organisational structure relates to responsibilities within job positions and new arrangements due to the BIM-working method. Workflow-renewal and the integration of additional workflow elements are necessary.[36] Activity- and workflow-related aspects obtain priority, because they are responsible for efficient working parts of performance in an organisation.[37] Financial and human resources have to be determined for individual BIM-application cases. Area Technology describes the

- quality of technical endowment (hard- and software, use of IT-systems for organisational terms),
- order of integration of digital technologies,
- data security,
- automatically data structuring,

[33] cf. Bergmann/Garrecht (2016), p. 2-3.
[34] cf. Bea/Göbel (2019), p. 26-27.
[35] cf. Schreyögg/Geiger (2016), p. 9-10.
[36] note of author: multidimensional workflows arise: technical, sequential, frame conditions.
[37] cf. Mangler (2010), p. 8-9.

- decision support due to generated data and
- automation of decision processes for employees.[38]

The error-free technical area is important for any communication and collaboration processes between the stakeholders, who work model-based. The strategy used to define long-term measurable objectives. Entrepreneurial culture specifies the willingness and corporate values and the level of participating leadership within change processes. Due to individual change and behaviour, the research captures growth of competences and responsibility displacement during the BIM-contact.[39] For research purpose, the following chapter concretises the description of digital success in the area of organisation as an important field for BIM-application.

4 SET OF VARIABLES WITHIN DEVELOPED THEORETICAL FRAMEWORK

4.1 Standardized category system

The present focus will be on the categories of organisational structure. The research will embed organisational culture and individual performance prospectively. Table 1 illustrates the standardized category system for organisational structure-related descriptions. The coding enables the allocation of CSF to the single categories afterwards.

Table 1: standardized category system of change management: organisational structure

No.	Area	Description	Code AR (Area)
1	**Structure**		
	work tasks		
a	object of work tasks	amount and sort of model-based working tasks	AR.ObjWT
b	synthesis of work tasks	amount and sort of model-based working tasks in each position	AR.SynWT
	workflow		
c	abolition of processes	amount of processes	AR.AbProc
d	rearrangement of processes	data drop points (technical workflow) written BIM-standards (workflow of framework requirement)	AR.RearrProc
2	**Resources**		
a	human resources	amount of model-related stakeholders/employees	AR.HR
b	financial resources	invest in implementation	AR.FR
3	**Technology**		

[38] cf. Rank//Scheinpflug/Bidjanbeg, (ed.) (2010), p. 16.
[39] cf. Scherm/Pietsch (2007), p. 250.

	requirements of technical equipment		
a	quality of hard- and software	difference between current equipment and necessary equipment for BIM-goals	AR.QualHS
	index of technical integration		
b	degree of internal cross-linking	amount and sort of internal (corporate) BIM-application cases for data exchange (native software, data transfer format, structure of communication, common data environment)	AR.DegintCross
c	degree of external cross-linking	amount and sort of external (project team) BIM-application cases for data exchange	AR.DegexCross
	decision support by technology		
d	automated data structuring	workflow-point and amount of automated data structuring (structuring by construction components, by communication formats, by common data environment parts)	AR.AutDS
e	automated decision processes	workflow-point and amount of standardized decision processes	AR.AutDP
4	**Strategy**		
a	mobile, digital infrastructure	hosting and cloud-using	AR.DigInfra

(Source: own representation based on Lauer (2014), p. 8; Staehle *et al.* (1999), p. 934; Kraus *et al.* (2010), p. 16)

4.2 Project description and dependent variables of digital success

Primary data build up the initially relevant investigation level. Authentic internal documents of a public promotion of economic development: *digitalisation of the value-added chain in the construction sector* are the base. Five german enterprises of the construction sector participated between the years 2016 - 2018. Those enterprises form a construction project team for a BIM-pilot project. Considered construction project phases are planning (architecture and expert planners), preparing and executive construction work. The primary goal is a BIM-approach for the stakeholders by regular workflow-practice, with the long termed objective of risk-free entrepreneurial implementation.[40] Table 2 contains the defined project goals of digitalisation, which build up the frame of the dependent variables.

Table 2: digital success definition as dependent variables

No.	Digital Success	Description	Code DV (dependent variable)
1	digitalisation of working processes (construction planning + execution enterprises)	a) optimisation/change in work/task structure b) optimisation/change in workflows c) downsizing of working tasks within	DV.DigWP

[40] cf. Bauhaus-Universität Weimar (ed.) (2018), Digitalisation of the value-added chain in the construction sector.

		spheres of job positions	
2	simplified collaboration for all stakeholders (planning + execution processes)	a) project-based central data pool b) network and collaboration structures within the construction process (data drops and co-working within one model) c) mobile communication forms	DV.SimpColl
3	consistent lifecycle management of construction	creation of central data pool as building model, which is usable in all lifecycle phases	DV.ConsLife
4	error-free practicing of BIM	a) BIM-workflow-performance according to client information requirements and BIM execution plan b) error-free BIM-workflow-performance	DV.ErrFree
5	authoritative forecast of costs, quality and time	a) model based quantity determination b) model based scheduling c) model based link to schedule of services	DV.AuthCQT
6	BIM-implementation in established organisational structures and culture	change management-related areas (entrepreneurial and construction project-related)	DV.ImpOrg

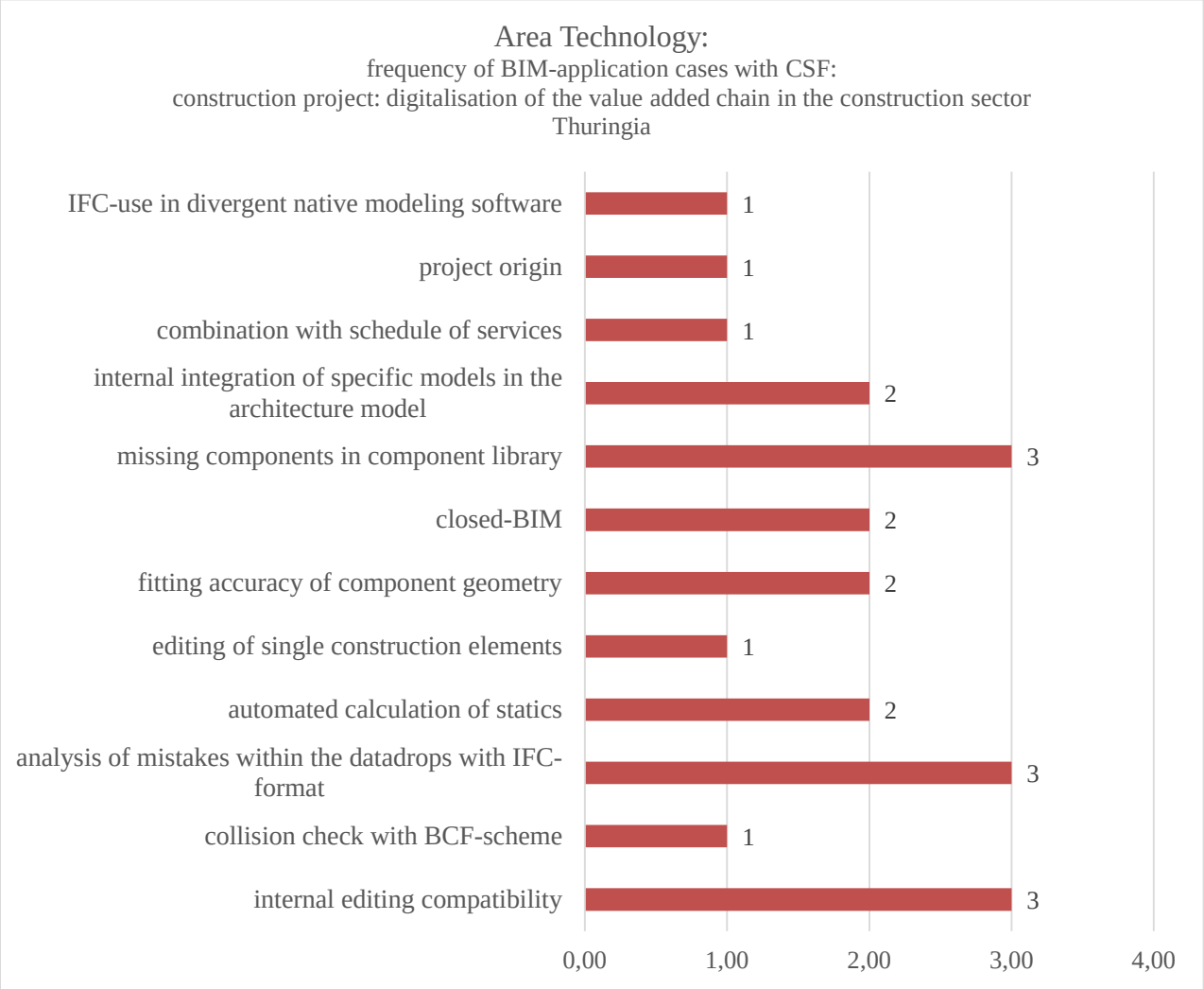
(Source: own representation based on Bauhaus-Universität Weimar (ed.) (2018), Digitalisation of the value-added chain in the construction sector.)

The following chapter consolidates technology-related BIM-application cases and CSF for highlighting cross-linked working as well as communication and collaboration contents.

5 TECHNOLOGY-RELATED BIM-APPLICATION CASES AND CSF EVALUATION

Results from primary data show the appearance of CSF within the frame of technology. Figure 7 visualizes the application cases regarding to their frequency of occurrence during the project duration.

Figure 7: critical success factors in the entrepreneurial structure: area technology (internal documents, primary data)



(Source: own representation based on project evaluation: internal documents: digitalisation of the value added chain in the construction sector, promotion of economic development, Federal Ministry economy, science and Digital Society Thuringia, 2016-2018)

The application cases range from editing of construction elements and collision checking to fitting accuracy of component geometry as well as looking for missing components in object libraries and the use of BIM-models in divergent native software. The central point of documentation in this paper are the collaboration and communication-related CSF in the area of technology, summarized in table 3.[41]

[41] own representation: project evaluation: internal documents: digitalisation of the value added chain in the construction sector, promotion of economic development, Federal Ministry economy, science and digital society Thuringia, 2016-2018.

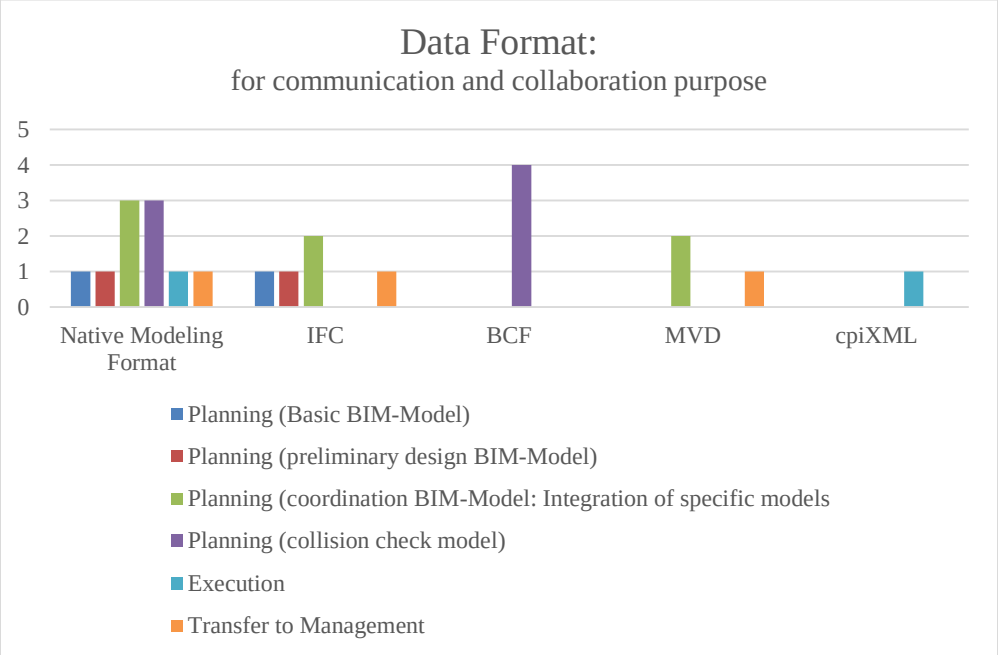
Table 3: CSF concerning collaboration and communication processes within a construction project

No.	BIM-application case	critical success factor
1	internal editing compatibility	a) single IFC-using supports only closed-BIM-application b) applied model view definition (MVD) determine the visible and readable information of model parts for stakeholders
2	analysis of mistakes within the data drops	defective IFC-export because of disregard of the standardized IFC-structure: detention of information for recipient can follow
3	collision check	a) overlap of construction elements, evaluated with the use of BCF-scheme as digital post-it for the responsible processor within the team; b) verbal description and component views for the responsible processor
4	fitting accuracy of component geometry	detection of missing accuracy in the combination of partial models from different object designer or combination of specific models (building equipment, bearing structure)
5	missing construction components	component libraries do not provide all necessary types: lack of digital availability in project process and BIM-workflow

(Source: own representation based on project evaluation: internal documents: digitalisation of the value added chain in the construction sector, promotion of economic development, Federal Ministry economy, science and digital society Thuringia, 2016-2018.)

Because of different requirements within the construction phases, the need of different types of information transfer arises among the stakeholders. Data format plurality is the result in construction management processes. Figure 6 shows different data types in construction phases.

Figure 8: data format: for communication and collaboration purpose

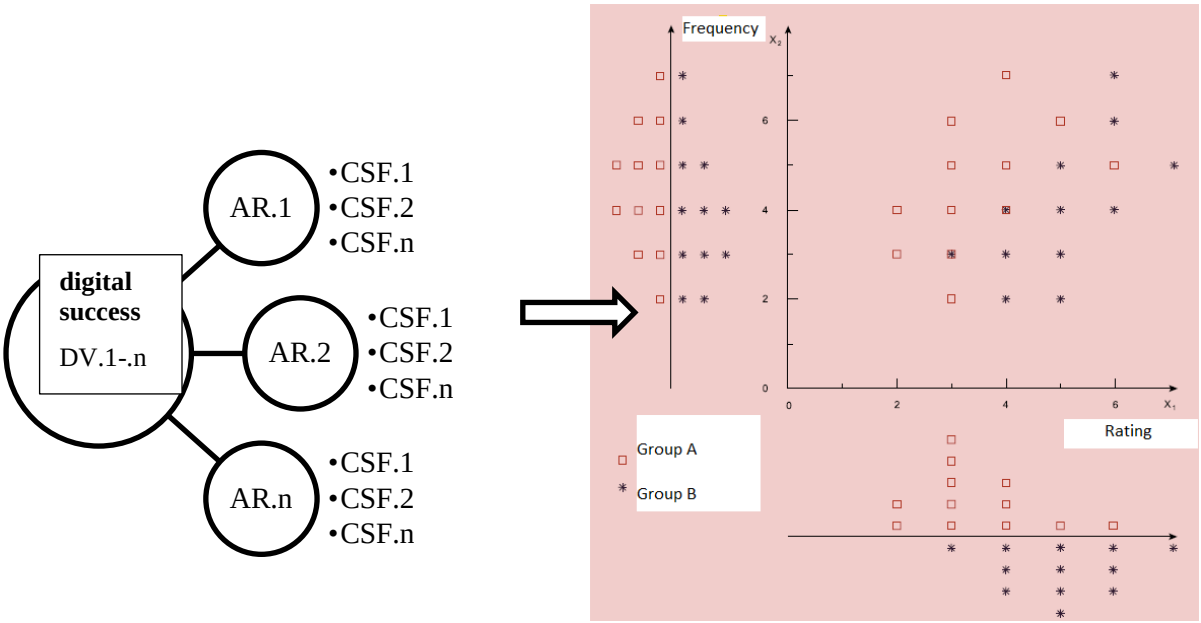


(Source: own representation based on project evaluation: internal documents: digitalisation of the value added chain in the construction sector, promotion of economic development, Federal Ministry economy, science and Digital Society Thuringia, 2016-2018)

This variety of data formats arise within the digital communication structures among the stakeholders. Native formats for creating the BIM-Model base extend all over the lifecycle. The requirement for changing construction elements in their attributes and parameter persists. The IFC-format goes along with the data drop context and occurs in moments of BIM-model enrichment by different participants. BCF-Format represents a communication tool for coordinators in planning. Further, it is a tool for checking of collisions after the combination of coordinative and specific BIM-Models. The MVD-format enables the inside and access to readable information in and from a BIM-Model only in determined sectors. An exceptional position for information transfer captures the cpiXML-Format (Construction Process Integration). It combines the final draft model information with the schedule of services for executing construction enterprises.

By analysing further construction projects (secondary data: Fraunhofer IRB), the factor collection will extend. Figure 9 shows the progress after the evaluation and allocation of the CSF to the areas of the category system. Advanced research by discriminant analysis shall discover risk potential of CSF for digital success. A CSF-classification conducts the assignment to low- and high-risk-groups, dependent on associated organisational area and frequency of occurring in construction projects.

Figure 9: scheme for CSF-classification and risk-categorisation



(Source: own representation based on Backhaus *et al.* (2016), p. 227.)

6 CONCLUSION

The options to communicate and collaborate within BIM-based construction projects are multifaceted, but also the critical factors are. For a sustainable implementation strategy of BIM-based work, it is necessary to have a reliable summary of all CSF-influenced categories and dependent success elements. Therefore, the formed standardized category system in organisational context should contain the areas, which have to be under examination for specific and individual change management purpose. Because of the disruptive structure and workflow change by BIM, especially strategic areas are included in risk research.

An early coding and scaling of the standardized category system lead to further measurement possibilities, if the collection of factors is growing. For evaluating correlation between variables of CSF and variables of digital success as well as areas fraught with risk, it is required to bring the variables in quantifiable mode. Otherwise, the overview of connected variables is not ascertainable.

Results of the partial evaluation within the organisational area show that the most frequently appearing CSF within technological-related BIM-application cases contain cross-linked possibilities:

- closed BIM-application, without cooperation possibility in one model,
- invisible information and model parts, due to defective defining,
- defective model export, because of disregard of standardization,
- defective verbal description for responsible processor in clash-detection.

With the integration of additional BIM-project documents, a reliable portfolio of CSF establishes. By analysing significant data from comparable construction projects in structure, workflow and subject, the collection is growing. Discriminant analysis will lead to CSF-groups of low- and high-risk potential within specific organisational area. The classification of CSF and portfolio presentation will show a survey-like risk collection and low-threshold risk-assessment. This proceed reveals risks as an overview for BIM-initial contact situation in small- and medium-sized companies. Based on the pre-implementation status, the BIM-application functions strategically by eliminating risks prospectively.

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Modes of linking organisations with space: A historical account of the evolution of DEGW's concepts and methods

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ABSTRACT

Purpose: The purpose of this paper is to investigate methods used to create relationships between organisations and space in the knowledge economy. The empirical work unpacks the evolution of concepts and methods of a pioneering workplace design consultancy DEGW. projects in order to understand the spatial influences of changing organisational practices.

Theory: Adopting John Law's view that method enacts reality, DEGW's world view and concepts could be accessed by studying their methods of working. DEGW's methods as enacted in their projects are their modes of linking space with their clients' organisational practices.

Design/methodology/approach: Curation of the DEGW 'living' archive was used as an archival research method to make sense of the DEGW archive. The methods consisted of discussions with DEGW members, analysing the archival materials and curating an exhibition.

Findings: DEGW methods evolve from considering space in terms of solely physical and quantitative terms, towards a more complex interaction between space and organisational practices. This shift also resonates with the changes in the working practices and a movement towards distributed working in the knowledge economy.

Originality/value: There is a growing interest to understand the relationship between organisations and space. This interest has been articulated as the spatial turn in organisation studies. This paper presents new empirical work drawing from the DEGW archive for a better understanding of methods that are used to create relationships between space and changing organisational practices in the knowledge economy.

Keywords

archival research, curation, DEGW, organisational practices, workplace design

1 LINKING ORGANISATION AND SPACE THROUGH DESIGN

The organisation studies field has recently seen a 'spatial turn'(Kornberger and Clegg, 2004; Marrewijk and Yanow, 2010). This canon has been substantiated by various empirical studies exploring the relationship between organisations and building design (van Marrewijk, 2009; Hirst, 2011; Decker, 2014). However, very few studies analyse the design methods that are deployed to link organisations and space (cf. Sailer and Thomas 2020; Gillen et al. 2019). Sailer and Thomas (2020) posited a lack of research that investigates the fit between an organisation and internal workplace layout. However, such endeavor to understand relationship between organisations and interior layouts could be traced back to Frank Duffy's doctoral dissertation at the Princeton University:

"*Assuming the independence of these two basic pairs of dimensions — Interaction and Subdivision, and Bureaucracy and Differentiation — a hypothetical model is constructed which distinguishes between types of office organization (highly bureaucratic and highly interactive; highly bureaucratic but low in interactivity, etc) and types of layout (highly differentiated, low in subdivision; highly differentiated, highly subdivided etc.)*" (p.iv; Duffy 1974)

Frank Duffy's dissertation was a key intellectual foundation of DEGW who were an architectural and space planning consultancy specialising in workplace design. DEGW became a prominent actor in shaping the field of office space planning, internationally, by enriching architectural knowledge through their research. This paper investigates DEGW's methods to understand how they conceptualised the relationship between organisations and space.

2 INVESTIGATING DEGW'S METHODS

This paper draws on the research around the DEGW Archive, which is located at the Special Collections at the University of Reading.[42] The archive contains DEGW's project consultancy reports as well as their company documents covering their work from 1971 to 1997. The consultancy documents often report the methods that were used on a project and this paper presents an analysis of the reports to trace the evolution of DEGW's methods and grasp the conceptual schema that DEGW adopted in their work. Frank Duffy and other members of DEGW have an extensive publication record. However, it is through this archival analysis of project reports, that a clear connection could be traced between the ideas that DEGW members have published and how they were applied on the projects.

A method can be seen as performative of reality. As Law (2004) suggests "*Method is not, I have argued, a more or less successful set of procedures for reporting on a given reality. Rather it is performative. It helps to produce realities*" (p.143). This paper explores the implications of adopting such an understanding of the method that workplace designers use. By analysing the methods adopted by DEGW, insights can be gained into DEGW's worldviews, their concepts and their realities to understand the framing of the relationship between organisation and space.

[42] http://www.reading.ac.uk/architecture/degw-archive.aspx

3 METHODOLOGY

A series of pop-up exhibitions were organised along with lectures and workshop as part of the process to unpack the DEGW archive. Curating was mobilised as a mode of doing research in the archive as well as in fostering a dialogue with members of DEGW network with an intent to relate the archive to current concerns facing the built environment. This approach is akin to 'Curating Sociology' "*as a methodological commitment to collaborative knowledge production for creative public intervention and engagement*" (p.43, Puwar & Sharma, 2012). Art curator Hans-Ulrich Obrist suggests that the role of professional curator involves: preservation of artefacts, selection of new works to be added to a collection, undertaking scholarly research into the collected artefacts and making exhibitions (Obrist 2014). While preservation of the materials in the DEGW archive is carried out by professional archivists at the Special Collections department of the University of Reading, the latter three activities were collaboratively conducted with the archivists and the members of DEGW network. Curating as a social practice (Kreps 2003) opens the potential to explore relationships between archival materials and DEGW members who were involved in creating and using those materials. Curating thus supports conceptualising the archive as 'a living archive'(Hall 2001), not just to open the possibility of connecting new materials to the archive, but to also enable learning from the archive to respond and reframe current concerns.

The design methods developed and used by DEGW were analysed to understand their conceptual framework while curating the 'DEGW design methods' exhibition in 2016. This public exhibition accompanied the first DEGW Foundation Lecture by John Worthington, co-founder of DEGW. The exhibition presented an alternative narrative to that of John Worthington's regarding the development of DEGW as gleaned from the DEGW archive. Various project reports in the DEGW archive were studied to understand and articulate the methods of DEGW to link organisations and buildings. The archival reports related to DEGW projects are referenced in the footnotes in this paper. Three DEGW design methods are discussed here: space standards, space-utilization and time-utilization.

3.1 Method 1: Space standards

According to DEGW, workplace standards codified the amount of space, degree of enclosure and type of furniture each grade of staff was entitled to. Space standards were used to test a building's ability to suit the user client's needs and ensure the fit of the building for the organization.[43] Space standards were initially determined on the basis of the staff grade.[44] Even within a given staff grade, the standards varied to suit types of work.[45] Based on their database which was gathered by working with different organisations, the consultancy was offered to clients to benchmark their standards. Different workplace standards also required different furniture configuration, which required working closing with the furniture manufacturer to develop furniture systems. This was the case with their client Electricity Supply Board in Dublin.[46] During the 1980s, the standards had to be revised to accommodate emerging information technology[47], and particularly in case of desks on the dealing floors in the City[48].

[43] Making premises work, DEGW A/86/26, 1985
[44] Office accommodation study for Sharp MacManus Ltd., DEGW A/258/1, 1971
[45] New HQ building Geneva, Digital Equipment Corporation International (Europe)), DEGW A/98/4, 1976
[46] Re-location of Sales Department, Electricity Supply Board Dublin, DEGW A/108/4, 1978.
[47] Impact of information technology on office floors at Truman's Brewery, Brick Lane, DEGW A/297/1, 1983.

3.2 Method 2: Space utilization

Space utilization was initially measured as net usable area and circulation area.[49] This kind of quantification allowed estimating the growth of the firm that could happen in a given building, by projecting the space requirements (derived using space standards) commensurate with staff projections.[50,51] Such analysis was also useful to inform architects' designs and review the performance of the design proposals.[52] Space utilization analysis was also carried out for whole property stock of client organisations, to advice on the use of existing space and possibilities for rationalising the locations of their business units.[53] Using a set of definitions for building area, the efficiencies of various buildings could be compared and could inform alteration of internal layouts.[54] A software tool Space '81, also usable by non-specialist client users, was developed to assist space utilization analysis. Over the years, the definitions of areas measured were developed to form 'Space budget', the total space requirement of an organisation.[55]

3.3 Method 3: Time utilization

Time utilization method was developed to address increasing economic pressures on occupancy costs.[56] The consultancy for Hewlett Packard's field-based engineers, dating 1980, demonstrates how increasing pressure on the space could be relieved by creating shared desks for field-based engineers, Hewlett Packard.[57] The application of this method to design DEGW's own offices led to six categories of users and a floor plan with a combination of individually owned and bookable spaces.[58] The six categories of users were: the nomadic worker, team resident, independent, manager of multiple teams, support and the visitor. The DEGW office redesign was an early application of the activity-based working approach. The user categories were derived through the observations of time utilization survey.[59] The observations of DEGW office are also comparable to those of Rank Xerox[60].

4 DISCUSSION: CONCEPTUAL FRAMEWORK OF DEGW

One of the influential concept developed by DEGW is thinking of buildings in layers. The origins of this concept could be found in a 1970's publication by the DEGW co-founders Frank Duffy and John Worthington, where the building layers are thought of as shell, scenery and sets (Duffy and Worthington 1972). The classification and names of the layers have evolved over time in DEGW's work. However, the idea of a building as different layers changing at a different rate of time remained. The concept was widely disseminated and popularised by the Stuart Brand in his discussion of DEGW's work (Brand 1997). DEGW's work was ingrained

[48] Dealing floors, DEGW, DEGW A/84/1, 1984.
[49] Feasibility Study for DOW Corning International, DEGW A/100/1, 1972.
[50] Making Better Use of 54 Lombard Street, Barclays Bank, DEGW A/21/4, 1981
[51] Review of Space Requirements to 1986, American Express, DEGW A/6/3, 1982
[52] Hammersmith Development: a report on building depths for Fosters Associates, DEGW A/116/1, 1977.
[53] Space Study, for Scottish and Newcastle Breweries, DEGW A/253/1, 1978.
[54] Space Requirements Report for 19-20 Berners St, American Express, DEGW A/6/2, 1974.
[55] From briefing to design, DEGW A/86/19, 1993.
[56] Integrating People, Processes and Places, DEGW, DEGW A/86/25, 1996.
[57] Study for Field Engineers Workstations, Hewlett Packard (HP), DEGW A/141/1, 1980.
[58] DEGW brochure, Giffone Collection.
[59] Replanning DEGW, DEGW A/86/12, 1996.
[60] A study of salesforce time utilisation in Manchester and Birmingham, Rank Xerox, DEGW A/239/8, 1994.

with the fact that buildings change over time (Patel and Green 2020). The briefing and decisions pertaining to 'Shell' (long term) and 'Scenery' (short term) were advised to be separated to enhance the adaptability of buildings. The growth of an organisation meant that either the scenery had to be changed in the short term, or the shell of the building itself had to be changed in longer term. This was evident in the project reports discussed under space utilization method. Sailer and Thomas (2020) argue that the fit between an organisation and internal layout is not perfect as organisations continuously evolve. It can be learned from DEGW's work that the conception of buildings need to reflect such view as well. Moreover, different buildings can accommodate changes differently. Change in an organisation also requires new working adjacencies between organisational groups, thus requiring new stacking plans to ascertain how internal office layouts might be adapted.

The discussion of the three methods also demonstrates the evolution of DEGW's initial concept of shell, scenery and sets (Duffy and Worthington 1972). Services became a prominent aspect of buildings in the 1980s as evidenced in DEGW's work on dealing floors for London's financial services sector. DEGW undertook a multi-client study titled 'Office Research: Buildings and Information Technology' (ORBIT) which highlighted the implications of new technologies in reshaping organisations and their architectural needs (Thomas 2019). The subsequent development of the concept often referred to as the '4S model' in the DEGW parlance included services along with shell, scenery and settings. The findings from analyzing DEGW project reports demonstrate the DEGW methods and concepts were not stagnant and involved continuous learning and development in response to wider technological and economical changes.

The projects discussed above substantiate the changes required from the buildings to accommodate technological developments. The method of time utilization particularly as applied in the replanning DEGW's offices demonstrated the implications of mobile working on space design. It also involved a change in organisational practices such as introducing a clear desk policy to facilitate hot-desking. Gillen et al. (2019), using the example of time utilization study method, argue that data collection tools to understand use of offices need to evolve in accordance with the changes in our ways of working. It can be observed from the DEGW archive, that the methods to understand and design workplaces were evolving in response to the technological developments as well as changing organizational practices. Given the current context of COVID-19 pandemic, the workplace needs to be re-thought as distributed across an ecosystem of different spaces (Cushman & Wakefield 2020). As seen from the evolution of DEGW methods, such re-conceptualisation of office would require new methods and tools to understand relationship between organisation, space and the working practices.

5 CONCLUSION

"*The logic that has generated each project and each intellectual departure – environmental, social, the distribution of services, the accommodation of different requirements over time – is always evident. Each one of these DEGW designs has been driven by ideas. And of all the ideas that have obsessed DEGW over the years and have shaped its work, none has been more influential than what the concept of time means for design.*" (p.53, Duffy *et al.*, 1998)

This statement from DEGW's publication discussing its methods and concepts is substantiated through the empirical analysis of the DEGW archive presented in this paper. The analysis of the

DEGW archive demonstrates how DEGW a temporal view of buildings and organisations has been core to DEGW since the 1970s. The current trends of activity based working and dispersed working could be anchored in the historical development of DEGW's ideas on workplace design.

Two lessons are relevant in the wake of new ways of working that current pandemic has instigated. Firstly, the methods discussed in this paper namely space standards, space utilisation and time utilisation suggest that articulating a link between organisation and space demanded a fluid conception of buildings rather than approaching them as fixed objects. This is particularly relevant as future workplaces are imagined to be distributed across an ecosystem of spaces beyond the traditional office building. Secondly, the methods and concepts to design workplace continuously evolved in response to the changes in the ways of working. Designing an ecosystem of work spaces would require new tools and concepts to support the changing work practices.

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How can knowledge workplaces be optimised by new layout and technology?

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ABSTRACT

Purpose: To investigate the implementation and use of new workplace layout and technology in managing knowledge work organisations.

Theory: The study applies an overall Facilities Management (FM) perspective with a particular focus on workplace management and technological development. The analysis also draws on theory on value and business models, change management and intelligent buildings.

Design/Methodology/Approach: The empirical data is based on four case studies. Data was collected by document studies and interviews in three case organisations based in Denmark, while the last case was based on desk research of a US based Multinational Corporation. The cases investigate knowledge work organisations' experience with workplace change projects and workplace consultants' experience from advising their customers on these types of project.

Findings: The case studies partly support the common assertion in literature that enhancement of efficiency, both in terms of production efficiency and maintenance cost, is the most important reason to engage in new layout and technical redesign of knowledge workplaces. However, corporate branding, recruitment strategy and employee satisfaction are other parameters that in some cases are even more important to knowledge work organisations than enhanced efficiency. Two of the cases show how meeting rooms equipped with advanced audio-visual technology and virtual conference facilities can be used for production purposes. A common conclusion from the interviews is the importance of focusing on change management, especially in the post-implementation period, to ensure that the ambitions of the new workplace designs are being adapted to the work processes of the organisations in the way they were intended.

Originality: The paper contributes with new insights on how knowledge workplaces can be managed and optimised by new layout and technology. It also provides new insights on added value to the organisation, beyond the initial expectations of added efficiency.

Keywords

Facilities Management, Knowledge work, Workplace, Layout, Technology

1 INTRODUCTION

Investigating the implementation and use of new layout and technical work process aids in the management of knowledge work organisations is relevant, because these aspects of Facilities

Management (FM) have an impact on a number of parameters in the business model of these types of organisations.

The research question for the study was: "What impact does a combined workplace design and digital work process strategy have on knowledge work business models and efficiency?" The empirical data presented in the paper is based on a multiple case study of four cases related to workplace management and technical work process aids. Further information about the study can be found in Nielsen (2019).

The paper is structured with theory in section 2 and methodology in section 3. The case studies and findings from cross cases analysis are presented in section 4 and the paper finishes with discussion and conclusion in section 5.

2 THEORETICAL BACKGROUND

Managers of modern organisations are on constant search for the right balance between competencies and work methods that can mobilise the full potential of their workforce, and at the same time make the workforce dynamic enough to be able to adapt to the constantly changing demands of the markets. In a knowledge workflow, where automated processes and human decision-making and actions are mixed and the automated processes have an increasing speed and efficiency (Moore's law), the human actions are deemed to become the eternal bottleneck of these interacting processes. Thus, the support of the work processes in the facilities that provide the framework for human interaction, collaboration and decision-making becomes critical to market position for knowledge work companies in the future.

According to the strategic consulting company Gartner´s latest forecast on top tech trends for 2020 what they call the "Empowered edge", being the total of smart things and devices that will be implemented in knowledge workspaces to enhance efficiency, will increase dramatically over the coming years (Gartner, 2020). Gartner's forecast predicts that by 2023 there could be more than 20 times as many smart devices at the edge of the network as in conventional IT. Choosing wisely among the rising amount of technologies that potentially offers increased efficiency is a challenge to management, in itself. Setting up an FM organisation that can implement and maintain these edge systems and implementing the functionalities that these devices offer into the work processes and activities in knowledge workplaces requires an increasing amount of attention from corporate management.

The emergence of IBMS (Intelligent Building Management System) (Designing Buildings, 2019) and the demand for more accurate monitoring, sensors, controls and smart applications, for a building to become more intuitive, secure, productive and cost efficient, has expanded into many of the previously automated systems. With IBMS, data on various functionalities are generated and can be analysed for even further optimisation of FM. Smart functionalities in work process aids, such as Unified Communication and Collaboration (UC&C) technologies (Techopedia, 2020), smartboards, intelligent wayfinding, and intelligent meeting room booking systems can all generate useful data and insights on facility performance and utilisation. This means that the number of functionalities that the IBMS systems needs to include, in order to cover the full spectrum of FM, is expanding drastically.

With the ability to support a knowledge work environment that is constantly changing due to the fluctuating nature of the products and services that white-collar employees are either developing,

managing, administrating or otherwise involved with in their work methods, flexibility and reliability become key parameters for the demand of the facilities. This condition of constant change inherently puts a demand on the change management that derives from these changes. Attention to change management (Kotter, 2012) has a big impact on the level of success, when implementing new features in a work environment. When you rollout a larger strategic workplace change, for instance by implementing "Activity-Based Workspaces" (ABW) (Candido et al., 2019), the different set-ups of functionalities might not be equally relevant to all employee groups. According to the research and consulting company Leesman, the greatest challenge to maximum positive output of implementing ABW is the behavioural change management: *"Poor adoption of appropriate behaviour in activity based workplaces is a significant problem that limits widespread organizational benefits"* (Leesman, 2017).

Thus, technological enhancements in the design of workplaces could potentially provide user data that would enable organisations to monitor workplace behaviour among their employees and more precisely be able to adjust workplace design based on this data.

3 METHODOLOGY

The research started with a literature study on the subject, with respect to an overall FM perspective, supported by other academic perspectives. The main strategic topics were identified based on the literature study and formulated into the basis of the theoretical background. This was also supported by investigating newly published reports by relevant sources, such as advisory and consultancy organisations within the field of strategic FM.

Four cases that could illuminate the practical experience of putting the theory on the subject into practice were selected. All cases were selected as 'good examples' (Yin, 2014) in relation to the main strategic topics identified from the literature study. Data was collected by document studies and interviews in three case organisations based in Denmark, while the last case was based on desk research of a US based Multinational Corporation. Information about the interviewees' position is included in section 4. Interviews were analysed thematically and the cases investigate knowledge work organisations' experience with workplace change projects and workplace consultants' experience from advising their customers on these types of project. The selected cases were first analysed individually and afterwards a cross case analysis was made.

4 FINDINGS

4.1 Financial Institution

The company had recently relocated to a new office building in order to meet the organisations increasing demand for flexible space and they decided to implement ABW as the layout strategy for their new location. The company had outsourced all facilities services to a service provider, while everything related to space management and continuous adjustment in relation to workplaces are led by the internal department called Workplace Management. The case study is based on an interview with the head of Workplace Management and a project manager in this department.

The decision to introduce ABW in the financial institute was based on three main strategic reasons:

- To utilize their space more optimal
- A wish for the building and the technology to better support collaboration across departments and locations
- A wish for the new headquarters to communicate a "modern workplace"

The company's experience with implementing ABW and supporting this with a high level of technological functionalities showed, that the cost of increased complexity and the expected increase in derived FM expenses by providing the technology required to enable flexibility for the knowledge workers was beneficial to the organisation, due in part to an increase in work process efficiency. But it also showed that by implementing ABW, the organisation saved on m^2 expenses, because they could fit more people into less space, and the paradigm of free seating resulted in visible savings on cleaning and maintenance expenses.

When asked, if there were any downsides to the implementation of the new space management strategy, the interviewees replied that the amount of attention to the post cultural effects took them somewhat by surprise. Change management is an important part of the responsibility of the Workplace Management department, which was expressed by the following statement: *"as project managers we lead projects, but we also lead change."* (Interview, financial institute). The majority of employees embrace the project to a wide extend and adapted to the cultural change, the implementation of ABW required in order to function properly. However, there were certain departments and individuals, who were more reluctant to adapt to the new culture.

4.2 DTU Library

DTU Library is the central library on the campus of the Technical University of Denmark (DTU). It functions as a meeting place for students with space for group work, workspace for solo studies and larger spaces for events. According to the mission of DTU: *"DTU Library is a leading user focused and innovative research library that supports DTU's research, education and collaboration."* (DTU, 2020). This case is based on an interview with the head of Workplace Management at DTU Library.

DTU Library has recently been renovated and now has an extensive customer measuring system that measures via heat sensors, microphones and cameras, and generates data for research purposes on user behaviour in respect to occupancy, temperature, noise, and dwell-time. It also has an advanced LED lightning system installed that is self-regulatory, depending on time of day and amount and location of external sunlight.

The ability to more precisely register live insights of actual user behaviour, and act on them, will enable organisations to adjust workplace design more precisely to meet the needs of the users. However, the main task related to this potential insight does not lie with the technical installation and the gathering of data. It lies with processing the data and establishing the algorithms and building up the Artificial Intelligence (AI) that can extract and translate data into useful insights that one can take operational action on.

In respect to maintenance and cleaning there is a big potential in performing dynamic service depending on user behaviour, but it is the library's experience that external service suppliers were not yet ready with a business model that can incorporate this dynamic in the pricing of their services. This again highlights the importance of an organisation's ability to capitalize from the

benefits that edge technology potentially provides, and the importance of setting up the FM organisation in a manner that extracts the full value of edge technology.

4.3 COWI

COWI is a Danish founded engineering consulting firm. The company has 11 regional offices in Denmark. COWI is active in 35 countries in Europe, Asia, the Middle East, Africa and North America. COWI employs approximately 6,000 people internationally, with approximately 2,400 employees in Denmark. This case is based on an interview with a Chief Audio Visual (AV) Specialist.

Among the latest consultancy services, that COWI has started to provide, is AV solutions and design aspects in their consulting projects. It is COWI´s experience that AV has an increasing importance in the design of white-collar workspaces, and these types of projects represent an increasing part of the work that the interviewee's department deals with. One of the projects that the interviewee has been involved with is the technical set up of the AVIXA organisations workspaces.

AVIXA™ is the Audio Visual and Integrated Experience Association and the international trade association representing the AV industry (AVIXA, 2020). AVIXA works with licensing and certifications and develops international standards for the AV industry. In order to work consistently with the task of establishing and maintaining the standards, AVIXA has implemented a specific collaboration work method:

"In the conference rooms where we develop standards, there are two large screens. One screen can be freely shared between the participants, who can be either present in the room or be included via video link. Everyone has access to the screen. It is controlled via an IP sharing that everyone logs on to, where presentations, drafts, sketches, etc. are shared. All types of input, technical drawings sketches, text drafts, etc. are distributed and shared on that screen. There is a "technical writer" present at the meeting who has control over the second screen. As the participants come up with presentation input and the discussion in the meeting develops, we can see the document being created on the second screen by the technical writer. In these sessions, we have the opportunity to call in experts. We can share one of the two screens with material from external participants, which can then provide input to either drafts or the current final document. With this setup the actual production of work is taking place, and when we go for lunch, there is a new draft in place." (Interview, COWI)

This is an example of how to elevate a meeting from "a forum of expectation alignment" where the outcome is a 'to-do' list, to an actual production activity, where the final product is the outcome. By looking closely at the typical stakeholders and the typical product, a combined technical setup and a meeting work process has been established that shortens the time to market for the specific product in question. Precise technical design of collaborative platforms that has attention to the workflows and processes is required to exploit fully the advantages of these technologies. Collaborative platforms literally provides means and tools for new ways of working, that can bypass and shortcut previous workflows.

4.4 Procter & Gamble

Procter & Gamble (P&G) own a vast amount of consumer product brands, like Pampers, Ariel, Gillette and Duracell. They employ approximately 127,000 people in 80 countries and are

represented by these products in over 180 countries. This case is based on desktop research with Accenture (2019), Davenport (2013), FusionBrew (2019) and McKinsey (2011) as sources.

In 2010, P&G together with the consulting company Accenture formulated an active AV and collaborative innovation strategy called "Connect & Develop", in the light of the widespread geographical scattering of the company and the need to manage their Global Business Service in a more agile way. The main strategic objectives strategy were:

- Making P&G simpler, faster, flatter and more agile
- Speeding time-to-market for new products
- Strengthening connections to consumers
- Supporting P&G's commitment to sustainability

P&G are relying on data to manage sales and have developed their own Unified Communication & Collaboration system and process to establish and communicate a single source database that they use the same way globally on all product lines. The data P&G work with are collected in an interface called "Decision Cockpit". The Cockpit makes data available on the desktops of decision makers. The cockpits are customized, so they show live data on the topics and products that are relevant for the specific decision maker.

P&G´s CIO at the time, Filippo Passerini explains in an interview:

"What's different now is that all this data is coming together in the context of the business discussion … And because it's the single source of truth for P&G executives around the globe, it's not fragmented by geography or management level and, importantly, it's coming in real time to make better decisions faster in every single business review we do." (FusionBrew, 2019).

To utilise all this data and visualise it in a way that makes management able to decide business strategies from what the data tells them, P&G needed a tool that could make this data visible and shareable in their decision processes. Through looking very intensely at their internal development and product management processes, P&G developed a collaboration concept that they called "The Business Sphere", see Figure i. The business spheres were meant as technically enhanced meeting rooms that aimed to provide the ability to visualize the gathered data about each product. This was done to be able to work with the data of their products from across the globe and to establish a fast way of communicating the data collected about each product.

The decision in P&G to rollout this work process globally, and to make a standardized technical set-up in their "Business Spheres" across the organization, with the same principal for the "Decision Cockpit" interface, also enables P&G employees to switch workplace globally and work with other product lines, because the decision-making tools and processes are the same. This digital and spatial strategy, where they have defined a specific meeting room typology designed both in respect to layout and technology in a specific way, enables P&G to administer their various product lines in an agile manner.

Figure i P&G's "Business Sphere" (McKinsey, 2011)

4.5 Cross case analysis

A result from both the financial institution case and the COWI case is that efficiency is not the only driver for new design and technology in workplace design, and in some cases, other drivers are expressed as more important. This of course depends on the organisation, and their specific needs or challenges. One organisation might have challenges maintaining a steady flow in their recruitment pipeline of knowledge workforce, and others have spatial issues and again others experience a lack of efficiency, but they all decide to optimise or redesign their workspace as a response to these challenges. These individual needs might also change over time, so there is good reason to monitor these drivers constantly within an organisation, since the workplace layout and work processes have an impact on so many values.

The DTU Library case investigated how a constant flow of data generated from monitoring user behaviour creates valuable input in FM. These tendencies of monitoring user behaviour to generate data as a fundament for dynamically customising workplaces, according to the actual activities these workplaces support, have increased attention in the global real estate market and FM services and advisory businesses. Full integration of user behaviour and hard data on equipment uptime and scheduling of predictive maintenance, are some of the advantages that a more thorough monitoring and combining of data can provide for a more dynamic and responsive FM execution.

Both the case from COWI and the case for P&G shows how meeting rooms equipped with advanced AV technology and virtual conference facilities can be used for production purposes. Such meeting facilities can enable an integration of the physical and virtual work environment.

Based on the cross case analysis, the results can be summarised as follows. In order to achieve a workplace design, which at the same time responds to rising demand for flexibility, is cost efficient in respect to maintenance, and supports the work process efficiency that users and

knowledge workers expect in a modern workplace, the FM organisation must keep focus on the following four parameters:

- ***Occupancy:*** It is important to know if the workplace design is being used by the employees and in the way that it is intended. Gathering chronological data on occupancy and activity in specific areas of a workplace is essential to understand and dynamically adjust the design to the actual activity that the workplace is supposed to support and facilitate.
- ***Customization:*** Ability to design as precisely as possible, both in respect to layout and technology, to support the specific work processes. Having a precise knowledge of the work processes of each department, enables an organisation to support these work processes dynamically via the design and technical functionalities of the facilities.
- ***Profiling:*** Ability to distinguish which work functions benefit from which type of layout and technology, and which work functions to potentially exclude from a planned strategic change in work environment.
- ***Change management:*** When a new design is implemented, and all technologies are fully functional, one is only halfway there. Following through on the post-implementation change management is extremely important. Persistent change management is critical for an organisation to harvest the full potential benefit of a change project.

5 DISCUSSION AND CONCLUSION

The initial theoretical background research suggested that enhancement of efficiency, both in terms of production efficiency and maintenance cost, is the most documented and described reason to engage in workplace and technical redesign in knowledge workplaces. During the case studies, several other parameters as reasons for embarking on change projects in workspace management were revealed. Corporate branding, recruitment strategy and employee satisfaction are other parameters that in some cases are even more important to knowledge work organisations than enhanced efficiency.

Up to date technical setup to support collaboration is a work tool that new generations of employees expect in their future workplaces. It is therefore an increasingly common active tool in recruitment strategies in knowledge workplaces to have digital support for collaboration as an active work process strategy. The results also show that advanced meeting rooms can be used as production facilities that enable an integration of the physical and virtual work environment. The ability to mobilise peripheral competencies only when needed means that organisations can focus on the specialisation of their core competencies One will have to build up a reliable network of peripheral external resources in order to execute efficiently with this type of business model.

Change management is key to making the change in work processes stick; especially in the post-implementation period. Depending on whether the change in technical setup and work processes is a result of employee demand, or a management decision, the amount of change management needed to make the ambitions for a new culture stick can vary. A comprehensive change in work processes will always be more relevant or wished for by some employees than others.

Many academic disciplines come into play, when considering workplace layout and digital aids as a means to enhance work processes in facility design. FM is the umbrella discipline, but

innovations management, change management, architectural design processes, as well as electrical and digital engineering and project management are some of the academic disciplines that are important, when driving the layout and technology projects aiming to support and optimise knowledge workplaces.

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SESSIONS 18 & 19: DIGITAL WORK ISSUES

Work design in the digitization process in small businesses of the craft's sector

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ABSTRACT

In the wake of the lively discourse about digital transformation[61], many companies feel pressured to enhance their digital portfolio – from products to work equipment and processes. Especially in small companies, this is most often not accompanied by reflections about the impact of the changes on the working conditions of the employees. In the crafts sector this is accompanied by some special conditions and restrains that prevent many small companies to occupy themselves with digitization on a deeper level.

Despite the "prosumer" trend, the ubiquitous digitization has only slowly made its way into the crafts sector so far: The sector traditionally mostly consists of small businesses, only half of which have a website or offer services online. Customer communication is usually via phone and processes are planned and documented on paper. Also, the flow of information within craft businesses is often laborious. Coordination between customers and craftsmen, within the crafts businesses or between different companies working together on larger customer projects is traditionally characterized by personal dialogue till now. In this field of handwork, the now upcoming digital tools to manage processes or communicate with colleagues and customers mark an important change of work conditions. The article aims therefore at casting a closer look at the effects of digitization on the enterprises and employees in the crafts business, as well as the challenges and the potentials in this area.

The empirical findings are based on work situation analyses in the companies and interviews. The goal of these observations was the analysis and documentation of operational processes that are affected by digitization. The state of art of technology used in the companies and their areas of application was also recorded. Based on this, the business needs and possibilities and the requirements and wishes of the customers were determined in cooperation with the crafts businesses.

Although processes can get easier and more effective with using digital tools in the crafts sector, there are also restraints to overcome. The implementation period is a crucial phase with various negotiation processes. Differing views and logics of all involved parties have to be combined to create a solution that can be used to improve humane working conditions. Apart from that, the

[61] Digital transformation means the development in society and economy in the context of digitization and cross-linking between the virtual and the real world that is being discussed under the term "Industry 4.0" or "Work 4.0". Digitization is one, but not the only part of that process (Guhlemann 2020).

ergonomic requirements, on building sites for instance, demand compromises in the usability and selection of suitable devices. Due to time restrains, competency development that is needed for the usage of the new technologies must be fitted in the job.

The contribution shows potentials and restrains as well as possibilities of digitization in the crafts sector, and hints at approaches for target group specific humane work design suitable for small enterprises.

Keywords

digital transformation; digitization; craft sector; work organization, small and medium-sized enterprises, restrains and potentials, humane work design

1 INTRODUCTION

German handicraft enterprises[62] are confronted with a multitude of challenges: Problems in finding suitable personnel, which are often based on difficulties in making work in the skilled crafts attractive, an aging workforce, changing customer requirements and a lack of digital competence on the part of employees as well as the complication of work processes through excessive bureaucracy (Naegele 2020). At the same time, digitization is advancing steadily. In the wake of the lively discourse about digital transformation, many companies feel pressured to enhance their digital portfolio – from products to work equipment and processes. But despite progressive digitization in all sectors and areas, many (smaller) craft businesses currently still work mainly with paper and pencil or use office software for their internal administration and correspondence at most. This often delays processes considerably and causes duplication of work. In conjunction with the prevailing shortage of skilled workers in the skilled trades, this poses a twofold problem: Firstly, the use of digital technology could increase the attractiveness of the craft trade sector as an employer and, secondly, when staffing levels are tight, it is particularly important that as much time as possible is left for the actual core business and as little time as possible is wasted on bureaucracy, administration and poor agreements.

Due to the special features that characterize the craft trade sector, it is assumed that digitization strategies of industry and the manufacturing sector cannot simply be copied or "broken down", but rather, starting from the specific structural framework conditions, completely individual ways have to be found that are sector-specific and designed according to the company's own initial situation and requirements

With this regard, the aim of the paper is to show, how digitization can contribute to solving the problems in the craft sector, what potentials it offers and which resistances are blocking the way for the companies. This will be approached by enlightening the discourse and the findings literature offers regarding these questions, and supplemented by findings from the ongoing BMBF project “Athene 4.0” that show, how different types of companies in the craft sector use digitization, and what are the limiting factors especially for small companies. The paper closes with an outlook on the further development.

[62] This article refers to craft businesses that offer services around the house and/or building sites like painters, electricians or sanitary, heating and air-conditioning businesses.

2 DIGITIZATION EVERYWHERE – EXCEPT IN THE CRAFTS SECTOR?

In the scientific discussions on the topic of "4.0" craft trades are viewed rather subordinately in terms of examples of application and concrete design options (Schuh et al. 2016). Similarly, in the surveys on digital literacy, the craft trades tend to be a subgroup (e.g. Dengler/Matthes 2015). There is a lot of potential for the skilled trades, especially in the digitization of business processes, and the development and use of digital tools for data exchange/analysis is becoming a decisive criterion. This may mean not only increasing digitization of the internal processes, but also integration into digitized value chains or the development and expansion of digital business models in order to remain attractive to the market (Krause 2016, p. 37).

Taking a closer look at the sector, the following potentials and challenges in context with digitization can be identified:

Handicraft enterprises are small businesses: Handicraft enterprises are still largely family businesses today. The owners have often taken over the business from their parents and identify strongly with their own business (ZDH 2009; Brüggemann/Riehle 1985). In about half of the German craft enterprises, the wife of the owner/master works in the business. These relatively close, quasi-familiar manners in the company are not only typical for the relationship between master craftsman and employee, but also for the relationship between colleagues. For all employees there is a relatively high degree of transparency of the company, the scope of orders, the economic situation and the strengths and weaknesses of the individual employees (Glasl et al. 2008). In addition to social control, closeness also increases the feeling of dependence: overtime work or "stepping in" for colleagues in order to compensate for absences due to illness or covering up for failures are quite normal. There is scepticism, that digitalization will have a negative effect on this familiar environment, or destroy intuitive communication and cooperation routines.

Flexibility and chaos: For the majority of small businesses from the owner’s view, their size makes systematic planning unnecessary. Where it is normal for employees to be asked for help at short notice on days off or for the master craftsman himself to help when there is 'need', the impression of the unplannability of the workload seems to be still valid (Georg 2005). A central prerequisite for economic survival in the case of incoming orders that are difficult to predict is therefore the versatility of the personnel. In order to be able to react promptly and adequately to problems in a decentralized manner, smooth direct communication between master craftsmen and employees (based on a certain consensus of performance and values) is also necessary. Flexibility is not only a prerequisite for coping with the "everyday chaos" and a unique selling proposition but also creates great leeway for employees in the practical implementation of work orders, that could be in danger when digitizing processes and organization.

Pressure on the actors in the craft trades is growing due to the intrusion of globally operating corporations into the domains of the craft trades: Amazon or Alphabet, for example, have been providing craft services on a large scale (e.g. networked building services) in the USA since 2015. In order to avoid such risks, in addition to taking over activities that were formerly outside the sector (e.g. IT-related services in the field of networking by the electrical and electronic trades), the skilled trades must increasingly establish cooperative ventures with other trades and providers in order to tap market potential by offering the most comprehensive range of services possible.

Uncertainty as a challenge: In the average craft trade enterprise, a rather short-term oriented reaction to personnel, logistics and financing problems still prevails. Only with increasing company size, operational planning, cost control and personnel development are observed more frequently (Müller/Vogt 2014). Therefore, entrepreneurial action is often combined with relatively uncertain circumstances: thin capital cover, short project durations, constant reorientation to changing customer wishes/trends or also the direct effects of sales slumps (Osranek et al. 2013; Georg 2005). This feeling of insecurity must be taken into account especially with regard to the operational acceptance of design variants with long planning horizons.

Product-related factors: The use of digital technologies will only take place on the basis of a concrete demand situation, for example to counteract overloading the entrepreneur as a "knowledge centre". The owners must be convinced of the added value of the technology and the usability. At present, there is (still) a lack of low-threshold solutions that are specially adapted to the needs of the skilled trades.

Factors specific to the company: In addition to the ability to mobilize sufficient financial resources, the number of employees plays a major role in the integration of digital technologies, as larger personnel capacities are more likely to enable the use of applications (Zoch 2011). Moreover, SMEs tend to employ "generalists" rather than "specialists" and have more problems recruiting and retaining specialized personnel (Greilinger 2013; Stetter et al. 2013), which does not promote innovation (Welzbacher 2015).

Owner-related factors: The strong formative role of the entrepreneur determines the organizational structures of many crafts enterprises: In many enterprises, this results in a concentration of decision-making and instructional powers in the person of the entrepreneur. In order to prepare for the digital transformation, the awareness and motivation of entrepreneurs is therefore crucial (Welzbacher et al. 2015, p. 16). Added to this is the dominance of day-to-day operations, which often prevents systematic involvement with new technologies: It is difficult to create time frames for dealing with new technologies in everyday work (Osranek et al. 2013; Zoch 2011). For this reason, small and micro-enterprises often have rather reactive strategies for translating "analogue" into "digital" work contexts.

Work-related factors: The lower planning and control complexity of production processes (compared to industrial production) and the low number of employees make most small businesses shy away from further expansion of their digital infrastructure (Schuh et al. 2016). The digital pioneers in the craft trades have difficulties in finding appropriate skilled workers with digital know-how (Krause 2016; cf. Stetter et al. 2013). There is a need for adapted CET concepts, in which "digital skills" are taught in addition to the purely technical skills of employees.

3 DIGITIZATION IN PRACTICE – STEPS TOWARDS A SERVICE INNOVATION

The following findings are grounded by 7 qualitative interviews with owners of small businesses and works councils of big enterprises in the crafts sector and experts from Chambers of Crafts. These were complemented by work situation analyses in 3 small sized craft companies, 3 workshops with the owners of these crafts companies and 2 with experts from chambers and

professional associations. Businesses were electrical trade, painters/varnishers, sanitary, heating and air-conditioning and elevators/escalators. The focus was always on the level of digitization, concerning the actual state as well as the potentials, and stressful or burdening work processes.

To visualize the state of digitization in the companies of the sample, we use the compass 4.0, which was developed to give companies orientation and enlighten the various options of digitalization steps and processes. The symbols in the field represent the companies:

△ ○ ▭ small companies, 7-20 employees

★ 2 big companies, around 50.000 employees

Table 1 Levels of Digitization of the sample enterprises in the compass 4.0

	Applications				
Technology	Individual things, objects	Stand-alone solutions	Interlinked solutions	internal process solutions	cross-company processes
Sensor technology					
Assistive work equipment					
Clouds, platforms					
Autonomous software					

(Offensive Mittelstand 2019)

Table 1 shows, not very surprisingly, a close connection of the state of digitization and the company size. Digitization in the crafts sector, where most work is handy work, is mostly linked to the planning, documentation and the processes that accompany the work on the building site or at the customer.

3.1 Potentials in the smaller companies

The smaller, less digitized companies feel the need for digital communication, and enhanced competition for customers as well as employees. Connected to that, the companies put emphasis on different problems that could be solved with digitization:

(1) The growing competition from low-cost providers on crowdworking platforms and the increasing demands of customers for personal all-round solutions are leading to growing pressure to position the business in the market through innovative solutions, special customer service or an expansion of the range of products on offer. For an integrated, individual service, networking with providers of complementary craft services and a stronger involvement of customers in the process without major additional organizational effort is seen as necessary.

(2) The increasing coordination requirements, due to more and more complex processes, changing customer demands for individualized services, a growing number of employees in the company, digitalization and the expansion of the service portfolio mean that established communication and cooperation channels with customers and colleagues are reaching their limits.

(3) The retention of skilled workers is increasingly becoming a competitive factor in the craft trade sector. The profitable use of digital technologies for internal processes and risk assessment can make employers more attractive and facilitate processes, but also requires changes in work processes and new forms of health-conscious work design. In addition, the use of various digital solutions, e.g. one for internal and external communication, another for order processing and acceptance, increases the complexity of work processes.

3.2 Restrictions in the smaller companies

Restrictions in smaller companies can be found on a) the technical side, as the service solutions on offer are often made for bigger enterprises and build on a certain, not always available level of digital competencies on the side of owner and staff, leading to b) the human side, as working with digital devices is not part of vocational education, so strongly dependent on the individual. The transfer from analogue to digital work and communication processes is further restricted by both scarce resources and a scepticism about the added value of the applications for individual needs. Most of the available solutions are seen as time-consuming adaptation challenges to the needs of the company due to their lack of precision. Another problem are the differing digital skills of the staff. Due to the shortage of staff, time for qualification is short and learning-on-the-job with the help of each other difficult, especially in smaller teams, going down to one person.

However, these problems are strongly linked to the integration process of new technologies. Companies that went through the digitization process describe the adaption time as marked by resistances in the workforce and the need to shape the technologies to the needs of the company. Once the company is being used to working with digital technologies, the processes are described as smoother and more efficient, working with digital tools is regarded as an advantage in getting skilled staff and junior staff. The only increased work strains, especially on the level of masters and owners, is the increase in communication and accessibility, fostered by mobile devices and changed communication routines by customers, partners and employees as well as by the used systems themselves.

3.3 Potentials in the bigger companies

The bigger companies in the sample are already on a higher level of digitization. Apart from digitization in the planning, documenting and staff assistance, they also use digital tools for predictive maintenance and fault diagnosis. Knowing in advance the required skill level of the staff in the fields of maintenance and repair is linked to their strategy against the shortage of skilled workers: Jobs are divided in high- and low-skill jobs, thus, new possibilities for employing semiskilled workers arise. Another used potential is the integration of risk assessment measures into the work processes. Opening the process on his/her device, the employee is warned of potential dangers of the building or operation site. An interesting, yet unused option with promising potential is remote maintenance via data glasses, that could allow the expert to supervise a number of operation sites at the same time.

3.4 Restrictions in the bigger companies

The bigger, more digitized companies describe problems in humane shaping of the digitized work conditions, because they detected substantial changes in the daily work of the employees, combined with a polarization trend leading to a group of skilled experts and a group of lower skilled routine workers. If the workers are only operating within their skill levels, learning on the job is reduced as well as promotion and development potentials. The danger of constant accessibility is regarded as a big challenge for creating humane working conditions. There is also the danger of generating working conditions that are increasingly dependent on a stable network, whereas this is not always available on new building sites or shielded areas.

4 CONCLUSION

Regarding the question of potentials and possibilities of digitization to solve the problemes in the crafts sector, a multitude of new business opportunities and potential for handicraft enterprises can be identified: The ever-increasing demand for personal advice, individualized solutions and integration of customers in the entire service process can be met by networking smart devices, customers, employees, suppliers and businesses. Digital technologies can help small businesses in particular to use their resources more effectively and efficiently and to realize competitive advantages through speed and flexibility. After overcoming the adaption process, digital assistance systems, tools and products can increase productivity and be used to reduce workload and to focus more on the competitive element of personal contacts. As digital technologies become part of the working routines in the crafts sector, the competence requirements change. This will affect job profiles in the long run. The changing requirements and options for skilled workers in this area poses a challenge for the adaption of the educational contents, but also an option to integrate new target groups into the profession - which could be a counterweight for the lack of skilled workers.

The digital transformation will be a drive for further intertwining of production and service creation, and increase the proportion of person-centered services in the craft sector. In addition to the digital networking of horizontal value chains, the digital transformation will particularly promote virtualization, decentralization, real-time capability and mutability. However, it is not only to be seen as a technical or logistical use of IT, but has far-reaching consequences for work organization, innovation and skills development. Although processes can get easier and more effective with using digital tools in the crafts sector, there are also restraints to overcome. The

implementation period is a crucial phase with various negotiation processes. The differing views and logics of the business, of the developers of digital technologies and ideally findings from applied work sciences have to be combined to create a solution that can be used to create or improve humane working conditions. Apart from that, the ergonomic requirements on building sites demand compromises in the usability and selection of suitable devices. Competency development that is needed for the usage of the new technologies must be fitted in the job and can not take up too much time of employees as well as masters or owners. Continuous participation of the employees in the change process combined with a trouble shooting approach that solves problems when they occur tends to be most promising.

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Digital Work Assistance in Decision-Making: Information Richness, Trustworthiness, and Propensity to Trust

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ABSTRACT

Purpose: In an increasingly digital and complex world, technologies can be used as a decision-making assistance for employees. Trust in so-called assistive technologies is a key factor in this respect. The aim of this study was to investigate the influence of information richness, trustworthiness and individual trust disposition on the trust in digital work assistants.

Theory: We examined trust in technology by means of the construct of trusting intent, i.e. the perception that the technology can be trusted. Based on the organizational theory of trust (Mayer, Davis, & Schoorman, 1995; Schoorman, 2007) and previous empirical evidence, we expect that the higher information richness, trustworthiness and propensity to trust, the higher the trusting intention will be.

Design: Using an online survey, we presented four versions of a dashboard to 77 participants to help them make an important decision within a given scenario. The four versions were presented randomly and differed in their information richness. The participants then answered questions about the perceived information sufficiency, perceived trustworthiness (honesty, integrity, competence), propensity to trust and trusting intention. We also assessed age and gender, for which we controlled in the analyses.

Findings: In the version of the dashboard that shows the visualization with the highest information richness, not only the trusting intention is highest, but also the perception of having sufficient information and the confidence in the decision made. We further demonstrate that trusting intention is positively influenced when the technology is perceived as honest and competent. We could not find a significant relation between integrity and propensity to trust on trusting intention.

Originality: Developing suitable digital work assistance that supports decision-making at work is associated with several challenges. In this article we have explored trust and demonstrated that information richness and trustworthiness (honesty and competence) are relevant. Based on this study, we discuss design challenges that should serve as a basis for a more trustworthy design of digital work assistance.

Keywords

trust, decision-making, digital work assistance, information richness

1 INTRODUCTION

In an increasingly digital world, enormous amounts of data are being produced. Employees are urged to understand and interpret these huge amounts of data, classify their validity and evaluate which data is relevant and which is not (Woods, Patterson & Roth, 2002). However, on the other hand, companies can largely benefit from these data sets, for example, by using them to systematically monitor their processes or support more informed decision-making (Frisk & Bannister, 2017). Decision-making in the workplace is often complex and can become necessary in a situation of time pressure and the perception of having insufficient information (Edmund & Morris, 2000; Daft et al., 1987). A technology that visualizes needed data in an easily understandable way can help workers to get an overview of the information and thus support decision-making. In addition to technology acceptance (Venkatesh & Davis, 1996, 2000, Venkatesh & Bala, 2008), trust in the technology plays a key role when it comes to its use (Lee & Turban, 2001). Only if users trust a technology they will use it to support them in making a decision that is risky (Li, Hess & Valacich, 2008).

This study examined trust in a technology that supports decision-making processes at work. More specifically, we examined differences in trusting intention between four visualizations that were different in their level of information. We also investigated the effect of predictors of trusting intentions. Thereby, our theoretical basis is the theory of organizational trust by Mayer, Davis and Schoorman (1995; Schoorman et al., 2007). Within their theory, these authors distinguish two parties involved in the trust process: The trustor is the one who trusts and differs in his/her willingness to trust; the trustee is the one who is trusted and is characterized by trustworthiness. Transferring this concept, which is designed for trust between humans, to trust between humans and technology, the user represents the trustor and the technology the trustee.

1.1 Information Richness and Trusting Intention

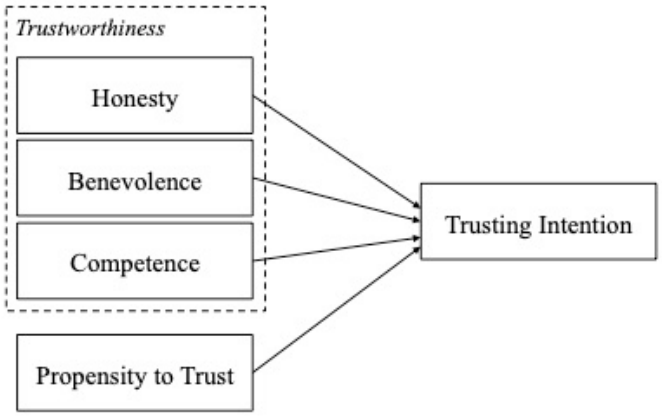
In the context of this study, we operationalized trust using the concept of *trusting intentions*. Trusting intention is defined as the willingness of the trustor to interact with the trustee (Gillespie, 2003; McKnight et al., 2002; Dimitriadis & Kyrezis, 2010). Characteristics of a technology can influence trusting intention (Li & Yeh, 2010). For example, the amount of information provided (the richness of information) has been found to be positively related to trust (Lo & Lie, 2008). Moreover, it has been shown that in ambiguous situations and equivocal tasks, people choose tools that offer greater richness of information and that interactions via richer media are associated with greater trust (Chesney et al., 2017). In line with that, we expect trusting intention to be higher when there is more information given. We explored differences of trusting intention, the perception of having enough information and the perception of feeling confident about the decision that has to be made between visualisations with varying information richness.

1.2 Trustworthiness, Propensity to Trust and Trusting Intention

In the theory of organizational trust (Mayer et al., 1995; Schoorman et al., 2007), it is suggested that trust is shaped by the characteristics of both the trustor and the trustee. The characteristics of the trustor represent trustworthiness, and comprises three aspects: benevolence, integrity and ability. These aspects have also been identified as relevant in a technological context (Casaló et al., 2007), where they are referred to as benevolence, honesty and competence. An honest

technology is perceived as predictable, consistent and reliable; a benevolent one enables the trustee to fulfil his or her task and shows potential for appealing to the trustee's interests; and a competent technology is one with the ability to meet the needs of the trustee (Casaló et al., 2007; McKnight et al., 2011). On the other hand, the characteristics of the trustee are represented by the propensity or disposition to trust. The propensity to trust is described as a person's general willingness to trust (Mayer et al., 1995). Neither trustworthiness nor the propensity to trust is related to a particular situation; rather, they are a result of experiences and socialization and are thus perceived to be fairly stable over time (Gefen et al., 2003). In the present study, we investigated the effect of trustworthiness and the trustor's propensity on trusting intention (see Figure 1). In line with the theoretical and empirical evidence, we expect positive effects of trustworthiness and propensity to trust on trusting intentions.

Figure 1 Proposed Research Model.



2 METHOD

2.1 Sample

Our sample included 58 females and 19 males aged 20 to 64 years (M = 32.84; SD = 14.36). Participants were German-speaking; 25 participants were employed full-time, 7 were employed part-time, 42 were students, 2 were in retirement and one indicated the category 'other'. Concerning education level, one participant had received compulsory education as the highest level of education, five had finished an apprenticeship, 46 had graduated from high school and 25 had finished university. Participants were recruited using the snowball sampling technique (Goodman, 1961). A standard recruitment ad was distributed via social media to the authors' friends and acquaintances who were asked to forward it to their friends. In addition, the students of a selected seminar on human-computer interaction could receive credits for their participation.

2.2 Procedure and Materials

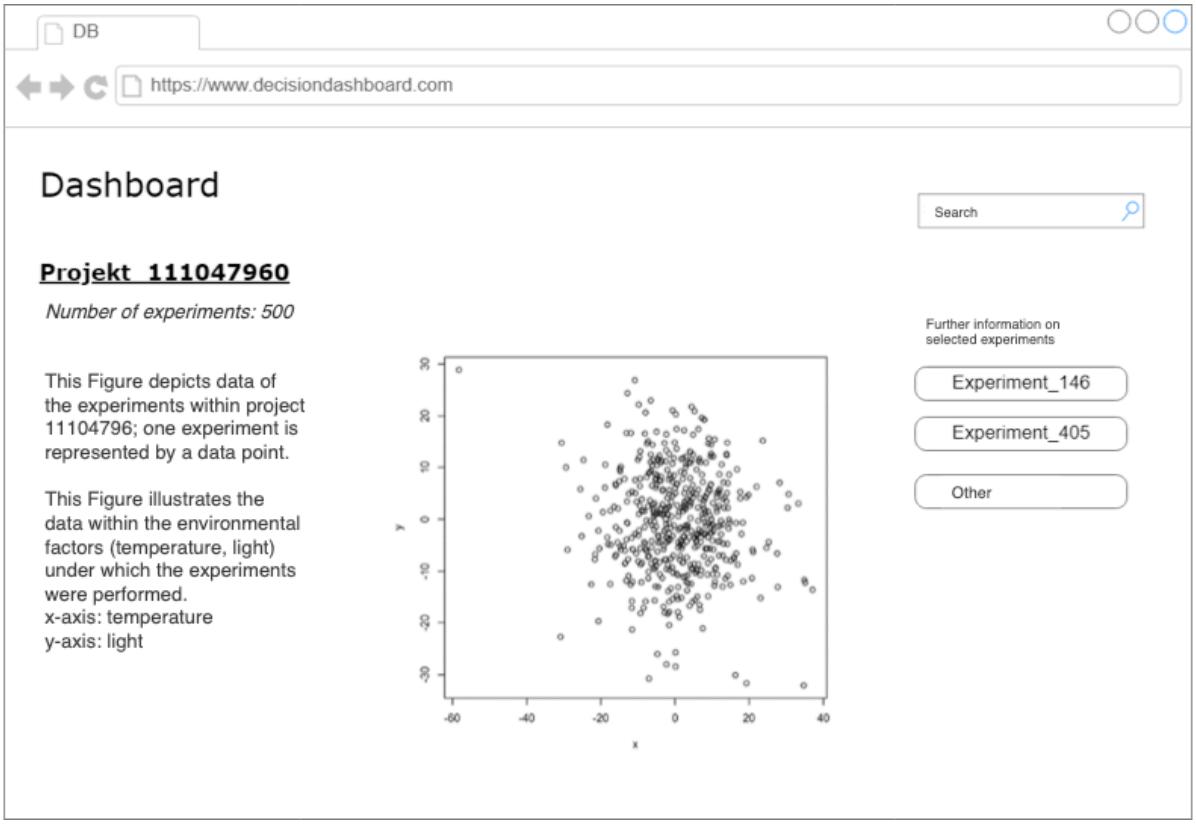
The survey was conducted using the online platform soscisurvey.de, which is a tool for designing and distributing surveys. Participants were provided with an information and consent form before the start of the survey. The form contained a description of the study, instructions for receiving the results of the study, a statement that participation was voluntary, proof that

anonymity was guaranteed and contact information. After agreeing to participate in the study, participants were asked to read the following instructions:

> *Imagine you work in the laboratory of a pharmaceutical company. You lead a team that conducts experiments. After they have been conducted, you have to decide whether the data collected in the last few weeks can be used further or whether you have to discard some of it. For example, data must be discarded if environmental factors (e.g. temperature, light) were not within a certain standard during the experiment. In the current, very cost-intensive project (in terms of time and materials), 500 experiments were conducted. Your decision on the possible destruction of data must be well justified, documented and communicated to the management in the form of a written statement. It is **your** responsibility to make and justify this decision. A dashboard helps you to get an overview of the data.*
>
> *Four versions of the dashboard are presented below. Please take a look at them and then answer the questions.*

The dashboard was designed as a static web browser mock-up (Figure 2). In particular, within a selected project, a series of experiments are visualized in relation to the environmental conditions temperature (vertical axis) and light (horizontal axis). The mock-up also contained a URL, a search function and the possibility to select an experiment for further information. The study was conducted in German; Figure 2 shows the dashboard translated into English.

Figure 2 Dashboard.

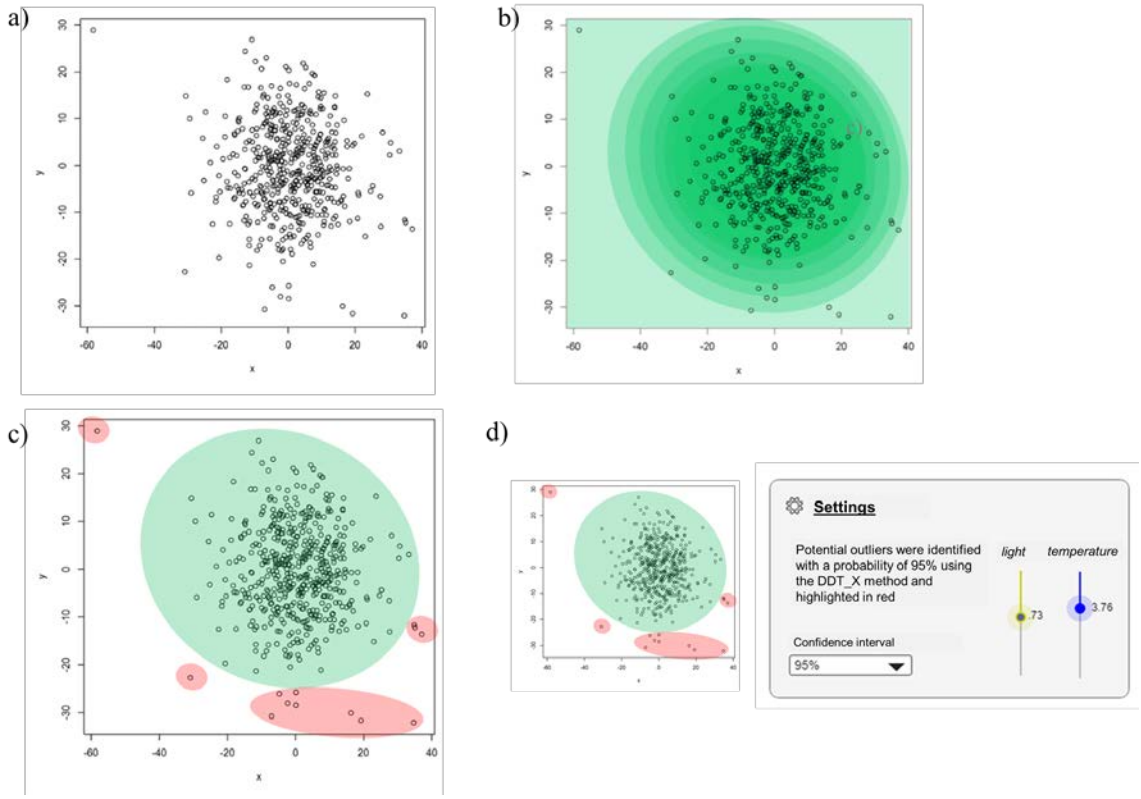


The main visualization on the dashboard was represented by a scatter diagram, which varied in terms of the degree of information provided (Figure 3). The first version (a) depicts the

temperature and light conditions of all experiments without additional information. In versions (b) and (c), the colour markings indicate outliers indirectly (b) or directly (c).

Within the study four scenarios have been presented in a randomised order: In the first scenario visualisation (a) was used; within the second, visualisation (b); within the third visualisation (c); and within the fourth scenario visualization (c) and additional information about the scientific methodology that determines the outliers. Accordingly, the scenarios differed in the degree of support for the decision to be made.

Figure 3 Visualizations.



Each scenario was followed by the same questions and participants were asked to indicate their agreement to the following study variables:

Information sufficiency was measured with the self-developed item 'I have a sufficient amount of information to make a decision.' to be rated from 1 (*strongly disagree*) to 5 (*strongly agree*).

Confidence in the decision was measured with the question 'How confident do you feel in making your decision?' to be rated from 1 (*not at all*) to 5 (*very confident*).

Honesty, *benevolence* and *competency* as dimensions of trustworthiness were measured based on a scale by Casaló et al. (2007), which we adapted for this study. Sample items were 'I think that this application has the necessary abilities to provide information.' for competence ($\alpha = .86$), 'I think that the design of this application takes into account the desires and needs of its users.' for benevolence ($\alpha = .86$) and 'I think that the information offered by this application is sincere and honest.' for honesty ($\alpha = .84$) to be rated from 1 (*strongly disagree*) to 7 (*strongly agree*). All items can be found in the Appendix.

Propensity to trust was assessed with a scale by Koufaris and Hampton-Sosa (2004), which consists of four items assessing that have to be rated from 1 (*strongly disagree*) to 7 (*strongly agree*). An example item is 'It's easy for me to trust a person/thing.' ($\alpha = .87$).

Trusting intention was measured based on a scale by Gillespie (2003), which we adapted for this study. A sample item is 'I feel that I could count on the application in a difficult situation at work.' ($\alpha = .91$) to be rated from 1 (*strongly disagree*) to 7 (*strongly agree*) All items can be found in the Appendix.

At the end of the survey, we asked the participants to indicate their preferred visualization. In addition, gender and age were assessed and used as control variables.

3 RESULTS

In the first step, we investigated the differences between the four presented scenarios. We found that most people (49) preferred the fourth scenario, which was the highest in information richness, followed by the third (15), the second (9), and the first scenario (5).

Performing a one-way ANOVA, we found significant differences between the scenarios for trusting intention ($F_{311,3} = 9.65$, $p < .001$), information sufficiency ($F_{311,3} = 7.32$, $p < .001$), and confidence ($F_{311,3} = 10.31$, $p < .001$). After performing a Tukey's HSD post-hoc test, we found that for all three considered variables, significant differences existed between the first and third scenario (information sufficiency: $p = .004$; confidence: $p = .001$; trusting intention: $p = .002$), the first and fourth scenario (information sufficiency: $p < .001$; confidence: $p < .001$; trusting intention: $p < .001$) and between the second and fourth scenario (information sufficiency: $p = .040$; confidence: $p = .003$; trusting intention: $p = .007$). Means and standard deviations are listed in Table 1.

Table 1 Means (Standard Deviations) of the Variables Trusting Intention, Information Sufficiency, and Confidence in the Decision Presented Separately for the Four Scenarios

	Trusting intention	Information sufficiency	Confidence
First scenario	3.64 (1.58)	2.56 (1.15)	2.59 (1.23)
Second scenario	4.06 (1.49)	2.87 (1.24)	2.89 (1.13)
Third scenario	4.48 (1.43)	3.21 (1.09)	3.31 (1.14)
Fourth scenario	4.81 (1.51)	3.37 (1.21)	3.53 (1.11)

Table 2 Results of the Hierarchical Regression Analysis of Predictors of Trusting Intentions

	Model 1			Model 2		
	B	SE	β	B	SE	β
Step 1 (Control)						
Age	.01	.01	.08	< .01	.01	.05
Gender	.15	.30	.06	.09	.17	.04
Step 2						
Honesty				.44	.12	.35**

Benevolence		-.07	.12	-.06
Competence		.67	.13	.58***
Trust Propensity		.04	.06	.05
R2	.01		.71	
R^2 change	.01		.71	
F change	.27		43.91**	

Note: $N = 77$, SE = standard error of B; * $p < .05$, ** $p < .01$, *** $p < .001$

In a second step, we investigated the role of influencing factors on trusting intention across all four scenarios. In particular, we tested the effects of the three dimensions of perceived trustworthiness (honesty, benevolence, competence) and propensity to trust on trusting intentions using hierarchical linear regression analysis. In the first step (Model 1), we included the control variables age and gender. None of the variables were significantly related to trusting intentions (age: $p = .527$; gender: $p = .627$). In the second step (Model 2), honesty, benevolence, competence, and trust propensity were included in the model. The results showed a positive effect for honesty ($\beta = .35$, $p = .001$) and competence ($\beta = .58$, $p < .001$) and no significant effects for benevolence ($p = .712$) or trust propensity ($p = .412$) on trusting intentions. Table 2 summarizes these results.

4 DISCUSSION

In this article we have examined the role of trust in a technology that aims to support decision making at work. We contribute to existing research in two ways. First, in line with previous studies (e.g., Chesney et al., 2017), we found that trusting intention, a feeling of having sufficient information, and confidence in the decision is high when information richness is high. Findings further indicate that not only information richness but moreover a concrete indication for a decision was perceived positively. Second, we found that trusting intention is predicted by the perceived trustworthiness of the technology. In particular, we found that trusting intentions are high when the technology is perceived as honest and competent, contributing to research on antecedents of trust in technologies (e.g., Casaló et al., 2007; Meeßen et al., 2020).

4.1 Limitations of the Study and Future Research

Our study has its strengths and limitations. One limitation is that we did not observe human-technology interaction in a real working environment, but worked with scenarios and mock-ups instead. Our study did, however, reveal some findings about trust in technologies that should be further explored in a field environment.

Another limitation of this study concerns the measuring instruments used. Unlike the measurement of trust in organizations (for an overview see McEvily & Tortoriello, 2011), there are no sufficiently validated scales for measuring trust in technologies. Therefore, we have developed the items for this study with all its limitations ourselves. We took a structured approach by analysing existing scales from Casaló et al (2007), Gillespie (2012), Koufaris & Hampton-Sosa (2004), Mayer & Davis (1999) and McKnight et al (2011) and selected those items that seem most appropriate for this study. In a second step, these were then adapted to the

context of the study. For future studies, however, we urgently recommend - as did Meeßen et al. (2020) - developing validated instruments for measuring trust in technologies.

A final limitation that we would like to mention here is that within the scenarios presented, we have mixed the amount of information with clues for possible decisions. There is a smooth transition between the exclusive provision of information to point to a concrete decision, and it is therefore relatively complex to differentiate this clearly. However, one possibility could be to ask the participants whether they have noticed a concrete decision hint. For future studies, we recommend examining the two concepts - information presentation and decision cues - separately from each other and to investigate trust and also the issue of responsibility in this respect.

4.2 Practical Implications: Design Challenges

When designing digital assistance for complex work environments, there are several design challenges that must be taken into account. First, one challenge is to represent the right amount of information through technology. On the one hand, the technology has the role of preparing complex and extensive data sets in such a way that the employee has a clear overview and can therefore better understand the complex work situation. On the other hand, our study also showed that the more information is presented, the higher the level of trust. When designing the technology, it is therefore important to find the right balance between reducing complexity and at the same time ensuring trust in the technology. At the same time, it should also be noted that the requirements for simplicity or richness of information differ across professional contexts, as well as across individual preferences and skills. To meet this challenge, we recommend designing digital assistance in layers from simple to more complex visualizations. The simple one can be used when there is a need for quick support or for users who are not interested in detailed information. Depending on time and interest, users can then obtain more information about the data, the preparation of the data or the method of analysis.

Second, when designing trustworthy technologies characteristics of the trustor and the trustee needs to be considered. Theoretical models such as the theory of organisational trust by Mayer et al., (1995; Schorman et al, 2007) or the theoretical model of trust in management information systems by Meeßen et al. (2020) provide solid frameworks that should be taken as a guidance within design processes. For example, perceived trustworthiness will be higher if the technology signals goodwill, honesty and integrity. At this point we would like to emphasize that these considerations must also be reflected in ethical terms. Benevolence, integrity and competence should not be communicated if the technology does not act accordingly.

A final challenge that we want to mention here is the question of responsibility (cf. Flemisch et al., 2012). To what extent can and should a technology merely provide information or also give concrete indications for a decision? Who is responsible for this decision: the human or the technology? Particularly in the work context, it is important to reflect on this and to clearly communicate the responsibility in implementing the technology.

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APPENDIX

Honesty	I think that this application usually fulfils the service it assumes.
	I think that the information offered by this application is sincere and honest.
	This application does not make false statements.
Benevolence	I think that this application is concerned with the present and future interests of its users.
	I think that this application takes into account the repercussions that their actions could have on the user.
	I think that the design of this application takes into account the desires and needs of its users.
Competence	I think that this application has the necessary abilities to provide information.
	I think that this website knows its users well enough to offer them relevant information.
	This application has specialized capabilities that can increase my performance.

Trusting intention	When an important issue arises, I would feel comfortable depending on the information provided by the application.
	I feel that I could count on the application in a difficult situation at work.
	I would rely on the application's skills and abilities.

Smart tools to enhance wellbeing at workplace

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ABSTRACT

New ways of working include many challenges to wellbeing at work. The variety of physical work environments, the multi-platform digital work environment, the number of work places, the distance between them, and the rhythm all affect the quality of work as well as people's ability to cope with it. At the same time, the boundaries between work and personal life are reducing. From organization's perspective, it is becoming increasingly important to take care of the employees and provide not only safe environment to do work but also pleasant and healthy environment for people to flourish. Moreover, with the development of digital tools, it is easier to offer more services for employees. In this paper, wellbeing is discussed in terms of digital services and tools for supporting wellbeing. Thus, the focus of the paper is to open up the potential for digital wellbeing services and to understand how they can support decision-making in companies.

The research is based on market data on wellbeing services and tools and enhanced by understanding wellbeing at workplace concept. Data from over 120 services globally were collected by using CBInsights tech market intelligence platform and analysed by using coding and direct content analysis.

The findings from available services' analysis support identified evolution of digitalisation and wellbeing understanding. Results show that most of the services aim at supporting functional and mental wellbeing at work but only around 40% of the services enable learning from the data by creating patterns of use or behaviour. Moreover, just over 20% of services include elements of network and support aspects of social wellbeing.

This paper gives a comprehensive overview of market development in terms of smart services to support wellbeing at work. Results of this study provide a ground for further academic discussion on wellbeing transformation in a digital society. For practitioners, this study can be valuable by widening the understanding of wellbeing services available for the users.

Keywords

Smart, Wellbeing, Digital, Workplace, Services

1 INTRODUCTION

Health and wellbeing at the office is 'the new sustainability' for organisations, individuals and buildings. Providing healthy and balanced environment can reward companies and their employees as well as landlords, developers and other concerned actors. At work, wellbeing can be approached as safe, healthy, and pleasant environment that affects employee productivity, commitment to work, might reduce sick leaves, thus, affecting overall organizational performance (e.g. Frey and Stutzer 2002; Diener 2000; Eid and Larsen 2008).

As technology has become an inseparable part of people's and organisations' everyday activities, it can also be used for enhancing wellbeing. Various technological solutions have the potential for strengthening wellbeing through new or improved services for employees, at the same time benefiting the organisation. For example, solutions that analyse the data and identify the elements for further development of intelligent systems can be considered as "smart" (e.g. Chen 2011).

Accordingly, this paper aims at understanding how wellbeing can be enhanced at the office through various digital services available and how available wellbeing solutions at the office could be developed further.

2 BACKGROUND OF THE STUDY

2.1 The concept of wellbeing

Since 1948, the World Health Organisation (WHO) has consistently defined health as a "state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity" (World Health Organisation 1948). However, there is still a challenge on defining wellbeing. The literature generally refers to two types: "affective wellbeing" and "subjective wellbeing" (Diener 2000). "Affective wellbeing" refers to 'arousal' similarly as 'ill' and 'not ill' in medical sciences (Warr 1990). Meanwhile, "subjective wellbeing" describes personal evaluation of life through multiple dimensions towards satisfaction (Diener et al. 2003; Diener 2000). In a broader context, wellbeing term is used to describe not only person's state and affective evaluation of it but also a relationship with its workplace (organisational wellbeing) and quality of life in the community (social wellbeing).

Individual wellbeing concentrates on personal factors that affect the quality of life of an individual. The consequences extend to other parties, such as work organisation and might have a negative influence towards the performance. A comprehensive study by Rath et al. (2010) of people in more than 150 countries revealed five universal interconnected elements that affect the wellbeing of our lives: physical wellbeing, social wellbeing, community wellbeing, financial wellbeing, and career wellbeing. Physical wellbeing including 'not ill' notion and healthy lifestyle in terms of a diet, exercise and sleep. Social wellbeing comprising of social connections, close relationships and love. A sense of engagement and belonging with the area one lives is part of the community wellbeing. Two other perspectives of wellbeing include the feeling of financial security (financial wellbeing) and enjoyment of work and reaching career goals (career wellbeing).

2.2 Wellbeing and workplace

Before the beginning of 20th century, worker's health and wellbeing were not a concern of their employer (Smith et al. 1995). However, it has changed in the mid-20th-century, when first laws and standards for safer working conditions were created and occupational health and safety field appeared (EHS Insight Resources 2019). Smith et al. (1995) proposed a framework for occupational health including hazardous work settings (such as unsanitary conditions, environmental toxins, etc. (EHS Insight Resources 2019)), personality factors and work relationships (e.g. Oishi 2012; Rath 2006; Danna and Griffin 1999), and occupational stress (influenced by the role in the organisation, relationships at work, organisational structure and climate, home/work interface, career development and factors intrinsic to the job itself (Cooper and Marshall 1978)).

Vischer's studies in environmental psychology of workplace had a major influence on the developing understanding of work environment effects on employee productivity and performance (e.g. Vischer 2004; Vischer 2008). She defined environmental comfort model of workspace quality consisting of three levels: physical, functional and psychological comfort (Vischer 2008). In her model, she explained that physical comfort refers to the basic needs of safety, hygiene and accessibility which are defined by, e.g. building standards. In terms of functional comfort, the author referred to the ability of the environment to support the user and its tasks and for psychological comfort, it included the feelings of the user from "belonging, ownership and control over workspace" perspective. (Vischer, 2008).

Employee wellbeing at work can have a significant effect to organisational performance (Cooper and Cartwright 1994). Right organizational wellbeing strategy can help with talent retention, morale or reduce costs of absenteeism, e.g. insurance costs and the cost of compensable disorders/lawsuits (Cooper and Cartwright 1994). According to Naydeck et al. (2008) research, every dollar spent on wellness program at organisation lead to ROI of $1,65. Moreover, costs can also be reduced through reducing presenteeism. Presenteeism is defined as a situation when employee is at a workplace but is not productive, e.g. when person is not engaged and work tasks, tools and methods do not support the individual.

2.3 Understanding the 'smartness'

Almost every part of personal life and business activities is being transformed by technology. Technology enables new solutions which help in solving complex problems. Often, ICT and internet enabled products and services are called 'smart' and refer to connectivity and ability to make decisions or enhance it (IG Global n.d.). According to Wuenderlich et al. (2015), the part of a smart solution is real-time data collection, continuous communication and feedback.

The role of data is crucial for intelligent decision making and creating value to business. In business life, decision-making has greatly improved with the use of technology, allowing not only looking into the past information but also getting insights from large datasets that previously were unavailable (Lepenioti et al. 2020). Based on the complexity and intelligence levels, data can be used to learn from the past and existing time (descriptive analytics), understand what and why might happen in the future (predictive analytics) and learn what could be done to prevent something from happening or improve it (prescriptive analytics) (Elliot 2013).

Another important part in 'smartness' is connectivity. Separate products and services are no longer sufficient by themselves but should be connected into systems (e.g. IoT) for optimal

performance (Verdugo Cedeño et al. 2017). Connectivity with the environment and possibility to react to it (responsiveness) is considered as part of the intelligence (Ituma 2012).

2.4 Smart tools to enhance wellbeing

Proactive decision-making and prevention of negative outcomes are relevant not only in creating business value but also in improving the outcomes, e.g. of people. (Occupational) healthcare is also changing towards more proactive and preventive care which is centred around the patient. It requires continuous monitoring of person's health and more training for doctors to manage in these changed circumstances (Chen 2011). It calls for a multidisciplinary approach and deep understanding of systems, analytics and human factors (users and applications) (Stroetmann 2013).

According to Chen (2011), the key components for intelligent systems to be able to empower people are:

- Knowledge-to-action: Providing information and supporting decisions through continuous communication
- Person self-efficacy: Confidence that people can change their behaviours
- Availability of just-in-time support: Based on known principles of health-behaviour change.
- Availability of social networks: Support and education of people.
- Assistive technologies: Availability of devices and systems to support care anytime and anywhere.

Intelligent systems, otherwise "smart tools" developed for enhancing wellbeing at work could be called as "smart wellbeing". The term combines aspects of the multi-level phenomenon ranging from physical wellbeing to mental and social wellbeing of an individual, organization, and the society. Combined with digital solutions, it requires a holistic approach to guide the flow of information and preventing existing and well-functioning data flows from being blocked.

3 METHODOLOGY

This study aims at understanding what digitally enhanced services and tools for supporting wellbeing are available and how they can support decision-making in companies through smart solutions. The research followed qualitative approach and analysed newly available services in the market globally. Market research provided an overview of industry trends for digital wellbeing service development and helped to identify the gaps/development opportunities for the future.

The data was initially collected by using CBInsights platform as a targeted database for digital businesses. CBInsights platform is one of the main sources of market intelligence and trends for technology investors. Data in their database is collected by algorithms analysing over 150,000 sources daily as well as inserted by platform users themselves (Abbi and Dungo 2014). The CBInsights database was searched for businesses with keywords "wellbeing", "workplace wellbeing", "health and wellbeing", and "workplace productivity". These keywords led to a list of over 1,000 service providers. Advanced search in the provided list was performed by using keywords "employee", "improve", "wellbeing", and productivity" which led to the list of 122

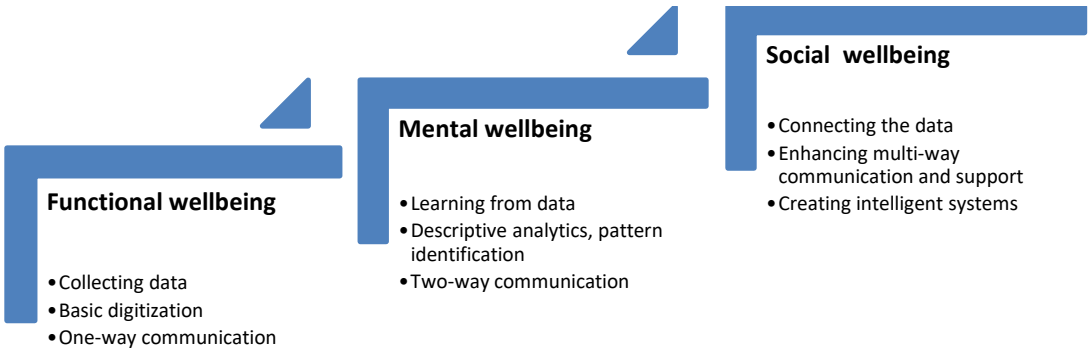
service providers which were included in the final list. CBInsights platform was further used to produce a general overview of the collected service providers such as their industry, target markets, funding and growth. The following step included data collection and analysis about each service provider. Data was gathered from their websites as well as publicly available press releases and marketing material. The data included their value proposition, key activities, customer groups, technology used and a general description how the service or a product works. The data was collected during 2018 and a list was updated in 2019 by inserting new companies or deleting the ones that went out from the business.

The data was coded by deductive coding technique with codes deriving from the literature review, followed by a thematic analysis. The analysis was also supplemented by descriptive statistics of analysed services.

4 FINDINGS

The literature review on the concept of wellbeing (at work) as well as the development of intelligent systems lead to the development of the "smart wellbeing ladders" (Figure 1).

Figure 1 Smart wellbeing ladders



At the level of *functional* wellbeing, smart services are based on knowledge of the individual and his/ her environment. Services support a healthy and safe work environment and working conditions within the organization and office areas with workstations. This level is sort of "must be"-conditions for the work and quantified data collected by different ways is the basis of the services.

At the level of *mental* wellbeing, smart wellbeing services are based on learning and they enhance behavioural change. With the help of machine learning and collected data, one can provide and get feedback about the behaviour. Services support activities that promote mental and physical well-being and aim to make behaviours, habits and routines healthier.

At the *social* wellbeing level, smart services are based on networking and strengthened community support. Services allow users to join and operate in different communities and they connect multiple tools or service providers in the network. Wellbeing is enhanced through interaction and encouragement among people: through shared goals and achievement of them.

Some examples of analysed digital wellbeing services include examples such as Halton Vario, FlowCreate Innovator by Neurocreate and Peerfit. Halton's Vario solution combines sensor technologies and digital tools for improved airflow management and distribution. By using neuroscience and artificial intelligence, FlowCreate Innovator helps employees to reach "Flow" state of mind and improve their productivity. Digital health company Peerfit offers a platform solution, which enables users to access multiple fitness or wellness providers with a single corporate wellness program.

The summary of the main findings from digital wellbeing service development in the market indicated that the presented ladders are not yet fully captured. Service analysis showed that over 60% (75 out of 122 services) supported physical wellbeing of employees through solutions for better indoor air quality, ergonomics, or safety at work while around 50% (65 services out of 122) supported mental wellbeing by providing services improving concentration at work, satisfaction (such as Biophilic design, aesthetic solutions) or reducing noise at the office. Most common value propositions in terms of wellbeing were "supporting the balance" or "changing habits". Often service descriptions included content of both physical and mental wellbeing and tried to provide "full solution" for wellbeing at work. However, social wellbeing (increased socialisation, feeling of belonging) was mentioned only in 20 out 122 services which indicates that social wellbeing at work is still overlooked.

Most of the analysed service providers offered digitized versions of wellbeing services, meaning that they present information that was previously either not available in the digital format or not available for the user at all. Only less than 40% (46 services out of 122) of services collected the data and used it for identifying usage and/or behavioural patterns through various algorithms. Less than 30 of analysed services (of 122) exploited network/platform approach for value delivery to the users.

The most common value propositions were "providing data" and "making it easier" and dedicated to user organisations rather than employees of these organisations. However, there are indications that new services are making use of available technologies better. Services or companies that were launched after 2015 utilized sensor technologies and wearables, employed machine learning (ML) and artificial intelligence (AI) technologies as well as based their services on advanced knowledge in genomics or neurosciences. While companies that were established between 2010 and 2015 mostly offered new types of software tools.

5 DISCUSSION AND CONCLUSIONS

Even though around two thirds of the digital wellbeing solutions in the market are aimed at supporting physical or mental wellbeing, their level of 'smartness' is low. As indicated earlier, less than 40% of solutions do any kind of data processing in order to summarize and learn from it. Therefore, even though useful for employees, these types of services might not add additional value to organisations through data insights for the development of operational actions to further support employee wellbeing.

The paper is based on a market review and, thus, on available market data which has multiple limitations. First, the market is changing at significant levels which might not be captured in the data analysis. New services and tools appear and disappear almost on a daily basis; however, data collection and analysis were not as flexible, therefore a time gap might make some of the

results irrelevant. Moreover, as only one database with several keywords was studied, therefore, the results might be subject to accuracy and bias.

For practitioners, this paper might help in future selection of wellbeing services offered at their organisations. Especially emphasizing the need for smart solutions and being able to learn from the data. The more "advanced" level of the ladder, the more complex digital solution it becomes. Nowadays, it is not enough to produce an app or a software tool, but in-depth understanding of data is required. The earlier introduced "ladder" for smart wellbeing can act as a reminder of the complexity of wellbeing concept and it can help to rise the discussion and define the desired outcome (from supporting the basic needs to advanced social development). Additionally, employees might "bring own wellbeing device" in the future and it might open up some new opportunities at work.

This study provides a ground for further academic discussion on wellbeing transformation in a digital society too. It is important to understand how a concept of wellbeing changes when digital tools are involved and what effects digital tools might have to the final perception of wellbeing. This paper brings in the needed technology discussion in workplace which is still rather limited in workplace studies. Research in occupational health will also get new insights from these results. Occupational health in office environments and in smart built environment with smart users includes many research openings. Nonetheless, wellbeing enhanced by digitalisation is a transformation on both demand and supply side of wellbeing services. Therefore, it is important to understand both markets and user experience.

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Predictive analytics in facilities management: The effects of the physical environment on employee comfort and productivity

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ABSTRACT

Purpose: The recent emergence of wireless environmental sensors has enabled workplace professionals to measure the indoor office environment in more detail than ever before. However, it remains unclear to what extent this technology can be used to improve working conditions for occupants. As such, the purpose of this project was to develop and refine a methodology for exploring the relationship between indoor environmental quality, comfort, and productivity.

Theory: The research is grounded in the Environmental Demands-Resources (ED-R) model, which conceptualises the workplace environment as a composite of pathogenic environmental demands and salutogenic environmental resources.

Design/Methodology/Approach: A pilot study was conducted at one office site, and subsequent data were also collected at two additional office sites. Across the three sites, 59 employees provided 670 momentary assessments of the workplace environment.

Findings: The findings of the studies suggest that adherence to best-practice comfort policies is associated with higher levels of subjective environmental comfort, but only weakly. However, there were strong associations between subjective comfort and productivity. The results suggest that the most effective workplaces will both adhere to environmental comfort policies and allow users to craft local environmental conditions to their own preferences.

Originality/Value: To our knowledge, these studies are the first to combine the use of environmental sensors in real workplaces with experiential measures of comfort. The results are valuable for facilities managers and other workplace professionals in the maintenance of effective workplace environments.

Keywords

Environmental psychology; Environmental sensors; Workplace environment; Environmental comfort; Wellbeing; Productivity

1 INTRODUCTION

The Environmental Demands-Resources (ED-R) model of the workplace (authors, blinded for review) suggests that characteristics of office environments can be essentially divided into environmental demands and environmental resources. Environmental demands are pathogenic (i.e. harm-causing) aspects of the environment which contribute to physiological and/or psychological strain, whereas environmental resources are salutogenic (i.e. health-promoting) aspects of the environment which motivate employees and protect them against the pernicious effects of stress.

To provide healthier and happier workplace environments, practitioners must identify and mitigate environmental demands. One area where demands might be present is indoor environmental quality (IEQ; comprising air quality, thermal environment, and luminous environment). Polluted indoor air, uncomfortable temperatures, and poor lighting can all have a negative impact upon the wellbeing and productivity of building occupants (Al Horr *et al.*, 2016a, 2016b).

Best-practice workplace wellbeing certifications such as the WELL Building Standard (International WELL Building Institute, 2018) assert that the risk of occupant discomfort is minimised through adherence to IEQ comfort policies. For example, it is recommended that carbon dioxide (CO_2) is maintained at 800 parts per million (ppm) or lower, that light levels are maintained between 300-500 lux, and that humidity is maintained between 30-50% relative humidity (%RH). For temperature it is recommended that mechanically-ventilated buildings use Fanger's (1970) Predicted Mean Vote (PMV) method to derive the optimal temperature range, which is typically around 21-24 degrees Celsius (°C).

A limitation of these comfort criteria is that they are largely informed by experimental studies conducted in climate chambers. Whilst such designs benefit from high control over experimental variables, they also introduce a risk that the results will not generalise to real office environments where numerous additional confounds might be present. Hence, there is a need for more field studies to explore the relationship between objective IEQ and subjective comfort.

In previous years, monitoring ongoing compliance with comfort policies was difficult, as measurements of IEQ necessitated the use of a mobile cart equipped with various on-board sensors (Parkinson, Parkinson & de Dear, 2015). The associated costs and impracticalities meant many organisations conducted only short monitoring periods or eschewed IEQ measurements entirely. However, the recent development of wireless sensor technology has made it far easier to continually monitor IEQ. Sensors can be installed and operated at a relatively low cost, enabling key IEQ parameters to be continually measured with a high degree of spatio-temporal specificity, directly within the context of interest.

The emergence of environmental sensors also enables field studies which overcome other limitations of previous workplace research, relating to the use of workplace satisfaction surveys which are completed at one time only (typically 6 to 12 months following occupation). It has been argued that measuring workplace satisfaction once only leads to responses which are far too general and which can be biased by various non-building related factors, and so are of limited practical utility to workplace practitioners (Deuble & de Dear, 2014).

As such, there are growing calls for traditional occupant surveys to be replaced by or complemented with repeated "right-here-right-now" assessments of the workplace environment,

which can be easily combined with objective IEQ data collected through sensors (Candido *et al.*, 2016; Choi & Lee, 2018; Deuble & de Dear, 2014; Li *et al.*, 2018).

The purpose of this research was to develop a methodology for combining sensor-based IEQ measurements with occupants' repeated assessments of the workplace environment. In an initial pilot study, we developed a brief daily workplace assessment survey which was distributed by e-mail to employees. In a subsequent follow-up, we explored whether the response rate could be improved by shortening the survey and distributing it using smartphone notifications.

Whilst the hypotheses across the two studies were not exactly the same, several were broadly similar. These are as follows:

H_1: Satisfaction with air quality will progressively decrease as CO_2 concentration increases.

H_2: Visual comfort will progressively increase as illumination increases.

H_3: Thermal comfort will progressively decrease as the measured temperature increasingly deviates from the PMV-derived "optimal" temperature.

H_4: Self-rated productivity and wellbeing will increase at higher levels of environmental comfort.

2 METHOD

2.1 Pilot Study

The research took place in different office sites belonging to a large facilities management organisation in the United Kingdom. An initial pilot study (authors, blinded for review) was conducted within a single "neighbourhood" of a large open-plan office, containing 58 permanent workstations as well as bookable meeting rooms and informal break-out areas. The aims of the pilot study were to develop the repeated workplace assessment survey, present a methodology for integrating these data with the objective IEQ data, and provide proof-of-concept for the 'experience sampling' research design.

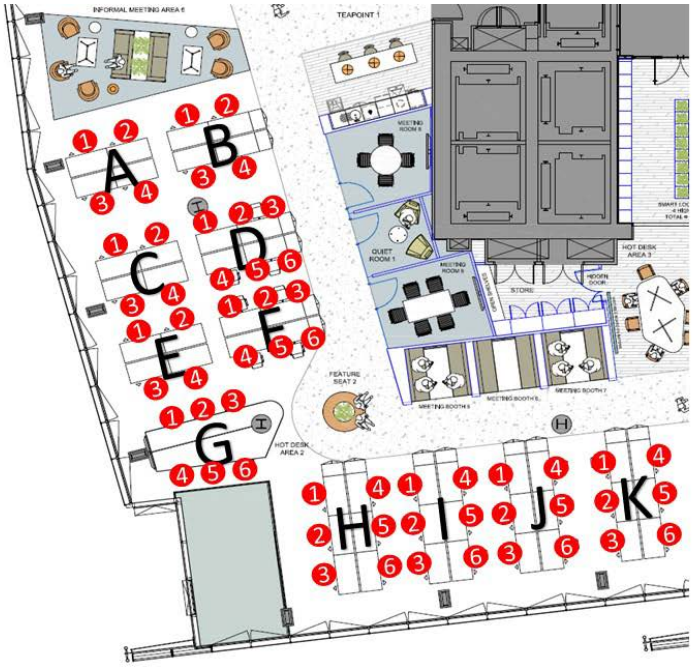
In total, 47 employees were contacted by e-mail with an invitation to participate in workplace environment research. Additionally, information leaflets were placed on desks within the study area, and the primary investigator verbally communicated information about the study while in the office. No incentives were offered for participation. Overall, 15 employees (9 male, 6 female) volunteered to participate, and together completed 78 assessments of the workplace environment across an 11-day study period.

The items on the survey were designed to correspond to traditional occupant surveys, although slight alterations were made to item wordings to capture momentary (rather than general) perceptions. Different items on the survey measured *satisfaction with air quality, thermal comfort, satisfaction with humidity, satisfaction with amount of light, satisfaction with amount of daylight, individual environmental control, control over workspace appearance, workspace availability, distractions, privacy, work-related interactions, social interactions, depression-enthusiasm, anxiety-comfort,* and *self-rated productivity.* All items were responded to using 7-point Likert scales.

Spatial and temporal identifiers were used to combine the questionnaire responses with building data. Each time they completed a survey, participants viewed a floorplan (Figure 1) and

indicated their current *location*, choosing between 11 different banks of desks. At each location, a desk-based sensor was installed to measure specific IEQ parameters. At nine desks a HOBO U12 data logger (Onset, 2019a) was placed in the centre of the desks to continuously measure temperature, humidity, and light intensity, and at two desks the HOBO U12 data logger was combined with a Telaire 7001 CO_2 sensor (Onset, 2019b) and a PCE-322A Sound Level Meter (PCE Instruments, 2019) to additionally measure CO_2 and sound pressure level. The survey software automatically recorded the time at which each survey was completed, so the questionnaire responses were combined with the average of each IEQ parameter from the closest environmental sensor(s) in the half hour preceding the completion of the survey.

Figure 1: The floorplan of the study area, which contained 58 non-assigned workstations



2.2 Follow-up Study

A follow-up study (authors, blinded for review) was conducted within two regional offices of the participating organisation, both of which featured predominantly open-plan layouts. Site A had permanent seating for 142 employees, whereas Site B had permanent seating for 56 employees. The aims of the second study were to explore whether the response rate could be improved by altering the workplace assessment survey, and to test the extent to which the findings from the pilot study generalised to different contexts.

Specifically, the survey was altered in two major ways. First, the number of items was significantly reduced (lowering the response time from ~5 minutes to <1 minute). Only the items pertaining to core aspects of IEQ (*satisfaction with air quality*, *thermal comfort*, *visual comfort*, *acoustic comfort*, and *self-rated productivity*) were retained. Each of the items was assessed using a 7-point Likert scale (1=Very dissatisfied, 7=Very satisfied), with the exception of the item on self-rated productivity which was assessed using a 100-point slider scale (1=Very negative impact, 100=Very positive impact). Second, rather than using e-mail reminders, the

survey was designed to be completed using smartphones and reminders were sent four times a day using push notifications. This was achieved by designing the survey within LifeData (LifeData, 2019), a commercially-available mobile application (app) specifically designed for experience sampling research studies.

At Site A, 121 employees were contacted by e-mail with an invitation to participate. In total, 13 individuals agreed to participate, and together provided 119 momentary assessments of the workplace environment across a 4-week data collection period. At Site B, 56 employees were contacted and 32 agreed to participate, together providing 417 momentary assessments of the workplace environment across a 2-week data collection period. As such, the combined dataset in this study contained 536 observations from a total sample size of 45 employees (24 female, 21 male).

Once more, environmental sensors were used to continuously monitor key IEQ parameters. At Site A, 17 Elsys ERS CO_2 sensors (Elsys, 2019) were permanently installed on interior walls to measure CO_2, temperature, relative humidity, and illumination. At Site B, eight Hobo U12 data-loggers (Onset, 2019a) were placed on desks within the office to measure temperature, relative humidity, and illumination, and three Telaire 7001 CO_2 sensors (Onset, 2019b) were used to measure CO_2. The floorplans which the participants used to indicate their *location*, and the location of the different sensors on those floorplans, are shown in Figure 2. Again, the relevant half-hourly averaged IEQ data were combined with subjective data using spatial and temporal identifiers collected in the questionnaire responses.

Figure 2: The floorplans, including sensor locations, for the two sites in the follow-up study

3 RESULTS

3.1 Procedure

Given the nested structure of the data (i.e., repeated measurement occasions within participants), multilevel linear modelling was used to analyse the data, following the procedure outlined by Field *et al.* (2012). All data analysis was performed using R Studio (R Studio Team, 2016), using the *nlme* package (Pinheiro *et al.,* 2017) for fitting and comparing multilevel models and the *MuMIn* package (Barton, 2018) for calculating pseudo-R^2 to estimate the proportion of outcome variance which can be explained by the predictors. Models were fitted using the restricted maximum likelihood procedure.

Descriptive statistics for IEQ and subjective responses at each of the three office sites are shown in Table 1. In the main analyses, the raw values for each of the IEQ parameters were used except in the case of temperature. For temperature, "compliance with temperature comfort policy" was calculated by taking the absolute value of the difference between the actual temperature and the PMV-derived 'ideal' temperature (22.4°C for the pilot study, and 22.55°C at both sites in the follow-up study).

*Note: In the pilot study, self-rated productivity was rated using a 7-point Likert Scale rather than the 100-point visual analogue scale used in the follow-up study.

Table 1: Descriptive statistics of environmental parameters and subjective responses at each of the three sites

	Pilot Study		**Follow-up Study (Site A)**		**Follow-up Study (Site B)**	
Measure	***M***	***SD***	***M***	***SD***	***M***	***SD***
Indoor Environmental Quality parameters:						
CO_2 (ppm)	1424.9	287.46	753.19	94.48	785.05	320.61
Temperature (°C)	23.59	0.5	22.71	0.82	25.33	1.19
Humidity (%RH)	52.18	4.42	45.63	4.18	45.53	4.91
Illumination (lux)	448.91	219.48	233.16	418.66	171.13	271.88
Subjective Measures:						
Satisfaction with Air Quality	4.69	1.21	4.55	1.45	3.76	1.24
Satisfaction with Temperature	4.5	1.47	3.49	1.7	3.71	1.39
Satisfaction with Lighting	4.94	1.27	4.18	1.33	4.37	1.17
Satisfaction with Noise	3.67	1.26	4.97	1.46	4.23	1.28
Self-Rated Productivity	4.33*	1.39*	51.05	19.36	48.71	17.83

3.2 Pilot study

To assess whether repeated assessments of environmental comfort were justified, the intraclass correlation coefficient (*ICC*) was calculated for each of the outcome measures. The *ICC* measures the proportion of total variance that is due to variance between participants and can therefore be used as a measure of test-retest reliability. According to Cicchetti's (1994)

guidelines, *ICC* > 0.6 is the minimum criteria for "good" rest-retest reliability. The only measure that met these criteria was workspace availability (*ICC* = 0.67), with most measures showing very poor test-retest reliability, particularly satisfaction with temperature (*ICC* = 0.08) and distractions (*ICC* = 0.06). These results showed that individual's experiences of different aspects of environmental comforts tended to fluctuate significantly each time they were asked, confirming that the experience sampling methodology was a more appropriate tool for measuring these experiences than the one-time only questionnaire.

Multilevel regression models were used to test whether subjective comfort could be predicted using objective IEQ data. Our results confirmed that higher levels of CO_2 were associated with more negative ratings of air quality ($p < 0.0001$). The pseudo-R^2 estimate indicated that approximately 14.8% of the variance in ratings of air quality could be attributed to the CO_2 level (marginal_GLMM^2 = 0.148), constituting a moderately-large effect size. However, there was no evidence to support the predicted relationships between illumination and satisfaction with light intensity ($p = 0.9$), or between compliance with temperature policy and thermal comfort ($p = 0.27$).

The models exploring the relationships between environmental comfort, wellbeing, and productivity provided moderate support for our hypotheses. Higher levels of enthusiasm were predicted by higher satisfaction with air quality ($p = 0.02$) and also by lower levels of distractions, although this latter effect was marginally above significance criteria ($p = 0.055$). Higher psychological comfort was also predicted by lower levels of distractions ($p < 0.0001$). Finally, higher self-rated productivity was predicted by lower levels of distractions ($p = 0.0026$), higher ratings of control over workspace appearance ($p = 0.0091$), and higher satisfaction with air quality ($p = 0.039$).

Summary statistics for the multilevel regression models are shown in Table 2.

Table 2: Summary statistics for each of the multilevel linear regression models in the pilot study.

	Model for predicting perceived air quality (*n* = 64 observations, from 14 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
CO_2 concentration (ppm)	-0.002	-4.78	<0.0001
Marginal r^2 = 0.148			
	Model for predicting perceived thermal comfort (*n* = 535 observations, from 39 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
Temperature (deviation from comfort policy; °C)	0.36	1.13	0.27
Marginal r^2 = 0.017			
	Model for predicting perceived visual comfort (*n* = 64 observations, from 14 participants)		

Explanatory Variable	**Estimate**	**t-value**	**p-value**
Illumination (lux)	0.00007	0.12	0.9
Marginal r^2 = 0.0002			
	Model for predicting enthusiasm (*n* = 460 observations, from 31 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
Satisfaction with air quality	0.26	2.36	0.02
Distractions	-0.18	-1.2	0.055
Marginal r^2 = 0.118			
	Model for predicting comfort (*n* = 460 observations, from 31 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
Distractions	-0.26	-2.88	0.005
Marginal r^2 = 0.065			
	Model for predicting comfort (*n* = 460 observations, from 31 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
Distractions	-0.32	-3.15	0.003
Control over workspace appearance	0.28	2.7	0.009
Satisfaction with air quality	0.25	2.11	0.04
Marginal r^2 = 0.35			

3.3 Follow-up study

The same general data analysis procedure was conducted in the follow-up study. The measurements of *ICC* showed that visual comfort (*ICC* = 0.61) was marginally above Cicchetti's (1994) guidelines for adequate test-retest reliability, whereas self-rated productivity (*ICC* = 0.59), acoustic comfort (*ICC* = 0.56), and thermal comfort (*ICC* = 0.26) all fell below the cut-off point. Again, these results broadly confirm the assumption that participants' environmental comfort ratings tended to vary moderately each time they completed the survey, confirming the appropriateness of the experience sampling methodology.

Multilevel regression models were used to explore the associations between IEQ and subjective comfort, with a binary variable representing site (1 = Site A, 2 = Site B) added to all models to control for any contextual variance between the two offices.

The results showed that higher deviation from recommended temperatures was negatively associated with thermal comfort (p = 0.0031), although the effect size was small ($marginal\_GLMM^2$ = 0.011). However, there was no evidence to support the predicted associations between CO_2 concentration and satisfaction with air quality (p = 0.21), or between illumination and satisfaction with light intensity (p = 0.74).

Finally, the model exploring the relationship between environmental comfort and productivity confirmed that higher levels of self-rated productivity were predicted by higher acoustic comfort, thermal comfort, satisfaction with air quality (all p values < 0.0001), and visual comfort (p = 0.0001). The pseudo-R^2 estimate indicated that more than half of the variance in productivity was accounted for by these components of environmental comfort ($marginal\_GLMM^2$ = 0.508).

Summary statistics for the multilevel regression models are shown in Table 3.

Table 3: Summary statistics for each of the multilevel linear regression models in the follow-up study.

	Model for predicting perceived air quality (*n* = 536 observations, from 39 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
Organisation	-0.26	-0.75	0.46
CO_2 concentration (ppm)	0.0001	0.89	0.37
Temperature (deviation from comfort policy; °C)	-0.18	-4.24	<0.0001
Marginal r^2 = 0.063			
	Model for predicting perceived thermal comfort (*n* = 535 observations, from 39 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
Organisation	0.45	1.34	0.19
Temperature (deviation from comfort policy; °C)	-0.12	-2.17	0.031
Marginal r^2 = 0.011			
	Model for predicting perceived visual comfort (*n* = 460 observations, from 31 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
Organisation	-0.93	-1.73	0.1
Illumination (lux)	0.00004	0.33	0.74

Marginal $r^2 = 0.054$			
	Model for predicting self-rated productivity (*n* = 460 observations, from 31 participants)		
Explanatory Variable	**Estimate**	**t-value**	**p-value**
Organisation	-0.78	0.19	0.85
Visual comfort	2.41	4	0.0001
Satisfaction with air quality	2.23	4.34	<0.0001
Thermal comfort	3.46	7.68	<0.0001
Acoustic comfort	4.2	8.21	<0.0001
Marginal $r^2 = 0.52$			

4 DISCUSSION

In two studies conducted across three office sites, we developed a methodology for integrating sensor-based measurements of IEQ with employees' repeated assessments of comfort and productivity.

The results of the studies generally confirmed the appropriateness of the experience sampling methodology for conducting workplace assessments. The *ICC* statistics for the survey responses tended to fall below the criteria for acceptable test-retest reliability, indicating that responses differed each time the survey was completed. This is in line with theoretical expectations about the concept of comfort being an experience which varies on a moment-to-moment basis, in response to varying environmental conditions at different locations and times.

Hence, the experience sampling methodology is able to measure comfort with greater precision than the traditional occupant survey. Experience sampling survey responses can be combined with live IEQ data using spatial and temporal identifiers, enabling workplace researchers to conduct rigorous field studies into the relationship between IEQ and subjective comfort.

The tentative early findings of the studies suggest that environmental sensors are particularly useful for identifying environmental demands when the physical conditions deviate more strongly from comfort policies. For example, a significant relationship between CO_2 and satisfaction with air quality was observed in the pilot study (where CO_2 frequently exceeded the 800 ppm upper bound) but not in the follow-up study (where average CO_2 at both sites was lower than 800 ppm). Similarly, a significant relationship between temperature and thermal comfort was observed in the follow-up study (where temperatures significantly exceeded recommendations at one site in particular) but not in the pilot study (where temperatures were almost entirely within the recommended range). These findings highlight that environmental sensors can be effectively used to ensure compliance with conditions in which the risk of discomfort is minimised.

However, the effects of IEQ on subjective comfort are relatively weak, meaning that compliance with comfort policies is no guarantee that comfort will be the result. There is significant inter-

individual variability in environmental preferences, and it is likely that a certain proportion of occupants will remain dissatisfied even under perfect adherence to IEQ comfort policies.

To achieve the highest levels of satisfaction, it may be necessary to consider crafting strategies which allow occupants to adjust local environmental conditions to their own preferences (e.g., Kim *et al.*, 201). This might allow ambient environmental conditions to be relaxed beyond strict IEQ guidelines, without any concurrent rise in discomfort. Similarly, activity-based working could be implemented to allow employees to choose the most appropriate space from which to work. Viewed from the perspective of the ED-R model, such strategies can be seen as examples of environmental crafting, because they enable employees to proactively mitigate demands and enhance resources.

Whilst the provision of subjective comfort is complex, it should be considered a crucial business concern. Across the two studies, the results indicated that higher levels of environmental comfort were associated with higher enthusiasm, comfort, and self-rated productivity. Aspects relating to the acoustic environment ("levels of distraction" in the pilot-study and "satisfaction with noise levels" in the follow-up study) had the strongest effect sizes.

Hence, workplace practitioners can help employees to work more effectively by providing more comfortable offices, focusing on mitigating noise distractions in particular. Strategies used could include the use of more sound-absorbent materials in office furnishings, the use of sound masking systems, and/or workplace management strategies such as the designation of "silent working" areas within the office.

5 CONCLUSION

"Smart building" technology, including wireless environmental sensors, is predicted to grow exponentially in the coming years. Facilities managers and other workplace professionals will be able to understand the performance of their workplace environments in far greater depth than ever before. However, without understanding how these data relate to employer-relevant outcomes such as employee wellbeing and productivity, the potential benefits of smart building technology may never be realised.

In this paper, we have presented the results from two studies in which we developed a methodology for integrating sensor-based IEQ measurements with occupants' subjective experience. Our tentative early findings suggest that adherence to IEQ comfort policies helps to minimise the risk of occupant discomfort, yet to fully optimise the environment it will be necessary to consider further strategies that allow each employee to proactively craft local conditions to their own preferences and requirements.

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From Coworking Space to Coworking Building

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ABSTRACT

The world of work is changing, and this is creating new demands on office buildings. Project and development times are becoming shorter and shorter, which also reduces the planning horizon of companies. On the other hand, the technical requirements for buildings are becoming ever higher, so that construction costs and construction times are increasing. Investors are thus faced with the dilemma that they no longer receive predictable and secure rental income for their investments. Only large companies can conclude long-term rental agreements and, in return, receive tailor-made properties that are not highly suitable for third-party use. Smaller companies with shorter planning horizons can only find rental space in existing buildings and therefore usually have to cut back on the standard. Co-working spaces close this supply gap. Is it possible for investors to respond to the new demand situation with a flexible building concept?

Keywords

Working environment, Coworking, Real Estate, Smart Building

1 INTRODUCTION

Office properties need to be thought of in new ways. The public debate on sustainable construction is largely focused on the construction of the buildings and the following operating costs. Drivers for this are social change, which is bringing the green idea increasingly to the focus of attention in real estate as well, and also economic aspects such as continuously rising energy costs. But users and investors are also increasingly demanding "green buildings". In 2018 "green buildings" already accounted for 22% of the transaction volume of commercial property in Germany (BNP Paribas Real Estate 2018). Investors are increasingly taking sustainability criteria into account in their investment decisions and prefer to invest in "green buildings". The same applies to users. This has led to a continuous increase in the proportion of certified office buildings in Germany. In Frankfurt, 20% of office space is already in certified buildings.

The next trend in sustainable building is the Cradle to Cradle approach (Braungart 2014). With the Cradle to Cradle principle, recyclability is already considered at the planning stage. In contrast to recycling, materials should be reused again and again for the same goods without any loss of quality. The Cradle to Cradle principle has the vision of a waste-free economy. Also, the legislator causes with different editions and laws, e.g. energy saving regulation, that the buildings may need less and less energy. So far, studies have not sufficiently addressed the costs of re-letting. Particularly in the case of high-quality office properties, planning and development is carried out according to the individual specifications of the tenants, who in return conclude a

long-term lease agreement. But at the latest when moving out and often already during the rental period, costly and raw material-intensive conversions become necessary.

2 NEW WORK - WORKING ENVIRONMENT 4.0

Office concepts were previously characterized by individually partitioned office cells for one to four people and each employee had his or her own fixed workplace. Changing work processes and work methods driven by digitalization are dissolving this fixed structure in more and more companies.

With the digitalization of the working environment, individualization and flexibility have become the focus of attention. New Work is the epitome of this transformation. Digitization, connectivity and globalization as well as demographic change are among the driving forces behind the transformation of the world of work (Spath 2012). This new generation is called Digital Natives because they are used to working with digital media from childhood. This generation will demand a change in corporate culture, which will also redefine the working environment. In the meantime, a large part of this generation is shaping today's working environment and is calling for a modernization of traditional forms of work. Digital natives have an attitude to life that prefers conventional status symbols such as home, cars, workplace, etc. to self-realization that goes hand in hand with high flexibility and spontaneity. Existing models and concepts of the world of work and living must be questioned regarding their longevity. Furthermore, younger people are increasingly striving to combine their private lives and their work as much as possible to create the necessary freedom for a balanced everyday life that corresponds to their wishes. The motto "Sharing is Caring" rounds off the attitude to life of many digital natives and is reinforced by the constant use of digital media. (Kürschner 2015)

The workplace is increasingly becoming a place of well-being. The new "Working environment 4.0" is characterized by an open and flexible office landscape. The familiar cell structure with its static division has given way to an open concept in which mutual exchange is encouraged. From a business point of view, the productivity and motivation of the employees should be increased, and work processes optimized. This can also result in cost advantages for the property owner if it is no longer necessary to carry out an individual tenant fit-out for each tenant.

Today, tenant fit-out does not only consider the specifications of work processes and working methods, but also increasingly the specifications of corporate identity and corporate culture and corporate design. This means that every change of tenant requires a new fit-out according to the specifications of the new tenant. The costs for this are always charged to the rent and thus to profitability. Sustainability goals are often disregarded, even though user expansion is now also considered in DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen DGNB e.V. - German Sustainable Building Council) certification. In addition to environmental aspects, the DGNB's assessment of a sustainable fit-out focuses on the health, well-being and comfort of the employees and on the assessment of the construction with regard to its relatively short service life. There is no economic consideration at the level of the landlord regarding the fit-out costs in relation to the rent and lease term.

3 COWORKING – A CHANGE IN WORKING ENVIRONMENT

One of many definitions of coworking is: "Coworking is a new way of working, in which self-employed people, start-ups, creative people and increasingly more and more large companies work together in one space - in a coworking space - independently and simultaneously. Although everyone is working on individual projects, exchange and mutual help are a central component."[63]

Coworking is characterized by the sharing of office space in by freelancers, digital nomads, independent creatives as well as small start-ups and large companies. Coworking brings together a group of diverse people to work together in a collaborative environment. All parties share the core values of coworking such as community, collaboration, sustainability, accessibility and openness. You work independently and on a wide variety of projects and products. At the same time, a community is created between the different members. Living the coworking values and sharing the open workspace creates a special atmosphere in a coworking space that encourages continuous interaction between members (Gandini 2015).

The coworking space is of key importance. Here users can rent a workstation, a meeting room or a team area. In contrast to classic office space, no usable space is rented out, but instead ready-to-use user units. The user is provided with the complete infrastructure of an office and can take advantage of additional services such as reception, catering, community manager, etc., so that he can immediately concentrate on his core business. The main advantage for users of a coworking space is the shorter duration of the rental contracts (often only one month). A study by Colliers (Kiese 2018) examined the main motives of users for renting a coworking space. The most frequently cited reasons for renting were "reduction of fixed costs for only temporarily increased space requirements", "lack of space availability in the current market situation at the desired location" and "temporary renting during start-up and growth phases". But coworking is about more than just renting workplaces as flexibly as possible. Other motives result from the "coworking fundamental values"[64]: Community, openness, collaboration, sustainability and accessibility. Central elements in a coworking space are communication hubs, the integrated coffee shop and community management.

However, a coworking space does not only include open spaces. The demand from larger users leads to hybrid models in which, in addition to large, shared workspaces, there are also many more private offices. In this way, larger companies benefit from a creative exchange and can also flexibly integrate external personnel at short notice. Increasingly, larger companies are renting exclusive areas in the coworking space and using the range of services, the common areas and want to be inspired by the spirit of coworking.

4 COWORKING PROVIDER

For a real estate owner, the coworking provider primarily assumes the task of maturity transformation. Real estate owners are looking for lease terms that generate a secure, stable and long-term cash flow. In the case of a classic office property, the office space is let to a tenant who provides a service in the space and the rent is then paid with the income from this service.

[63] https://coworkingguide.de/coworking/ (accessed 07.03.2020)
[64] https://coworkingguide.de/coworking/ (accessed 07.03.2020)

A coworking provider is comparable to a hotel operator who provides rooms to guests for overnight stays over a relatively short period of time, but at the same time concludes a very long (>20 years) lease term. The hotel operator's income depends directly on the occupancy rate and the achievable room rates, which are subject to seasonal and economic changes. The most common form of contract for hotels in Germany is the lease with a fixed amount to be paid, irrespective of revenue or operating result. The hotel operators are also responsible for the maintenance of the property. The landlord thus has a secure, stable and long-term cash flow. Only the default risk remains, which is made up of the management risk and the maturity transformation (short-term income and long-term lease obligations).

The study by Colliers (Kiese 2018) concludes that over 90% of coworking providers' rental contracts have a term of over five years. The user contracts, on the other hand, mostly only have terms of less than one year. The trend towards ever shorter user contracts is a consequence of Industry 4.0, as project and development periods are becoming shorter and shorter, thus shortening companies' planning horizons. And the world of work has also been undergoing fundamental and structural change for some years now. Coworking providers are responding to this trend, enabling flexible working without long-term contracts. A reversal of this trend is hardly conceivable and must therefore be considered when considering real estate.

Primarily, the coworking provider offers potential users a variety of fully functional workstations, supplemented by secondary services that allow users to focus on their core business. The decision to rent a coworking space is multifaceted and ranges from short-term job requirements to the search for a creative work environment. Location, accessibility and equipment are the most important criteria for coworking users.

The coworking provider is responsible for marketing and user acquisition, which is a continuous process due to the short user terms. Utilization and achievable prices have a direct impact on the operating result. The coworking provider can generate additional income from secondary services. The coworking provider takes the opportunities offered by digitalization. The marketing process is largely automated via a dedicated homepage or app. The Community Manager is responsible for onboarding and ongoing operations on site at the coworking space. All these services are comparable to the operation of a hotel or serviced apartment. For cost reasons the coworking provider strives to digitalize most of the services, so that the required number of employees can be reduced to a minimum and the staff can concentrate solely on the necessary personal support of the users.

This raises the question for the property owner about the necessity of a coworking provider or can this service not be digitized?

5 SMART BUILDING

The digital transformation has already led to the first applications in the field of real estate management. Buildings are increasingly being equipped with sensors and thus enable, for example, automatic control of building services. These smart buildings are characterized by improved user comfort and energy efficiency. The building recognizes its users when they enter in the morning and digital building services control heating, lighting and ventilation according to the preferences of the respective user, allocate a free workplace or meeting room or inform the catering service about the expected demand at lunch time (Jadhav 2016).

The Smart Building is to be further developed so that users have maximum freedom and property owners reduce management costs and increase revenues.

6 TRADTIONAL REAL ESTATE MANAGEMENT

Up to now, the real estate owner has only considered the space utilization based on the lease terms. A building is fully let when a lease term is concluded for each unit. But are all units actually used? And is there a need for additional space or workplaces? No service company has a constant need for workplaces and especially the change to "New Work" leads to constantly changing work processes. The current daily workplace requirement depends on many factors:

- Number of employees
- Order situation and order expectations
- Absences of employees due to vacation or illness
- Travelers, meetings, customer visits
- Work processes

When users decide on the term of a lease, they must consider the plannability of the required workplaces. Strongly expanding companies therefore often rent larger spaces or secure expansion space through options. In the event of opposing economic developments, tenants usually have only limited possibilities to react to a decline in the number of workplaces required, e.g. through subletting or special notice rights. It happens not infrequently that one user needs additional space in a property and another user would like to reduce his space. The tasks of an active real estate management are to regularly analyze the space requirements with the users. However, most office buildings suffer from a lack of structural flexibility to react to changes in space requirements at short notice. However, users are also unable to rent additional space without further conversions due to excessively high individual requirements.

7 FROM COWORKING SPACE TO COWORKING BUILDING

The office layout of a service company usually consists of a reception area with attached meeting rooms. Depending on the way of working, there are then separate cellular or group offices or individually designed open-space areas. In addition, the quality and color design are adapted to the individual specifications of the tenant. In a multi-tenant office building, it is not uncommon for all units to have different fittings. A quick change of users is therefore hardly possible and usually associated with considerable fit-out costs. With every change of user, the space is refitted to meet the needs of the new users. Only in low-cost office locations are the users willing to take over a space in the same fit-out as the previous user.

The ecological and economic consequences of this individual space design are demonstrable, but usually difficult to quantify. The costs for individual tenant fit-out are passed on to the tenant via the rent, but this does not mean that these costs are paid by the tenants only. The landlord cannot generate any rent during the period of the fit-out work, and there is usually seldom a re-letting without vacancy periods.

Both tenants and landlords must rethink their behavior. When renting in a coworking space, users already give up on implementing their individual preferences. When making their rental

decision, users can choose from a variety of providers and opt for the coworking space that best meets their requirements in terms of location, accessibility, equipment, services and atmosphere.

In recent years, numerous coworking providers have rented large spaces in top locations. The rents are usually in the upper range of the market rent. The international coworking providers sign long-term contracts. In reward, the landlords grant rent-free periods and cost subsidies. The coworking providers require the subsidies for the initial furnishing. The landlords then expect a long-term, secure and stable cash flow without the usual costs of re-letting during this period.

In the case of office properties, the landlord takes responsibility for letting management or commissions a service provider with the know-how to do so. The aim of letting management is to sign as long lease terms as possible. As an incentive, a tenant with a longer rental period receives an additional bonus in the form of a longer rent-free period or a higher subsidy for extension costs. And, of course, every landlord strives to let as much space as possible to one user, so that the rental costs are reduced.

As with any long-term decision, the letting of larger spaces is time, cost and management intensive. First, the user and the available space must be matched, which is usually only possible through an estate agent. The user must decide on the new location and make decisions about the scope and fit-out. How easier would it be if the user were free of these decisions, if he did not have to commit himself unnecessarily in the long term and if he could choose from a standard product portfolio? These advantages are offered by coworking providers and are to be transferred to entire coworking buildings in the following.

8 REQUIREMENTS FOR A COWORKING BUILDING

Transforming the findings from the coworking space to the level of a real estate owner, the following four points should be considered when designing a coworking building:

1. user-specific building branding
2. standardized office units
3. flexible use concepts without expansion costs
4. provision of services

To 1.) Individualization should not take place at user level, rather at property level. When choosing a coworking building, the user should have the possibility to individualize. Every coworking building must therefore have a unique selling point with which the user can identify. This can be the design style, the furnishing and technical standard, or the service offering. Especially the service offer has numerous characteristics. Branding specifications form the basis of the architecture, interior design and ongoing marketing.

To 2.) An office building is composed of separated approx. 400 sqm units. The building is to be planned so that several individual units can be linked to form one unit. It should be a central entrance area and bigger buildings should also have secondary entrances so that larger users have separate entrances. In the central area, a supply unit is to be located that functions as a central hub. This is where the check-in for new users takes place and service orders can be accepted.

Each of these units will be equipped with a uniform standard and there will only be separate facilities for sanitary and kitchenette. The remaining space in the unit is open without dividers.

There is a uniform basic lighting, uniform air conditioning and surrounding electrical wiring with network access. The building depths and facade grids are based on the established standard, so that sufficient daylight is guaranteed. Sound absorption is an important criterion in the choice of floor and ceiling materials.

To 3.) The individualization for the user is exclusively provided by the furniture. The user can choose from a catalogue of desks, room dividers, cabinets and accessories. The design concept of the furniture is closely related to the building branding. T It will be necessary for the landlord to keep a basic stock of furniture in the storage area of the building. The unified furniture will allow users and landlord to respond quickly and cost-effectively to changes in user needs, and different users will be able to share office units. The design of the furniture must meet the requirements of the different target groups:

- inspiring interior design
- communication hubs,
- separate retreat and meeting rooms,
- spatial separation of areas for concentration and collaboration.

The last point in particular can be solved by asking users about their needs at check-in and then booking them into suitable areas. Users who make a lot of phone calls and work in a team should be separated from users who want to work concentrated and independently.

To 4) The coworking building should provide its users with a functioning office infrastructure. A fast internet connection is standard. In addition, there are the services that distinguish coworking buildings from ordinary office buildings. In addition to the obligatory coffee shop, children's playground, fitness and spa club or serviced apartments are conceivable. Regarding the services offered, the location must be taken into account in particular. A coworking building in a central inner-city location must certainly have a less service offer than a location in an industrial park.

The coworking building must have a minimum size so that all services can be offered, and an economical operation is possible. The central coworking space with connected separate office units is the core of the building. The coworking space serves as an incubator for new tenants, who can later move into one of the separate office units, and as a buffer if the tenants in the separate office units need additional workspace or want to fill up vacant workstations.

The real estate owner can use external service providers for conception, planning and operation. In the foreseeable future, the established coworking providers will also issue franchise licenses, so that the local real estate owner can benefit from an international network und established knowhow.

9 MANAGEMENT OF THE COWORKING BUILDING

Big-data methods form the basis of management in coworking buildings. The analysis is based on the current user data. In addition, the occupancy rate must be continuously recorded, and the users must be interviewed in order to estimate future demand. Big data also includes secondary data: Local Internet use, expenditure on secondary services (coffee consumption, parcel deliveries), economic indicators, local office market figures. The aim is to determine whether all workplaces in the coworking building are actively used and whether users can be offered

sufficient workspace in the medium term. The main task of management a coworking building is a digital maturity transformation to ensure a stable cash flow. The real estate owner must define the monthly minimum income and a fluctuation margin as a target. The system then has to control the user contracts accordingly and generate the required rental units through price adjustments. There are no additional costs for renting as in classical office buildings such as estate agents, construction costs and relocation costs.

The following management tools are available in the coworking building:

- Excluding the renewal of contracts of smaller users so that a larger user can renew his contract.
- If a large user intends to reduce his space, contracts with smaller users can be extended at discounted rates.
- If a tenant of a separate office unit has free workplaces, these can be assigned to the pool of workplaces from the coworking space. The additional rental income from subletting is then shared by the office tenant and the landlord.
- Should external effects such as the corona crisis in 03/2020 lead to a shift in user demand, the prices of rents can be reduced so that users are kept on and no expensive marketing measures are required later to attract new users.
- Vacant workplaces are displayed internally, reported to external letting platforms and placed in social networks. Communication between different coworking buildings is also conceivable.

The communication to the users and between them can be solved via an app. This app is used to handle contract management and users can book secondary services such as meeting rooms, catering, etc.

10 CONCLUSION

The coworking space is the implementation of the new requirements from the working environment 4.0 in the field of office real estate. The design of entire buildings according to the principle of a coworking space offers real estate owners the opportunity to meet the changed requirements of office users. The use of digital technologies in the management of a coworking building will increase efficiency and improve profitability and can replace the coworking provider. Legal and tax issues still need to be clarified for the implementation of the coworking building and the technological requirements for the digital management of a coworking building still need to be created. However, the most important step must be implemented by the property owners, in which no further individually fitted spaces are rented out, just to enable the tenant to conclude a lease with the longest possible term. The new users are no longer looking for space, instead they are looking for flexible workplaces in an attractive environment. The automotive industry has also had to recognize that in the future there will be a demand for mileage rather than vehicles. Hopefully the real estate industry will soon recognize this trend and take on board the needs of the digital natives.

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SESSION 20: VIRTUAL SPACES OF WORK

Virtual work challenges experienced by knowledge workers in organizations undergoing digitalization

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ABSTRACT

Purpose: This study aims to gain insight into the existing knowledge of the challenges affecting the well-being of individuals who engage in virtual work.

Theory: Powered by available and developing technology, digitalization enables work activity outside office locations as organizations transition from co-located to virtual work. Individuals can thus choose when and where to carry out their work tasks. However, the transition to virtual workplaces causes concern in both managers and employees, because it affects work distribution and organization, organizational structures, and management practices. Therefore, such a transition requires customized strategies for achieving optimized work performance and employee
well-being in virtual work.

Approach: We reviewed the available literature on virtual work to develop a comprehensive overview of the well-being challenges knowledge workers experience when working virtually.

Findings: By reviewing the literature on virtual work, we observe that such analysis is fragmented. Therefore, we compile six challenges in virtual work affecting the well-being of employees and managers.

Originality/value: The study contributes to research on digitalization of knowledge work by clarifying and organizing key challenges knowledge workers experience when working virtually and compile the available knowledge in a comprehensive overview.

Keywords:

Digitalization, Virtual work, Challenges, Knowledge work, Well-being

1 Introduction

The advancing technologies contribute to making work and daily life increasingly digital. Organizations integrate digital technologies e.g., online platforms, telecommunication applications, cloud services, analytic tools and artificial intelligence in workplaces (Schwarzmüller et al., 2018; Vuori et al., 2019). By integrating these technologies, organizations enable connectivity and flexibility for knowledge workers to take work activities outside of office locations and enable virtual work. As a consequence, individuals can choose when and where to carry out their work tasks, and therefore achieve increased autonomy (Kelliher & Anderson, 2010). Digital tools allow working virtually as individuals can use emails and access organizations' files anywhere using personal computers and other devices. Because of video conferencing, individuals can attend meetings while outside the office. Digital technology enables novel forms of virtual work, where both time, geography, organizational boundaries and culture create a distance to co-workers and colleagues (Fisher & Fisher, 2001; Jimenez et al., 2017; Larson & DeChurch, 2020; Martins et al., 2004; Taras et al., 2019).

Enabled by digitalization, co-located teamwork increasingly has been replaced by virtual work (Schwarzmüller et al., 2018), and collaboration in virtual space from different locations has become the norm (Jimenez et al., 2017). Digitalization and virtual work have especially gained importance since the outbreak of COVID-19. Until recently, the majority of knowledge-intensive organizations across the world have engaged in virtual work either through dispersed teams, virtual teams or having individuals' occasionally work from home offices.

Although the literature has addressed factors influencing employee well-being when working virtually, such as cultural differences and misunderstandings (Dekker et al., 2008; Henderson et al., 2018; Muethel & Hoegl, 2010), trust issues (Alsharo et al., 2017; Bisbe & Sivabalan, 2017; Choi & Cho, 2019), difficulty in working and managing from different parts of the world (Jimenez et al., 2017). Literature has not yet provided a comprehensive overview of the challenges individuals experience when working virtually. Therefore, this study aims to identify the challenges in virtual work that impede the well-being of individuals, followed by the research question: What are the common challenges experienced by employees and managers working virtually?

We begin by introducing the research area. Thereafter, we define digitalization, knowledge-intensive organizations, and virtual work, followed by the methodology of this study. Further, we present the challenges affecting the well-being of individuals working virtually, followed by the conclusion and opportunities for further research.

2 Definitions

In this study, we define digitalization as the application of digital technologies in organizations that change business processes, such as collaboration and communication (Mergel et al., 2019; Verhoef et al., 2019).

Digitalization affects collaboration and communication processes in knowledge-intensive organizations (Schwarzmüller et al., 2018). We define knowledge-intensive organizations as organizations that develop and utilise complex knowledge (i.e., theoretical, abstract and contextual) in creating its outputs and where the majority of workers have specialized skills and detailed knowledge (von Nordenflycht, 2010).

Literature uses different terms when describing work accomplished from distance by the assistance of digital technology. For example, remote work (e.g., Eddleston & Mulki, 2017; Olson, 1983), telework (e.g., Suh & Lee, 2017), mobile work (e.g., Chen & Nath, 2008), flexible work (e.g., Groen et al., 2018), virtual work (e.g., Makarius & Larson, 2017), digital work (e.g., Dittes et al., 2019), distributed work (e.g., Zolin et al., 2004), and dispersed work (e.g., Assudani, 2009). Frequently these terms are used interchangeably (e.g., Golden, 2006). This type of work is connected with domains such as virtual teams (Gilson et al., 2015) and global virtual teams (Jimenez et al., 2017), virtual offices (Fritz et al., 1998), distributed environments (Gressgård & Hansen, 2015) and flexible working practices (Kelliher & Anderson, 2010). In addition, the level of virtuality describes the extent to which work is accomplished in virtual space by the assistance of digital technologies (Makarius & Larson, 2017; Schaubroeck & Yu, 2017).

In this study, we use the term virtual work to refer to work that is enabled by digital technology and uses digital technology for transferring ideas and knowledge with a reduced face-to-face interaction (Makarius & Larson, 2017). Virtual work allows collaboration, communication and knowledge sharing via email, instant messaging apps, social media, video conferencing, and cloud services (Orhan et al., 2016). Individuals working virtually accomplish work tasks from their homes, co-working spaces, clients' offices and/or drop-in work stations closer to their homes (Raghuram & Wiesenfeld, 2004).

Furthermore, we broadly refer to individual well-being as the overall quality of individuals' functioning and experience at work (Voorde et al., 2012; Warr, 1987) which may be affected by elements such as job satisfaction and commitment, presence of stressors, quality of interactions and relationships between co-workers.

3 Methodology

The purpose of this study is to gain insight into the existing knowledge of the challenges affecting the well-being of individuals working virtually. To do so, we carried out a systematic literature review inspired by Webster and Watson (Webster & Watson, 2001). We used Science Direct as the main database to search for peer-reviewed journals, articles and book chapters relevant for the study.

When selecting articles and papers, we considered the research question and scope of the literature review to outline the selection criteria. First, we searched the database by using the term "digital"; further, we selected "digitalisation" following UK English. Followed by "digitalization" using US English to ensure inclusion of the relevant literature. To expand on challenges in virtual work, we searched "virtual work" and "virtual teams". Furthermore, since we were interested in challenges common in knowledge work, we searched by term "knowledge work". The reason we chose these keywords follows our assumption that virtual work in knowledge-intensive organizations is enabled by digitalization.

The selection of relevant articles included analysis of the title and keywords; if the article passed these filters, the paper was assessed for the scope of our project. The first step of the review process resulted in 333 articles, which we saved in Zotero library. In the second step, we analysed the papers' abstract, introduction and findings. While doing this, we selected 23 relevant papers for this literature review, which constituted as the main data for the literature analysis.

When analysing the selected papers, we specifically looked for challenges in virtual work affecting the well-being of managers and employees in knowledge-intensive organizations. We divided the challenges from the selected literature into core challenges and secondary challenges based on how many publications addressed each challenge. We found that core challenges were addressed in more than half of the reviewed selected publications i.e. more than 12, whereas secondary challenges were addressed occasionally i.e. less than 12 of the selected publications.

4. Analysis

Engaging in virtual work has various benefits, for example, working virtually removes the need for physical presence in a certain environment and the related costs, reduces travel time, preserves the environment (Dekker et al., 2008), and allows coordinating actions of individuals across the organization simultaneously (Schaubroeck & Yu, 2017). Working virtually leads to reduced work-related stress due to the increased flexibility that allows individuals to balance work demands and private lives (Raghuram & Wiesenfeld, 2004). At the same time, working virtually can be challenging due to the constant connectivity, increasing demands and lack of social interaction. Additionally, communication issues affect collaboration and trust in virtual work. These challenges impede the well-being and performance of work for managers and employees alike (Alsharo et al., 2017). Table 1 illustrates core and secondary challenges in virtual work we derived from the selected literature. Thereafter, we elaborate on each challenge.

Table 1 - Representation of core and secondary challenges in virtual work

Core challenges	**Secondary challenges**
Collaboration issues	Constant connectivity
	Increasing demands
Lack of trust	Incompatibility of technology and users
	Social isolation

4.1 Collaboration issues

Interpersonal collaboration is an essential aspect of knowledge work as both information and knowledge are key resources to knowledge workers, and collaboration facilitates knowledge and information exchange (Vuori et al., 2019). However, virtual work involves collaboration and communication with a reduced face-to-face contact, which diminish cohesion among the co-workers, limits interpersonal relation development, interrupts tacit information exchange, presents challenges in managing conflicts (Bisbe & Sivabalan, 2017; Choi & Cho, 2019), prolongs decision-making and effective collaboration (Alsharo et al., 2017).

Collaboration is important for achieving good performance, yet collaboration relies on trust, which promotes knowledge sharing within the team (Alsharo et al., 2017). Knowledge sharing contributes to both trust generation and collaboration among individuals working virtually.

However, frequently in virtual work, the knowledge transfer is slower and reduced (Bisbe & Sivabalan, 2017), resulting in individuals missing information for performing tasks or not receiving information on time (Orhan et al., 2016). Furthermore, sharing tacit knowledge in virtual work through solely verbal and written means is difficult as even with the use of richest virtual communication form, tacit knowledge cannot be fully grasped (Schaubroeck & Yu, 2017).

In certain situations, knowledge sharing may trigger loss of knowledge ownership, which, as a result, trigger reluctance in sharing knowledge with others (Alsharo et al., 2017). The reservation in knowledge sharing may interfere with collaboration and result in issues such as missed objectives due to distance.

4.2 Lack of trust

Trust is crucial in virtual work as it facilitates collaboration, coordination and knowledge sharing, yet building trust is difficult, especially in workplaces with a high level of virtuality, where individuals who are not familiar with one another collaborate via digital technology (Schaubroeck & Yu, 2017). In situations where individuals are located in separate sites, different time zones and have different cultural backgrounds that may involve having diverse trusting behaviours, values, expectations and ways of communicating and collaboration (Muethel & Hoegl, 2010; Zakaria & Mohd Yusof, 2018) which, as a result, contribute to difficulties in trust development and collaboration. Lack of trust is the key impediment to performance in virtual work (Choi & Cho, 2019). Trust is formed gradually and is based on the perceptions of trustworthiness and involves elements e.g., uncertainty, vulnerability and risk, which individuals working virtually need to overcome to work well together (Alsharo et al., 2017; Choi & Cho, 2019).

4.3 Social isolation

Another challenge in virtual work relates to the absence of social interactions, support and feeling of belongingness due to minimised face-to-face interaction and high dependence on digital technology, which lead to feelings of loneliness and isolation (Orhan et al., 2016; Vuori et al., 2019). These perceptions may negatively affect work-related outcomes. Virtual work diminishes opportunities for socialising and engaging in outside office interactions facilitating friendship building as digital technology cannot replace direct interactions. These relations contribute to trust-building and performance among coworkers (Jimenez et al., 2017).

Physical separation makes collaboration more difficult, and physical isolation might lead to the perception of missing the necessary information for work tasks and access to people involved in work tasks (Orhan et al., 2016). Due to the lack of presence and invisibility of individuals, information exchange may be delayed or absent. The absence of connections and hardships in accessing the required information for work tasks may lead to the experience of informational isolation. Individuals, with the least social interaction, face the highest informational isolation, as they are more likely to be excluded from information exchange among co-workers.

4.4 Constant connectivity

Connectivity to digital technologies allows individuals working in virtual contexts to enjoy spatial and temporal flexibility, however, research highlights challenges in disconnecting from work (Reyt & Wiesenfeld, 2014; Schwarzmüller et al., 2018). On the one hand, employees can perform work and accommodate private aspects such as childcare. On the other hand, employees

can reach out for work materials at all times, thus manifesting in overwhelm and feelings of stress (Gaudioso et al., 2017; Tarafdar et al., 2007). The connectivity enabled by digital technology contributes to individuals working longer hours. Additionally, individuals often experience pressure to respond immediately to emails and instant messaging platforms (Barber & Santuzzi, 2015; Barley, 2015; Wajcman & Rose, 2011). As a result, the overextended use of digital technology may provoke technostress and/or burnout (Dittes et al., 2019).

For prevention purposes, organizations need to focus on increased leader attention and establishment of special procedures. However, also leaders experience pressures related to connectivity. For example, organizations demand leaders for innovation and fast decision-making, which result in long working hours. The increased flexibility requires availability and leading people at all times, thus bringing more pressure on the leader, and, at the same time, establishing the constant connectivity as the norm of the workplace (Schwarzmüller et al., 2018).

4.5 Increasing demands

Virtual work enabled by digitalization, change the requirements for employees and leaders in organizations as individuals work from different places, requiring them to adopt different skills, behaviours and methods in their work (Schwarzmüller et al., 2018; Serban et al., 2015). Research highlights the need for having at least basic level IT literacy, abilities in problem-solving and information processing, decision-making, and social skills. Individuals should adopt a higher level of agility, cultivate cultural awareness (Schwarzmüller et al., 2018; Sousa & Rocha, 2019; Taras et al., 2019), develop resilience for coping with the challenges of digitalization and contemporary work arrangements (Vuori et al., 2019), and self-regulate their performance (Bisbe & Sivabalan, 2017).

Leaders managing individuals need to adopt IT proficiency, establish competencies in intercultural skills, obtain knowledge in distance management (Dulebohn & Hoch, 2017), and master abilities in navigating the increased complexity (Schwarzmüller et al., 2018). Overall, employees and leaders alike experience higher job demands at work due to increased complexity, more technology systems, and need to process increased information load (Schwarzmüller et al., 2018). While digital technology allows accessing and organizing knowledge and information, individuals are not trained to process and interpret large volumes of information (Vuori et al., 2019). Inability to process information may lead to information overload and a sense of losing control. Furthermore, the implementation of additional digital technologies, platforms, interfaces and operating systems to improve productivity and efficiency in work tasks, may contribute to a hectic work environment, where individuals are dealing with frequent interruptions, multitasking and information overload (Franssila et al., 2016; Vuori et al., 2019). Due to new digital devices and intuitive information systems, organizations require individuals to perform work tasks, previously done by administrative staff. The digital tools can be highly complex and learning how to use the tools may lead to an increased workload.

4.6 Incompatibility of technology and users

Virtual work includes a high dependency on digital technology requiring individuals to use digital tools to accomplish work tasks and handle related issues (Saafein & Shaykhian, 2014). While digital technology assists individuals in performing their tasks, the technical aspects of digital technology may impede their work. For example, technology clashes, malfunctions, and network issues may cause delays. Using digital technologies can be frustrating especially if individuals face issues with the technology and lack training in using the tools and in addressing

the related issues. These issues may contribute to lowering job satisfaction, engagement, affect productivity and quality of work. The usability and user-friendliness of digital technology is a critical component for employees to embrace and use technology at work (Zhang et al., 2018). Additionally, digital tools limit communication due to loss of richness in communication (Jimenez et al., 2017; Schaubroeck & Yu, 2017).

Furthermore, research outlines issues relating to user groups and their use of technology (Dittes et al., 2019). For example, older generations tend to use digital technology more reluctantly. Even though many elders actively use digital technologies, others are more reserved. Many may not intuitively know how to use digital tools at work and thus may face exclusion (Hill et al., 2015). At the same time, younger generations, even with proficiency in technology use also tend to struggle without prior training (Vuori et al., 2019).

5 Discussion and conclusion

This study provides an overview of the six challenges affecting well-being of individuals in virtual work: (1) collaboration issues; (2) lack of trust; (3) constant connectivity; (4) increasing demands;
(5) incompatibility of technology and users; and (6) social isolation.

Collaboration issues and lack of trust are the key challenges represented in the literature on virtual work. The literature relates these challenges to virtual group dynamics, as collaboration and trust are especially important for work accomplished in settings with a high degree of virtuality e.g., global virtual teams. Additionally, literature associates social isolation to virtual group dynamics due to the reduced face-to-face interactions and limited potential for socialising.

Less than half of the selected literature included in this study covers constant connectivity, increasing demands and incompatibility of technology. Literature relates these challenges to the concept of digitalization, as these challenges can be experienced even when individuals are working from an office or in teams with reduced virtuality e.g., with occasional face-to-face interaction.

Table 2 outlines the overview of this literature review, including the two main concepts and the associated variables with the reference to the corresponding authors.

Table 2 – the overview of concepts, variables and authors

Concept	Variable	Authors
Digitalization	Constant connectivity	Schwarzmüller et al., 2018; Vuori et al., 2019; Dittes et al., 2019
	Increasing demands	Schwarzmüller et al., 2018; Vuori et al., 2019; Sousa & Rocha, 2019; Verhoef et al., 2019; Matt et al., 2015; Oberländer et al., 2020
	Incompatibility of technology and users	Vuori et al., 2019; Dulebohn & Hoch, 2017; Schaubroeck & Yu, 2017; Dittes et al., 2019; Zhang et al., 2018; Hill et al., 2015; Saafein & Shaykhian, 2014
Virtual group dynamics	Collaboration issues	Schwarzmüller et al., 2018; Dulebohn & Hoch, 2017; Jimenez et al., 2017; Schaubroeck & Yu, 2017; Alsharo et al., 2017; Zhang et al., 2018; Taras et al., 2019; Guinalíu & Jordán, 2016; Orhan et al., 2016; Dekker et al., 2008; Muethel & Hoegl, 2010; Bisbe & Sivabalan, 2017; Choi & Cho, 2019; Zakaria & Mohd Yusof, 2018; Saafein & Shaykhian, 2014
	Lack of trust	Schwarzmüller et al., 2018; Vuori et al., 2019; Dulebohn & Hoch, 2017; Jimenez et al., 2017; Schaubroeck & Yu, 2017; Alsharo et al., 2017; Zhang et al., 2018; Guinalíu & Jordán, 2016; Orhan et al., 2016; Henderson et al., 2018; Bisbe & Sivabalan, 2017; Choi & Cho, 2019; Saafein & Shaykhian, 2014
	Social isolation	Vuori et al., 2019; Dulebohn & Hoch, 2017; Jimenez et al., 2017; Hill et al., 2015; Orhan et al., 2016;

Being studied for almost 30 years, virtual work is not a novel phenomenon (Raghuram et al., 2009). A large proportion of literature on virtual work focus on virtual teams where individuals are located in different locations while collaborating on interdepended tasks (Dulebohn & Hoch, 2017; Fisher & Fisher, 2001; Perrin & Godart, 2004). In these teams, the coherency in collaboration and the development of trust is crucial. Yet, literature is limited when describing these elements in virtual work with a reduced degree of virtuality. Furthermore, the literature on digitalization discusses distress associated with digital technology use e.g., constant connectivity and increasing demands (Schwarzmüller et al., 2018), however, publications on virtual work do not represent these issues thoroughly despite the increased use of digital technology.

This study contributes to providing a comprehensive overview of challenges associated with virtual work as brought about the digitalization. These contemporary challenges lead to frustrations and hamper well-being of employees and managers. These challenges require

awareness from both researchers and practitioners, which would provide opportunities for establishing and implementing action steps minimising the influence on individual well-being.

Future work will expand on the challenges and effects of virtual work in knowledge-intensive organizations. This literature review is used as a baseline to structure and inform the empirical study for result validation.

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APPENDIX 1 – CONCEPT MATRIX

	Digitalization			Virtual group dynamics		
Authors	Constant connectivity	Increasing demands	Incompatibility of technology and users	Lack of trust	Social isolation	Collaboration issues
(Schwarzmüller et al., 2018)	x	x		x		x
(Vuori et al., 2019)	x	x	x	x	x	
(Sousa & Rocha, 2019)		x				
(Verhoef et al., 2019)		x				
(Matt et al., 2015)		x				
(Dulebohn & Hoch, 2017)			x	x	x	x
(Jimenez et al., 2017)				x	x	x
(Schaubroeck & Yu, 2017)			x	x		x
(Alsharo et al., 2017)				x		x

(Dittes et al., 2019)	x		x			
(Zhang et al., 2018)			x	x		x
(Taras et al., 2019)						x
(Guinalíu & Jordán, 2016)				x		x
(Oberländer et al., 2020)		x				
(Hill et al., 2015)			x		x	
(Orhan et al., 2016)				x	x	x
(Dekker et al., 2008)						x
(Henderson et al., 2018)				x		
(Muethel & Hoegl, 2010)						x
(Bisbe & Sivabalan, 2017)				x		x
(Choi & Cho, 2019)				x		x
(Zakaria & Mohd Yusof, 2018)						x
(Saafein & Shaykhian, 2014)			x	x		x

Social Structure of Digital Space

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ABSTRACT

Purpose: It is often thought that co-operation in digital spaces happens by itself. However, the social structure of digital space is important to identify, experience and manage. This paper investigates the user experiences of digital collaboration space especially from the perspective of social structure.

Theory: Social structure refers to the often-unconscious structures of social interaction and power conveyed through various artefacts, which influence the work performance. Digital spaces therefore always have a social dimension. Like in physical spaces, individuals who work in digital spaces create meaning for the spaces they use.

Design and methodology: The research is qualitative by its nature. The data is gathered in participatory workshops among small and medium-sized companies in Finland. The topics of the workshops included the digital collaboration and work crafting in remote and multilocational work. The data was analysed by content analysis.

Findings: The results can be summarised in three social structures identified from the data.

Originality/value: The experience-based research provides new data to be applied in the digital code of conduct, which is not yet widely used. The academic contribution provides insights to interaction design, team behaviour and workplace management by applying frameworks of social theories to space.

Keywords

Digital, Space, Experience, Collaboration,

1 INTRODUCTION

According to Syner (2015), new studies show that technology is no longer just a device for human connections. It is an integrated artefact in the human exchange and communication process. Digitalization is inseparably part of the changes that can be observed in work.

Digital space is a space where individuals can meet one another and interact. Digital spaces therefore always have a social dimension. Just like in physical spaces, people who work in digital spaces create meaning for the spaces they use. The aspects physical or material space as well as social, cognitive or mental spaces are used in the research on new ways of work.

Digitalization has yielded new forms and processes of social spaces. As a result, we are witnessing and experiencing new norms and patterns of behaviour, values in human connections, expectations of one another, language, and other symbol systems: a digital culture. This paper aims to understand the social structure of digital space in the context of work environments.

2 DIGITAL SPACE

In the meta level, in the actor network theory (ANT) i the academic field of research of science, technology and society are integrated. It has inspired many empirical studies e.g. about meanings and social interests related to technology (Bijker et al 1987; Bijker and Law 1992) and the manner in which networks are built. Gloor (2005) used the temporal visualization of communication networks through Temporal Social Surfaces to discover different phases in the life cycle of virtual communities. They were able to visualize periods of low and high group activities as well to identify potential periods of high productivity and information dissemination. Such quick overview of online group dynamics provides interesting insights to communication pattern analysis.

In social theories, Castells (1996) focuses on the concept *space of flows*. Giddens (1990) considers that the examination of recombinations of time and space, separation of time from place and space from place is crucial to understanding the dynamism of modernity. Strassoldo (1993) discusses *social structures* like boundaries, which are protecting and boundaries which are defending. The connectivity to digital spaces always requires access over defined boundaries and the chosen digital place is protected by invisible boundaries. Strassoldo also points out one social structure, which is a centre. The social centre of digital space is conducted in the space in collaboration. According to Lefebvre (1991), space is used in the meaning of specialized spaces in daily life. He discusses spatial practice, which embraces production and reproduction, and the locations and spatial sets characteristic of each social formation, like a sense of belonging. Lefebvre (1991) also states that spatial practice ensures continuity and some degree of cohesion. In this research, the interest is in spatial practices, the sense of belonging and cohesion in digital space. The challenge is to identify them in a web-based digital space, which has no physical boundaries around it.

Psycho-social environment and its fit for individuals has been the interest of Vischer (2007). Environmental comfort encompasses three hierarchical categories: the physical, functional, and

psycho-sociological. This model has been applied by Hyrkkänen et al. (2012) in research of digital collaboration among knowledge workers. They found out that at the level of physical fit, building codes and standards should be expanded to cover also the needs generated from the new working modes i.e. mobile and digital work. At the level of functional fit, the access creates the threshold of work. Access to digital spaces by well-functioning infrastructures, tools, programmes and applications must be attained regardless of the time and physical place. Enhancing the fit at the psychosocial level, the mixture of physical and digital places and simultaneous existence in both should be more effectively understood and supported. A particular challenge, which demands a lot of learning, lies in controlling the simultaneous co-presence, simultaneous use of many digital communication and collaboration channels as well as simultaneous use of work and leisure related virtual channels.

- It is often thought that co-operation in digital space, place and reality takes place by itself. However, it is important to identify, experience and manage the social structure of digital space. According to Pankiewicz (2015), the impact of anonymity, interactivity and self-disclosure on perception of the communication mediated by technology are relevant. Based on her studies on e-learning already complex group interactions are getting even more complex when considering digital communication. The two main factors of this complexity are: lack of colocation and the need to use sophisticated information technology to communicate. Digital communication takes place when involved individuals do not share the same physical place; however, these interactions are perceived to be real, as they may potentially occur in a real context. Digital relationships are supported by computer-mediated communication tools. Such communication is depending more or less on elements supporting social perception, e.g. gender, age, status, facial expressions or gestures. McKenna and Green (2002) found out the differences and similarities between internet groups and traditional groups and according to Syner (2015), the dimensions related to digital communication and online group dynamics change behaviour, language, group dynamics, and communication exchange between team members working in a distributed organization.

3 METHOD

The research is qualitative by its nature. Altogether 29 Finnish small and medium sized companies and 110 employees participated in the national Crafting New Ways of Work -project, which aimed to understand the challenges of the job crafting in the new ways of work in individual, team and organization levels. The data was gathered as a part of the context interviews and participatory workshops of the project in 2017–2019. In each company there was one context interview which directed to find out the situations of the companies related to the adoption of the new ways of work such as ICT-based mobile work. The interview acted as a ground for workshops. Three workshops were arranged in every company. The topics of the workshops included digital collaboration and job crafting in remote and multilocational work. The interviews were recorded and transcribed and the data of workshops was summarised according to agreed protocol.

The data was analyzed by content analysis by using the step-by-step process. It included three interactive sub processes. The first data reduction phase consisted of generating initial codes, e.g. the usage of tools, applications for virtual collaboration and team meetings, the usage related

experiences (positive, negative, neutral) and impressions of adequacy of virtual interaction skills and developmental needs.

During the second phase of the analysis, the themes were reshaped according to the modified Vishers (2007) theory of the psychosocial fit of virtual places addressing the concepts of territoriality, privacy and control. Territoriality was connected to the need for belonging and the proper usage of interactive communication tools and channels (Hyrkkänen et al. 2012). The need for privacy was connected multi-presence demands arising from simultaneous use of many virtual places as well as also physically being in some social space. The need for control -theme was connected to the phrases describing the need to better manage the behaviour in the digital collaborative settings. All the codes were collated into potential themes. The comprised themes were reviewed against the themes of the first phase's initial codes. Finally, defining and naming the final themes and the drawing of conclusions were implemented by reflecting the results also on the earlier findings of the researchers. The final themes were related to the needs of belonging (connectivity by visibility), privacy (privacy by silence) and control (collaboration by listening). The validation was made by using different researchers conducting the same steps.

4 RESULTS

The final themes which were identified were: Connectivity by visibility, privacy by silence and collaboration by listening.

4.1 Connectivity by visibility

The data indicated the challenges in getting connected to digital space as a crucial factor affecting the digital space experience. However, it is often an individual effort. In terms of social structure, we found out that the visual connectivity is important in terms of sense of belonging. Using a web camera is not yet an automation for all the participants of digital collaboration. There were many experiences about using web cameras. However, in terms of being present in collaboration, seeing human faces helps us to interact. Seeing each other increases the quality of communication and creates trust among participants. It is also important to see the emotional reactions of the other people.

Reasons why not to use the web camera:

"I'm at home, the kitchen is unclean, I do not want the meeting participants to see the mess."

"I still have a night-dress on, while we have this meeting so early – I cannot be seen in the camera."

"My network capacity is not strong enough – the connection will be bad if I put the camera on."

"Nobody has asked to use the camera."

However, there are some underlying reasons why the webcam is not used:

"I don't turn on the camera because I can get some other important tasks done at the same time."

"A meeting is probably just listening again, so I can just listen."

"What is the benefit of seeing the faces of others, I know the people anyway."

4.2 Privacy by silence

Collaborating in digital spaces might mean doing many things simultaneously. Usually, collaboration involves sharing material, crafting material, discussions, recording, using chat tools – watching, listening, thinking at the same time. Silence is the way to seek one´s own space, but silence is often misinterpreted.

Interpretations may be e.g.

"Why doesn't anyone answer – are they doing something else?"

"Was my question unclear, do I need to repeat the question or say the same thing in another way"

"Are they now talking about me or the group in the chat?"

"Now it is hard to follow: did I miss something?"

Because multichannel working is overwhelming, it is important to notice that the reason for silence might mean that participants are just thinking. They need more time to catch their own thoughts – they are not interacting all the time in digital space, at least if there are many channels in use at the same time. This is a way to find privacy within the social structure.

4.3 Collaboration by listening

Discussions in digital environments require rules. They are even more important than face-to-face meeting practices. Frequently, the discussions suffer, or progress is based on the group dynamics and different structures of power: it might be more important to be heard than really listen to what others are saying. Depending on the participants' meeting practices and the way they are present, they have an even greater impact on the atmosphere in the digital meetings.

Examples of power structures:

"*Someone in the meeting always discusses their opinions in the Me format, referring to discussions in the hallway with leading experts on how to deal with it. Instead of expressing his own opinion, he brings into the conversation an invisible group of several people who are thinking in the same way."*

"*A person speaks for 15 minutes without interruption, bringing in all the ideas he has for the subject being discussed. The rest will be in the role of repetition: I had that same…"*

"*One person comments on other person´s idea. Such "being always right" causes the group to withdraw from the conversation and the atmosphere of the digital meeting weakens."*

Collaboration is interlinked with the social structure of cohesion in digital place.

5 CONCLUSIONS

The identified three themes can be reflected with existing theories in order to identify the digital structure of digital space. What is in the physical space a meeting room, is built by visual connection. Seeing each other in a digital place provides a shared territory. It is related to the sense of belonging and thus to the boundaries that open up: the digital space is a common area of a community where members can easily and safely enter, see each other and spend productive time to collaborate. This set the territorial boundaries to digital space.

What is one´s own chair in the physical meeting room is silence in the digital space. Privacy in collaboration in digital space is achieved by taking some time to be in one´s own thoughts and it often means silence. This sets the protective boundaries to digital space and provides a spatial practice for everyone to have a sense of control over their own place within the space.

Finally, what is a meeting practice in face-to-face meetings is the way how communication flows and how well people listen to each other in digital collaboration. It is important that the commonly agreed practices and rules enhance active listening in digital space. This creates a centre for the digital space and increases cohesion.

As academic contribution, this research applies the conceptualization of space and integrates the ways how invisible digital space can be structured in a social way. We create borders by seeing each other, in whichever location they are. We find our own place in the digital structure by allowing time to be silent during the collaboration, especially when multiple channels are in use at the same time. We craft the centre of the digital space by interaction, which is based on listening.

The practical contribution is on guidance to develop commonly agreed rules about the use of cameras, multichannel tools and discussion habits. Everything is not solved only by setting rules and agreements, one also needs time for training and learning new principles as part of the digital behaviour. The collaboration in digital space requires more awareness of our eyes and ears than the collaboration in physical space, where we are present in a much more holistic way.

Future studies are needed in particular to capture how the collaboration in digital space can increase the productivity of meetings. The perspectives of different stakeholders who are providing digital spaces also bring interesting insights into future studies. The context of digital places and work can also learn from understanding the context of digital places and social collaboration in them, for example in the health care sector or leisure time activities.

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Autonomy and Responsibility in an Augmented-Reality-Supported Assembly Task

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ABSTRACT

Purpose: Similar to physical characteristics of the workplace, the deployment of digital technology affects well-being and productivity at work. Augmented reality (AR) is one of these technologies that has become increasingly popular in the corporate environment, especially in the context of manufacturing (Daling et al., 2020; Dey et al., 2018). Since previous research has focused on comparing AR-based assembly instructions with other types of instructions in terms of effectiveness and efficiency (e.g., Hou et al., 2013), little is known about how AR alters working conditions. In this article, we shed light on the sense of autonomy and responsibility people experience during an AR-supported assembly task.

Theory: Autonomy as a working condition represents the degree of freedom one has in one's work. A high degree of autonomy is related to the feeling of being responsible for work (Job characteristics model; Hackman & Oldham, 1976, 1980). Within the scope of AR assistance, autonomy may be increased if workers feel supported by the technology in carrying out their tasks autonomously, but may also be reduced if people experience that they are controlled by the technology. In the latter case, we expect a sense of responsibility to be limited.

Methodology: We conducted a laboratory experiment with 117 participants who were asked to assemble a workpiece using an AR system. We then conducted interviews in which we asked the participants about their experiences and their sense of autonomy and responsibility.

Results: Findings demonstrated a limited perception of autonomy during the AR-assisted assembly. Connected to this, the participants took over a passive role and experienced a limited sense of responsibility concerning the output. Surprisingly, however, the participants still internally attributed errors they had made.

Originality/Value: Research on the increasingly digital workplace is important, especially as the boundaries between real and virtual environments may merge in future work environments. In this study, we investigated an AR-based assembly instruction, explored effects on autonomy and responsibility and derived design implications that should support future digital workplace design.

Keywords

Workplace technology, augmented reality, mixed reality, assembly, autonomy, responsibility

1 INTRODUCTION

Augmented reality (AR) allows "*the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it*" (Azuma, 1997; p. 356). There are several definitions of AR (for a review see Speicher et al., 2019), like the one from Milgram and Kishino (1994), who define AR as being on a mixed reality continuum between completely real and completely virtual environments. AR can be realised via mobile devices such as tablets, smartphones, or via head-mounted displays (HMD) such as the Microsoft HoloLens [65].

AR is considered as promising to be deployed in manufacturing environments (Alcácer & Cruz-Machado, 2019), where AR can be used to support employees in their work tasks, for instance by guiding them through an assembly task (Daling et al., 2020; Dey et al., 2018). While previous research has focused on comparing AR-based instructions with other types of instructions such as paper-based assembly instructions (Büttner et al., 2016; Hou et al., 2013; Tang et al., 2003; Zheng et al., 2015), less is known about how AR changes working conditions such as job autonomy. Thus, within this article, we shed light on the sense of autonomy that people experience during an AR-supported assembly task.

Job autonomy as a working condition represents the degree of freedom one experiences within one's work (De Spiegelaere et al., 2016). We argue that besides the design of the physical workspace (Elsbach & Pratt, 2007), the design of the information and communication technology, that is used for conducting the work, can alter feelings of autonomy.

Theories of work design highlight the beneficial effects of job autonomy on performance, motivation and well-being (Self-determination theory, Deci & Ryan, 2000; Gagné & Deci, 2005; Ryan & Deci, 2000; Job demands-resources model, Bakker & Demerouti, 2007; Demerouti et al., 2001; Job characteristics model, Hackman & Oldham, 1976, 1980).

Hackmann and Oldham (1976, 1980) define autonomy as one of four core job characteristics; it is "*The degree to which the job provides substantial freedom, independence, and discretion to the individual in scheduling the work and in determining the procedures to be used in carrying it out*" (p. 257). They further explain the effect of autonomy on personal and work outcomes (e.g., intrinsic motivation, satisfaction, work quality) via so-called critical initial psychological states. In particular, autonomy increases the feeling of being responsible for work outputs and, in consequence, leads to high internal work motivation, for instance. Experiencing responsibility for work outputs is defined as "*The degree to which the individual feels personally accountable and responsible for the results of the work he or she does*" (p. 256).

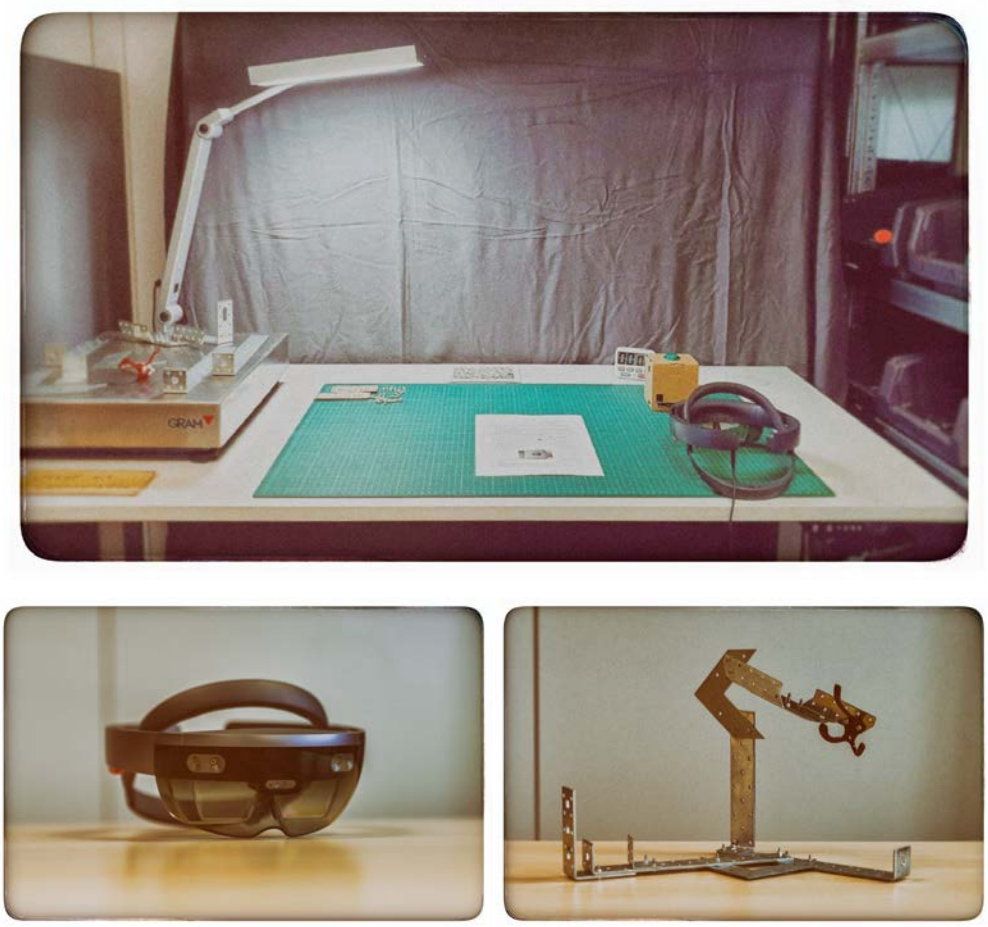
Applying this theoretical evidence to the situation of AR-assisted assembly, we expect that autonomy can be high if one feels supported by the technology in fulfilling the work task, but it can be low if he/she feels controlled by technology. In the second case, one will also feel less responsibility for the work task.

[65] For this study we used the Microsoft HoloLens™ (1st generation); www.microsoft.com/hololens

2 METHOD

To explore our research assumption, we conducted a laboratory study at an assembly workstation at the Austrian Institute of Technology (Figure 1). The work station consisted of a height-adjustable table, a lamp, an abstract workpiece, an intelligent scale, the HoloLens, and accessories for assembly (i.e., screws, nuts). We asked participants to assemble an abstract workpiece they were not familiar with (Figure 1, bottom right). The assembly instruction was augmented using the HoloLens (Figure 1, bottom left), which is a transparent, optical, head-mounted display that displays the assembly instructions at a fixed position in space - in the present case, above and behind to the real workpiece (Figure 1, top).

Figure 1 Workstation, head-mounted display (HoloLens), workpiece.



In total, 117 individuals participated in the experiment, of whom 51 were male and 66 were female. Table 1 provides an overview of the participants and their previous experience. This project was carried out as part of several bachelor theses at the Institute of Psychology at the University of Vienna. Some participants were recruited in the social environment of the co-authors. Further participants were recruited from a course on human-computer interaction at the Faculty of Computer Science and received credits for participating in the study.

Table 1 Sample description

	Mean	SD	Min	Max
Age	27	9.50	20	61
Technological Skills*	3.44	0.97	1	5
Previous Experience VR/AR**	1.84	1.19	1	7
Previous Experience Assembly**	2.83	1.46	1	7

Note. *1 = very bad, 5 = very good; ** 1 = layperson, 7 = expert

We instructed the participants to work quickly and accurately. For orientation, we placed a stopwatch in front of them so that they could see the time passing and informed them that people have needed on average 10 minutes to complete the task; the participants required an average of 12.25 minutes (*SD* = 4.75, min = 6.17, max = 47.65). The workpiece consisted of 17 parts that were to be assembled in a certain predetermined sequence. The instructions for assembly were presented step by step. After visualising the workpiece in a first step (as an indication to select it, see Figure 2, first row), the way it should be assembled was visualised in a second step (Figure 2, second row). Participants were given feedback on whether the right piece had been selected with a check mark or a cross mark. Regarding the instruction on how to assemble the given piece, the workpieces that had been assembled correctly were shown in green; pieces to be assembled were presented in blue in an animated way and remained blue as long as the piece was assembled correctly; incorrect assemblies were presented in red. For a more detailed description and for a comparison with other mixed reality applications, we have classified the present application according to the classifications proposed by Speicher et al. (2019) in Table 2.

Figure 2 Design of the augmented instructions.

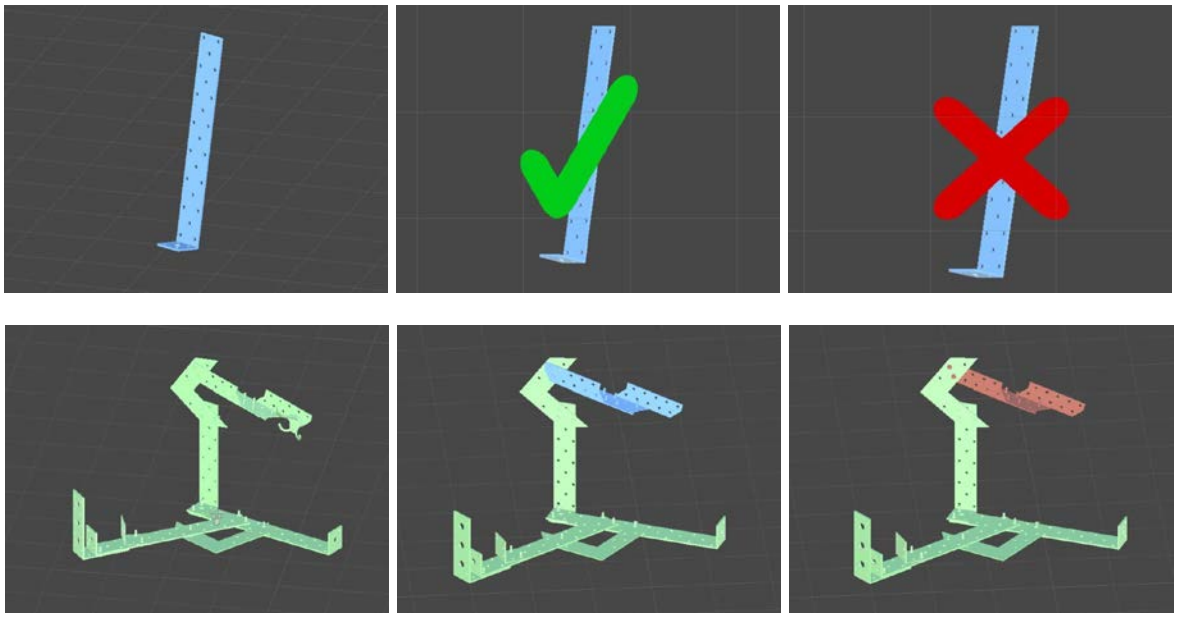


Table 2 Classification of the application referring to Speicher et al. (2019)

Number of Environments	One environment since everything happens on the same device (HoloLens).
Number of Users	The application can be used by one user.
Level of Immersion	The level of immersion lies between not immersive and partly immersive.
Level of Virtuality	The application is partly virtual.
Degree of Interaction	Interaction is implicit (simulated via a Wizard of Oz[66] setup).
Input and Output	Input is via simulated object recognition, and output was visual.

After the assembly, participants were asked about their experiences within semi-structured interviews. In particular, we asked them about their i) general experience, ii) sense of autonomy and iii) sense of responsibility, pride and learning. The interviews lasted between 1.55 and 14.97 minutes (M = 5.23; SD = 2.58) and were conducted by five interviewers (co-authors from the University of Vienna). To maintain a standardised procedure, the interviewers were guided by predefined questions.

To investigate the perception of autonomy, we asked the participants how much influence they had had on the work process. To assess their sense of responsibility, we asked them whether they perceived the workpiece as the result of their own doing, whether they were proud of the workpiece and who was responsible for assembly errors. All interviews were conducted in German, except one interview was in English.

The interviews were audio-recorded and subsequently transcribed and analysed by two independent raters based on thematic analysis (Braun & Clarke, 2006; Froschauer & Lueger, 2003). The raters reviewed the transcripts separately before coming together to discuss extracted themes. We have opted for a qualitative analytical approach since we want to illuminate the mechanism between autonomy and responsibility in a specific digital workplace, rather than determining the frequency of this relationship.

3 RESULTS

The participants described their overall impression as hedonically stimulating and positive. For instance, participants described that the interaction was something *'new and exciting'* or *'fun'* (#023, male, 26; #017, female, 22). Some even experienced a feeling of presence and immersion. Specifically, participants described, for example, being very *'focused'* on the task (#048, male, 21) or feeling *'absorbed'* during the task (#006, male, 22; #070, female, 26). Besides that, the participants also mentioned drawbacks. For instance, one mentioned that the initial encounter was somehow strange and confusing (#061, female, 23); another expressed concern that wearing an AR device over time can be annoying and restrictive (#134, female, 22).

Apart from this overall impression, we will now shed light on the experience of autonomy and responsibility, in the following two sections.

[66] The Wizard of Oz method allows users to interact with a system while responses are generated by a human.

3.1 The perception of limited autonomy and the passive work attitude

Like in a real-world assembly task on a shop floor, the steps of the assembly task in the AR-instruction were predefined. Thus, the participants had limited freedom in the assembly task. Accordingly, the participants experienced a low sense of autonomy during the assembly, which we found to be related to a passive working role.

Regarding the **low sense of autonomy**, the participants mentioned that they could not influence the work process at all, that they felt *'restricted'* about how they worked (#009, female, 23) and that they did not experience a *'free will'* (#024, female, 22). One participant described the perception of limited autonomy in the following way: *'None at all. So maybe you can influence how you hold the pieces and that I have turned the object a little bit to make it easier for me. But I felt myself quite limited because, for example, I could have mounted the screws from behind and not from the front as suggested. And somehow you stick to what they [the technology] tell you to do. So, therefore ... not independently so to speak'* (#009, female, 23).

Associated with this limited sense of autonomy, the participants reported assuming a **passive working attitude** during the assembly task. Referring to this passive role, the participants described that they *'just did what I was told'* (#058, female, 25), or that they were solely following the technology's instructions (#040, female, 21). Some participants even experienced a sense of authority or dominance from the device. For instance, participant #008 (male, 34) described himself as an *'executing body'*. Others described that they felt *'patronised'* (#070, female, 26) or *'steered'* (#116, female, 22). The participants further expressed that they were not thinking on their own anymore and were just relying on what the HoloLens demanded. One participant described that *'by the fact that everything is so exactly given ... [I am not thinking] about how I am going to do it'* (#030, female, 21). Another participant described a similar situation in which she executed the tasks rigidly according to the instructions of the technology, although she had easier ways of doing this work in mind: *'But what I also thought when I built the workpiece together with the HoloLens is that I often held the parts as it was shown there and didn't turn it into another perspective so that I sometimes made it complicated for myself because I had this clear picture in front of me as it was shown there where it might have been easier to turn it the other way round ... so it was actually a bit stupid'* (#090, female, 22). Within this statement, she described a kind of dissatisfaction with the situation, which was described somewhat more drastically by another participant, who had a fundamental concern: *'I think it's a cool thing in itself, but as I said before, it reminds me a bit of all that "Black Mirror"*[67] *stuff and then I'd be afraid that it's going to be abused and that you're just... an executing machine without thinking or making decisions for yourself but just executing'* (#071, female, 21).

Finally, we want to highlight that in relation to the passive working attitude, the participants described a limited learning effect. (Please note that we did not ask the participants to do the assembly again, but rather asked them if they thought they could do the assembly again without the digital support.) The participants described that they relied on guidance during the assembly and did not focus on remembering. One participant described that *'well, I wasn't really thinking that much'* (#040, female, 21); another said, *'No because I was so stuck on the fact that the HoloLens tells me what to do anyway that I didn't really memorise a thing'* (#069, female, 24). Another said, *'Good question. I didn't think accurately, because I didn't concentrate at all. I just followed the HoloLens'* (#112, female, 31). Others described more precisely that they were very

[67] 'Black Mirror' is a science fiction television series.

focused on the instructions (#119, female, 60) at the time and forgot the step after it was finished (#134, female, 22), having in mind that the technology provided the information. One participant stated, *'I concentrated very much on the individual steps but I didn't concentrate so much on the overall picture'* (#132, female, 22).

3.2 Experiencing responsibility

We asked participants if they perceived the assembled workpiece as their own output. Participants described a limited sense of responsibility and explained that it came from a limited sense of autonomy. For instance, one participant, being asked if she conceived the workpiece as her outcome, said *"Not really. Nope. Because it [the technology] gave me the design, you had to do it the way it was described. I think it would have been mine if I had done it myself the way I wanted. But I did it in the way it was described"* (#067, female, 23). In a similar manner, participant #105 (male, 24) answered: *"Mhh no. […] Mhh because I got an instruction how to build what I should build and I would rather call my result something that I did for myself without any external influences."* Others describe similar reasons: *"Because the HoloLens told me what to do"* (#069, female, 24)*; "Well no, because I just followed instructions like a manual that I received visually"* (#099, female, 25); *"Because I was told how to do it"* (#102, female, 58).

The data also indicated that although the participants perceived a low level of autonomy and responsibility, they nevertheless felt responsible for errors in the assembly. For example, participants justified assembly errors with *"did not pay enough attention"* (#004, female, 21); *"did not watch properly"* (#076, female, 30; #123, female, 21); *"it was my dullness"* (#023, male, 26); *"Yes, for sure I am responsible for it because I was not able to realize the instructions immediately"* (#096, female, 61). Although rare, few participants blamed the technology for errors. One participant, for whom the assembly task was difficult and who therefore welcomed the technology's support, described that she had "only followed instructions" and therefore the technology was made responsible for the errors (#070, female, 26).

4 DISCUSSION

Similar to physical characteristics of the workplace, the deployment of digital technology affects well-being and productivity at work. Research on the increasingly digital workplace is important, especially as the boundaries between real and virtual environments may merge in future work environments. In this study, we studied an AR application and investigated the effects on user experience during an assembly task. Although AR is becoming more and more popular in the corporate sector (Daling et al., 2020; Dey et al., 2018), even less is known about its effects and especially about how AR affects working conditions. Our study contributes to existing research with two main findings.

First, we demonstrate that in a step-by-step AR-instructed assembly activity, participants perceive low autonomy. This is critical, as job autonomy is a central job resource that supports employees to manage work-related stressors (Bakker & Demerouti, 2007). In addition, we found that, connected to this low autonomy, participants took over a passive role in the working process and, at the same time, felt limited responsibility for the task. The latter relation is in line with the proposed effects of the job characteristics model (Hackman & Oldham, 1976, 1980).

Second, we found that although the participants had only limited freedom in the assembly task and felt limited responsibility for the task, they attributed errors internally (participants felt responsible for errors in the assembly). When there is an internal attribution, individuals see errors being due to a person's predisposition, while external attribution means that errors are perceived as being due to a situation (see attribution theory; Kelley, 1967) or, in our case, to technology. These results suggest that even with a low level of experienced autonomy, users perceive themselves as a source of error.

4.1 Limitations and future research

One limitation is that this study was not conducted in a real work context. However, the laboratory environment was similar to an industrial workplace and allowed us to control influencing factors that can occur in an actual work situation. Still, we propose to replicate the study in a real work context. Another limitation concerns the technology used. Participants complained about discomfort when wearing the technology due to the weight and limited field of vision. Therefore, for future studies, we recommend to use an improved version of the HoloLens or similar devices.

4.2 Practical and design implications

One of the most important challenges in designing digital workplace technology is to enable an experience where the system is perceived as sufficient support but not as dictation. In order to master this balancing act, we have the following recommendations:

First, there is a need for interaction procedures that enable an active working role. Different modalities (e.g. auditory, gestures) of input can be implemented so that the user can instruct the technique according to his or her preferences. For example, workers can instruct the technology to start, stop, repeat or skip instructions. Second, the technology should, to some extent, allow the user to assemble the workpieces according to his or her own preferred pace and sequence. Applications should start with the visualisation of the final workpiece and then provide guidance for the steps in between when needed. Instructions should also adapt to the user's previous knowledge and the complexity of the task.

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