What is a smart office environment? An exploratory study from a user perspective

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Abstract

Purpose – This paper aims to explore the meaning of smart office environments from a user perspective by investigating user preferences and expectations.

Design/methodology/approach – Eleven semi-structured interviews with the users after moving into a smart office building of a Dutch Municipality and an observation as complementary data were conducted. The data were analysed based on the grounded theory and thematic analysis, combining a reflexive approach to the literature review.

Findings – Two main themes were revealed addressing user expectations and preferences for smart office environments: "enhanced interaction" with the social and physical office environment and "sense-making" of the smart concept (or smartness). Within these themes, basic and smart office aspects were identified and classified based on their association with smart office concepts or technology.

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Practical implications – The findings reveal the meaning of the smart office concepts from a user perspective by highlighting the importance of user experience on enhanced interaction and sense-making of the smart office concept, equipped with basic and smart aspects.

Originality/value – To the best of the authors' knowledge, this study is the first to qualitatively examine drivers underlying the meaning of smart office concepts from a user point of view. Organisations, environmental psychologists, designers and managers can use the findings of this study to develop guidelines for a successful smart office design.

Keywords Smart office environments, User perspective, Expectations, Preferences, User satisfaction, Experience, Office, Satisfaction, Preferences, Smart

Paper type Research paper

1. Introduction

Smart office concepts became popular with the profound use of advanced technologies in office environments. Although organisations have been adopting smart office concepts aiming to provide efficient and effective workplaces for their users (Bodker, 2016; Mikulecky, 2012), the literature has paid little attention to a user point of view. In particular, the literature has a wide range of the definition of the smart office concept, mainly revolving around technology development (Alberdi *et al.*, 2018; Belafi *et al.*, 2017; Ianeva *et al.*, 2015; Sinopoli, 2010), and user perspective is mostly missing. Even though it is widely acknowledged that user preferences and expectations are significant to be considered when designing workplace environments (Kim and De Dear, 2012a; Van der Voort and Van Wegen, 2005), it is unclear what expectations and preferences users have for smart office concepts and what specific aspects validate smart office designs and distinguish them from other (non-smart) office types. Thus, it would be of high scientific and societal interest to gain empirical evidence to understand the user perspective for smart office environments.

The present study aims to explore the meaning of smart office environments from a user perspective; thus, it strives to answer how users experience smart office environments, what office features or experiences would lead them to experience the smart aspect, whether there are particular user preferences and expectations for smart office concepts. To gain an in-depth understanding of the practical application of smart office concepts from a user perspective, a qualitative research method is employed in a single-case exploratory study of a smart office building of Eindhoven Municipality in The Netherlands.

2. Literature review

The definitions of intelligence or smartness of built environment have been developing in the last decades. However, the literature still has broadly defined smart office environments, driven mainly from a technology and facility management point of view. In general, the definitions address workplaces equipped with advanced technology where interactive systems are supported by the internet, sensors and mobile devices (Brugmans *et al.*, 2017; Buckman *et al.*, 2014; Ramos *et al.*, 2010; Marsá-Maestre *et al.*, 2006; Mikulecky, 2012; Niezabitowska and Winnicka-Jasłowska, 2011; Sinopoli, 2010). Examples of (smart) technologies implemented in offices are location-based user applications, monitoring space use, user detection and monitoring user flow (Valks *et al.*, 2020; Buckman *et al.*, 2014; Sinopoli, 2010). The smartness of an office environment is mostly associated with advanced technology allowing change-outs of building components and providing the ability to control environments to minimise environmental effects (Ghaffarianhoseini *et al.*, 2016; Kua and Lee, 2002). Thus, some scholars define smart offices as environmentally friendly, cost-effective and intelligence-driven (Ghaffarianhoseini *et al.*, 2016; Jadhav, 2016; Wong and Li,

2008). Besides, smart offices are expected to incorporate new workplace characteristics, such as sharing workstations and clean desk policy (Appel-Meulenbroek *et al.*, 2011; Bodker, 2016; Brugmans *et al.*, 2017), and to provide safe, healthy and comfortable working environments (Ghaffarianhoseini *et al.*, 2016; Jadhav, 2016; Wong and Li, 2008).

As it is widely acknowledged that user preferences and expectations can significantly influence user experiences in office environments (Kim and De Dear, 2012a; Van der Voort and Van Wegen, 2005), it would be important to consider user perspective when designing smart offices. However, the user point of view is quite limited in existing empirical studies, and users are only addressed as end-goals of smart office designs with the expected benefits. The existing literature has only involved user behaviour by collecting sensor data used to develop technology and improve the quality of smart workplaces. For instance, Zhou *et al.* (2020) developed a user activity recognition system that anticipates user preferences and expectations to support user activities in smart office environments. Ianeva *et al.* (2015) collected occupancy data focusing on preferences to increase workplace efficiency in smart workplaces. Belafi *et al.* (2017) used sensor data to predict user expectations to provide thermal comfort in smart offices. Alberdi *et al.* (2018) collected behavioural data to anticipate preferences to avoid occupational stress in smart offices. Although these studies have provided an understanding of user behaviour in smart offices, it still remains unclear how users perceive smart office concepts and whether they have particular preferences and expectations. Hence, there is a need for an extended and in-depth investigation that can widen the understanding of the user point of view for smart offices and provide insights into the definition of smart office environments from a user perspective.

2.1 User preferences and expectations

To have a better understanding when investigating user perspectives for smart office environments, it would be significant to gain a fundamental understanding of user preferences and expectations. In general, the literature is quite consistent in suggesting that user preferences and expectations are crucial when designing an office environment. Studies show that a better fit between users and working environments can positively affect work-related outcomes, such as user satisfaction and productivity (De Been and Beijer, 2014; Oswald *et al.*, 2015; Veitch, 2018; Vischer, 2007). From an environmental psychology perspective, studies have supported the idea deriving from motivational theories, such as Maslow's hierarchy of needs (Maslow, 1943) and Herzberg's Motivation-Hygiene Theory (Herzberg, 1959). These studies generally suggest that users can be in their most productive conditions when they are satisfied with the office environment that fulfils their needs (Bodin Danielsson, 2019; Guo *et al.*, 2019; Oseland, 2009; Soriano *et al.*, 2020; Den Heijer, 2011). Some studies have associated user needs and preferences for territorial experiences in terms of the interrelationship between users and their office environment with privacy (Haans *et al.*, 2007), safety (Preiser and Vischer, 2005) and sense of belonging (Inalhan, 2009). Some studies have shown the importance of user needs and preferences in terms of physical office characteristics by showing the influence on comfort and ability to perform tasks effectively, such as thermal conditions (Kim *et al.*, 2018), lighting (Despenic *et al.*, 2017), acoustics (Al Horr *et al.*, 2016; Evans and Johnson, 2000), office appearance (Hongisto *et al.*, 2016), office layout and configuration (Lee, 2010).

Considering user preferences and expectations, some scholars have attempted to classify office characteristics to provide insights for better workplace designs. For instance, Den Heijer (2011) have identified user needs for workplaces on-campus, considering Maslow's hierarchy of needs: *plain&efficient (safe, healthy)*, *meeting place (social, attractive)* and *representative (inspiring)*. Other scholars, Vilnai-Yavetz *et al.* (2005), have conducted interviews and defined three office dimensions to provide user satisfaction in office environments: *instrumentality* refers to the ability to perform and adapt to user needs and

preferences; *aesthetics* refers to aspects that significantly affect users' perceptions, and emotions (e.g. beautiful rooms as opposed to ugly rooms); and *symbolism* indicates the concept of the meaning of working environments. Kim and de Dear (2012b) has adopted Kano's satisfaction model (Kano, 1984) and identified three factors based on the potential nonlinearities between office quality and its impact on office users: *basic factors* refer to must-be, expected, satisfaction-maintaining factors; *proportional factors* indicate one-dimensional factors affecting user satisfaction or dissatisfaction proportionally; and *bonus factors* refer to attractive, value-added factors, and usually are not expected by office users and have an enormously positive effect when they are performed. In short, it would be significant to identify what preferences and expectations users have for different office characteristics in smart office environments.

2.2 New office concepts

Over time, organisations adopt various office concepts to improve workplaces and user experiences. However, users can have different experiences and expectations when habituating a new office concept or design (Tuzcuoglu *et al.*, 2020; Brunia and Hartjes-Gosselink 2009). Thus, it would be significant to understand user experiences to improve the concept and design better workplaces. For instance, Brunia and Hartjes-Gosselink (2009) showed that users sought ways to make their new workplace familiar and comfortable to fulfil their personalisation needs when they moved into a flexible office concept from a closed office environment. On the other hand, one recent study showed a low need for personalising in the traditional way in a flexible office environment by conducting an intervention for personalisation needs, i.e. electronic picture frame (Köhler, 2019).

Some studies investigating the adoption of different office concepts showed that current user needs could influence user experiences. For instance, De Been and Beijer (2014) showed that users prefer individual and shared room offices for privacy and concentration required tasks, while they prefer combi, open-plan offices for their communication needs. To meet different user needs, activity-based office concepts have been developed, whereby open-plan offices with flexible workstations and multipurpose rooms are provided. Studies investigating this concept showed that users expect to withdraw and seek social interaction easily (Pejtersen *et al.*, 2006; Tuzcuoglu *et al.*, 2020; Wohlers *et al.*, 2019), and easy access to various workspaces and smooth workspace switching to minimise time spent searching for a workplace (Haapakangas *et al.*, 2018). Otherwise, user productivity and satisfaction can be negatively affected. Hence, understanding user experience when habituating a new office concept would be important for organisations.

2.3 Usability theory and technology use

In terms of the relationship between users and office technology, usability theory can contribute to understanding the user point of view for smart office concepts. In general, usability theory is developed from a user-centric perspective within ergonomics in human-computer interaction by focusing on the core elements: effectiveness, efficiency and satisfaction. Workplace studies adopting usability theory suggest that user participation and continuous briefing are fundamental to identify user needs and any requirement for change regarding technology implementations in office environments (Alexander, 2005; Blakstad *et al.*, 2008; Hansen *et al.*, 2011; Windlinger and Tuzcuoglu, 2021). Some workplace studies adopted usability theory and elaborated for office environments. For instance, Aalto *et al.* (2019) have classified six usability elements: functionality, safety/security, healthiness, orientation, interaction and comfort.

In recent decades, the profound use of information and communications technology (ICT) in office environments has influenced workplace preferences and expectations. In particular, using digital tools in office environments has provided various advantages to office users in terms of communication, traceability and findability (Kim *et al.*, 2016). Considering these advantages, users prefer to work independently and expect greater autonomy in choosing their workspace in office environments (Kim *et al.*, 2016). Unsurprisingly, users expect to receive a good ICT solution to support their work tasks and flexibility in the office environments (Boivie, 2005; Gibson, 2003; Haapakangas *et al.*, 2018). On the other hand, despite the possibilities of automated system technology, users still seem to prefer to have the ability to control their office environment by themselves. For instance, Lashina *et al.* (2019) showed that users are more satisfied when they can control lighting in open office environments. Similarly, Kwon *et al.* (2019) associated higher controllability with higher satisfaction in terms of thermal and visual comfort in office environments. In terms of technology implementation, one recent study showed that users are happier with traditional acoustic desk partitions while the soundscaping technology implementation was found impotent in their experience (Köhler, 2019). User preference and experience with technology implementation can differ, and thus, understanding user perspective would be significant for organisations, technology developers and designers to provide successful workplaces.

Taken together, numerous studies investigated user perspective in terms of user experience with new office concepts and technology implementations; however, user perspective is quite limited in existing empirical studies on smart offices. Thus, it would be important to understand how users experience smart office environments and what specific aspects validate smart office designs and distinguish them from other (non-smart) office types from a user point of view.

3. Method

3.1 Research setting and case background

A qualitative research was designed to explore the meaning of a smart office environment from a user perspective, consisting of semi-structured interviews, participatory observations, and informal discussions. This research was conducted in a smart office building (Stadhuistoren) of the Municipality of Eindhoven in The Netherlands, which was especially suitable to investigate user perspectives and experiences after moving into this building. The building was renovated in 2018 by adopting a "smart" concept by real estate management. The motivations for the renovation aimed to improve the quality of workplaces with (new) technology implementations (e.g. individual climate control systems) and to achieve sustainable building goals (i.e. recycled material use, energy-efficient).

The previous building (Stadskantoor) had four floors out of six floors in use for the Municipality, with an overall 11,000 m^2 floor area. Each floor was shared by several departments and had a 2000 m^2 open plan layout with single, closed and silent offices and meeting rooms. A pantry was located distant from workspaces on each floor and used as a gathering and breakout area. The relocation of 590 employees was initiated in 2019. In total, 355 employees relocated to the smart office building and the rest into two other municipal buildings in the centre of Eindhoven.

The renovated smart office building is located in the same area as the previous one and has nine floors with an overall 5500 m^2 floor area. Except for the ground and the first floor adjoining the other municipal building, each office floor has a 450 m^2 area dedicated to one department. However, employees are given to use any workstation in the building. Each floor has flexible desk use in the open plan area with single offices and meeting rooms in different sizes. A social area with a table and kitchenette is located adjacent to the

workplaces on each floor. At the time of the study, four out of nine floors were occupied: 3rd (Communication), 6th (Call centre), 7th (Control), 9th (Security) floor. Although a common area on the first floor was planned to serve all employees with a restaurant and the ground floor was planned to serve other municipal events (e.g. service desk for citizens), they were temporarily closed due to ongoing renovation during the time of this study.

3.2 Research design and data collection

As the main data collection, semi-structured interviews were designed based on the existing literature and the objectives of this research, including open-ended questions, focusing on two main parts (Table 1):

(1) participants' experiences in and appraisal of the new working environments of the smart office building; and

(2) participants' description of an ideal smart office environment.

The first part was developed based on the issues that may influence experiences and workplace appraisal in terms of physical, functional, psychological conditions in the office environment (Budie *et al.*, 2019; Oseland, 2009; Preiser and Vischer, 2005), and the issues regarding emotional and behavioural responses when adopting new office concepts (Maher *et al.*, 2005; Inalhan and Finch, 2004; Scannell and Gifford, 2017).

The second part aimed to explore opinions for an ideal smart office environment by investigating participants' experiences, preferences and expectations for smart office concepts. No definition of smart office concepts was provided to avoid bias during the interview. Three pilot tests were run to audit the interview design before the data collection. After the revisions, an interview guide is prepared to assist the interview trajectory, including all sample questions summarised in keywords and clustered based on their contents. By following the rhythm of the conversation, the interview trajectory aimed to prompt new topics and questions to emerge that could answer the research question.

Eleven semi-structured interviews were conducted face to face by the first author between April 02 and May 28, 2019, with the decision of saturation point of the data gathered. Each floor was represented by at least one participant: three (3rd floor, communication), two (6th floor, call centre), five (7th floor, control) and one (9th floor, security). Participants represented different age groups with a median age of 45 years old (youngest = 28, oldest = 61; SD= 10.4) and held higher education (9 Bachelor, 1 master, 1

Table 1. Semi-structured interview sampling questions

Sample questions	Relevant group
1. How was your first week/days at the new office?	i
2. What are the things that make you satisfied and dissatisfied with the new office?	i
3. How do you experience social interaction in the new office?	i
4. How is your working experience (e.g., motivation, concentration) in the new office?	i
5. What do you think about the physical arrangements in the new office?	i
6. How is your experience with temperature/air/noise/lights in the new office?	i
7. How do you choose your workstation? And how is your experience?	i
8. How do you describe your lunchtime/coffee breaks?	i
9. Do you miss any specific things from the previous office?	i
10. What kind of expectations/opinions you had before moving to the smart office building?	i
11. What would you like to change in this office?	i, ii
12. How do you find the new office environment considering the smart concept?	i, ii
13. How would you describe your ideal smart office environment?	ii

PhD degree). Eight out of eleven participants moved to Stadhuistoren almost a year ago, two moved six months ago, and one moved three months ago. All prospective participants were invited to this study by email, including the study description and 'a consent form". Initially, the building management provided a list of prospective participants, and the following group were invited through these participants' referrals. After receiving the signed "consent form", interviews were started, recorded, and lasted on average 45 min. Participants were assured of the confidentiality and privacy of their data. They were informed that only anonymised data would be used for research publication, and they could withdraw from the study without giving a reason at any time of the study. After the interview, participants were asked to fill out a short questionnaire to gather additional data about gender, age, job department, time spent in the current and previous office, previous office and work type experiences.

As supplementary data collection, between 08 and 12 July 2019, the first author carried out a participatory observation on the 3rd, 6th and 7th floor, except the 9th because the access was denied. The main aim was to provide context information for the issues revealed in the interviews. The observed issues and activities were the general overview of the observed location (i.e. temperature, sounds, lights), user behaviours and interactions (how they behave and use office spaces), user activities and varieties among physical and social settings in each floor. Four different observation points were selected on each floor: one from the common area and three random workstations selected from both sides of the open plan working areas. Each point was observed approximately with one to two-hour intervals, and in total, twenty-five hours. Between intervals, informal conversations were made whereby users shared their experiences as they learnt about the study. All relevant information was jotted down and translated as a field diary, including observant interpretations. Any data that might identify any personal information was subtracted.

Significant considerations were given to the confidentiality and privacy of the collected data. Interviews and observation field notes were anonymised, and the anonymity of the participants was ensured using randomly generated identification numbers. Amberscript software (transcription tool) was used for verbatim transcription of the interviews.

Data analysis was made based on the grounded theory method (Glaser and Strauss, 1967) and thematic analysis Bryman (2012), Howitt (2010), Ryan and Bernard (2003), combined with Dunne's (2011) suggestion of a reflexive approach to the literature review in grounded theory method. The observation data were used as supplementary data (i.e. additional insights, complementing interview data) during inductive and deductive coding of the interview data, as Creswell (2014) suggested. Analytic software ATLAS.ti® (Scientific Software Development GmbH, version 8) was used for analysis, including coding, sorting and categorising the emergent themes.

The first author coded and analysed the transcriptions, considering the intra-coder reliability (Bryman, 2012). The analysis continued until a consensus on that potential data was coded into relevant and prominent themes and categories. The analysis started with reading the transcripts and field notes multiple times without making notes or interpreting the data. The following readings included making notes while getting familiar with the data. Then, the coding activity started, including exploring the present data with all issues, ranging from a single word to a complete sentence. Then, re-coding cycles were done multiple times to identify and sort all relevant codes, as Saldaña (2010) suggested. More elaborated coding activities were made, such as classifying, abstracting, conceptualising and theory building. Multiple coding and sorting cycles continued, and obvious themes emerged. Some obvious connections and interrelations were noted to assist the process and gain more insights while coding through a reciprocal relationship between the development

coding, as Weston *et al.* (2001) and Liamputtong (2009) suggested. The relevant literature was used to support the emerging codes, as Locke (2001) and Howitt (2010) suggested. Finally, the last coding cycles consisted of reconfiguring the interrelationships, grouping the codes that seem to belong to the same coding categories, and filtering the codes if necessary.

4. Results

The data analysis revealed two main themes addressing participants' expectations and preferences for smart office environments (Table 2):

(1) *"enhanced interaction"* with the social and physical office environment; and

(2) *"sense-making"* of the smart concept (or smartness).

The components within these themes were classified as *basic* and *smart* aspects. *Smart* aspects were identified as they referred to smart technology or concepts or as they were noted explicitly by participants while describing their ideal smart office environment (in bold texts in Table 2). *Basic* aspects were identified for the other components, which can be found in other non-smart offices and are not necessarily related to smart office concepts or technology; however, they were considered essential and explicitly expected by participants. During the interview, participants were specifically asked about their experiences when they moved into the smart office building. These conversations revealed that participants initially sought *basic* aspects before *smart* aspects when experiencing the office environment (Figure 1). At the same time, they implied to expect both aspects to be present and satisfactory in smart offices, contributing to "*enhanced interaction*" and "*sense-making*" with the smart concept (Figure 1).

4.1 Enhanced interaction

The enhanced interaction represents greater interaction expected in smart offices, referring not only to social and physical relationships between colleagues but also the relationship with attributes of the smart office environment. The components identified within this theme were categorised based on the form of the interaction: "*informative*", "*instrumental*" and "*territorial*".

4.1.1 Informative. The informative components refer to the interaction between users and their office environments based on "*obtaining*" or "*providing information (user participation)*".

Referring to *smart* aspects, several participants noted their expectation to obtain information about the office environment via an application or equipment (e.g. an informative screen). Most participants expected to obtain information on the real-time *crowdedness and occupancy of workstations*. Some noted their frustration looking for a convenient desk among the floors in the new office building and believed they could use their time more efficiently if occupancy data were available, especially before arriving at the office. Some participants stated that they expected to know the *current location of their colleagues* in smart office environments. A few associated this expectation with their struggle in knowing whether their colleagues were in the office or not. Some added that they experienced less visual interaction among colleagues as each floor is dedicated to one department and divided into two separate working areas with the elevator shaft located in the middle of the floor area. Considering the limitations of the physical office layout, several participants expected smart office technologies to offer a solution (e.g. socialising application) to facilitate interaction, enabling them to find their colleagues easily in the building. Most participants stated that they want to know what *office tools and features* are

Themes	Main Categories	Subcategories	Codes (components)	Amount
Enhanced interaction	Informative	Obtaining information*	*Crowdedness/occupancy of workstations (app-based)**	*5*
			*Office tools/features (app or/and product-based)**	*5*
			*Current location of colleagues (app-based)**	*2*
			*Indoor climate (app-based)**	*2*
			Prompt and convincing responses from building management	2
		Providing inf. (user participation)	User participation in design decision making	2
	Instrumental	Controllability*	*Adjustable office features (e.g., lights, temperature, workstations) **	*7*
		Vitality & health	Standing tables (*working standing*)	4
			Deskbike *(working in motion)*	1
		Personalisation*	*Smart workstation (customised desk and chair)**	*3*
		Interactive & multifunctional*	*Interactive screens**	*2*
			*Interactive (smart) meeting table**	*2*
			*Hologram meeting tools**	*1*
			*Autonomous coffee service**	*1*
			Wide, interactive screens in meeting rooms	1
	Territorial	Social interaction*	Spontaneous encountering	6
			Visual interaction	5
			Proximity to colleagues in other departments	4
			*(Smart) applications to stimulate social interaction**	*3*
		Personal-space, privacy	Quiet, isolated workspaces *(e.g. silent work, phone calls)*	4
			Separate secondary spaces *(e.g. a pantry, company restaurant)*	4
Sense-making	Fundamental	Comfort	Comfort with indoor climate *(e.g. temperature, acoustics)*	3
		Safety	Feeling safe (e.g. *persuasive emergency plan, entrance security*)	3
		Basic facilities	Basic facilities *(e.g. printer, coffee machine)*	2
		Belongingness	Being around colleagues	2
	Enrichment *(experience-based)*	Innovativeness*	*Innovative office features**	*5*
		Meaning	Definition of the smart office concept	5
		Usability*	*Easy to use, supportive office tools, features**	*5*
		Adaptiveness*	*Available workplaces/tools for an immediate need**	*5*
			*Diversity of work/places (for work and rest) **	*3*
		Familiarity*	*Homey features (feelings of warmth and cosyness) **	*3*
		Inspiration (and liveliness)	Inspirational elements (playful elements (e.g., *ping-pong table), colours, art objects, pleasant seats)*	3

Table 2.
Components of user preferences and expectations for smart office environments

Notes: Amount = number of participants who mentioned the relevant code at least once; italic texts = smart aspects; regular texts = basic aspects, * = sub-category including smart aspects

available, especially when reserving a workplace, enabling them to choose suitable options for their current needs. Some participants wanted to know the real-time *indoor climate* conditions (e.g. temperature, humidity) provided via an application or an informative screen. One participant noted her disappointment as she could not check the indoor temperature while feeling uncomfortable. Further, she thought providing information on indoor temperature should be a default feature in smart offices.

In terms of *basic* aspects, some participants expected to receive *prompt and convincing responses* to their complaints or requests, which could prompt greater communication with the building management. For instance, one participant seemed to be discontent as she thought she had waited for a long time to hear a response to her complaint. As another *basic* aspect, some participants highlighted *user participation in design decision-making* as they expect their opinions and expectations to be asked and considered during the design phase of a smart office building, which appeared to influence their satisfaction. One participant was discontent because she thought her expectations and opinions were not asked before the relocation. However, another participant was happy as he thought their opinion as a team was considered during the design process.

4.1.2 Instrumental. The instrumental components refer to the interaction between users and their office environment established via office facilities, classified based on the type of experience they provide: "*controllability*", "*vitality and health*", "*personalisation*" and "*interactive and multifunctional*".

Most participants noted that they expect smart offices to provide *adjustable office features* (e.g. blinding, lights, temperature and workstations), where they can control some settings of the office environment. Some expressed that when they feel discomfort with the temperature, they prefer to adjust it themselves rather than get in touch with the building management. However, some were hesitant about whether controlling common office facilities might cause conflict among colleagues considering that not all may share similar preferences for temperature or lights. As another *smart* aspect, some participants described their expectation for a *smart workstation* that can automatically adjust its dimensions to the preferred settings by logging in with an identification card, which can be related to personalisation needs. One participant believed that *smart workstations* could help them use their time efficiently instead of adjusting a new desk every day in a flexible office setting. Some expected *interactive screens* could create an interactive experience by enabling them to communicate their needs with the office environment, such as adjusting the indoor climate and searching for workplace information. Regarding participants' ideal smart office descriptions, several participants referred to innovative and state-of-art office technologies. For instance, one participant described an *interactive (smart) meeting table* with a digital surface that could enable everyone to work on the same digital document during a meeting in smart offices. Another participant stated that he would expect to have *autonomous coffee service* in smart offices. Another one expected *hologram meeting tools* to be provided in smart offices, which could enhance interaction in online meetings.

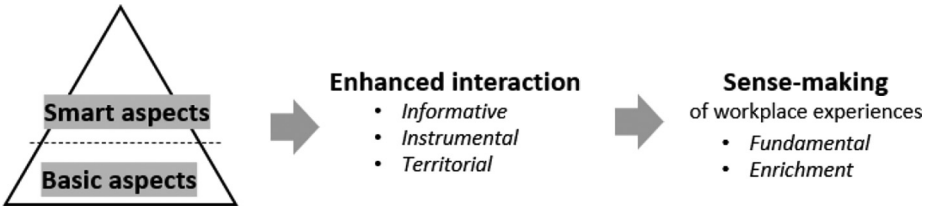

Figure 1.
Expected smart office experience from a user point of view

Referring to *basic* aspects, some participants underlined the importance of vitality and health in smart offices by noting their contentment with *standing tables* and *desk bikes* in the current office. They believed such facilities are fundamental and good for their health, enabling them to be physically active during a workday. As another *basic* aspect, one participant said that *wide, interactive screens* in meeting rooms are very useful and essential for meeting rooms. He further noted that he expects other features in smart offices that are distinctive and refer to smart office concepts.

4.1.3 Territorial. The territorial components define the interaction facilitated by territorial characteristics of the workplaces, which were grouped as "*social interaction"* and "*personal-space (and privacy)*".

As a smart aspect, several participants implied that they expect *(smart) applications* to stimulate social interaction. For instance, one participant thought the plan layout of the new office was insufficient to facilitate social interaction; thus, he expected that such smart applications could offer a sitting plan that regularly shuffles desks or creates events to enhance social interaction among colleagues. Referring to *basic* aspects, several participants highlighted the importance of *visual interaction* and *spontaneous encountering* within the office environment. Some participants pointed out that *proximity to colleagues in other departments* is significant. Some noted that they prefer to reach out to their colleagues easily and ask their questions in person as they think it is more straightforward and practical than making a phone call or sending an email. In terms of personal space and privacy, participants implied that they want *quiet, isolated workspaces* available for concentration required work or privacy-required meetings (i.e. phone calls, impromptu meetings). One participant noted that he expects to use such spaces to work concentrated with minimum social interaction and distraction while knowing that he can socialise whenever he wants. Some participants underlined the need for *separate secondary spaces* (i.e. a kitchenette, a pantry, a company restaurant) located distant from workspaces, providing privacy and comfort for work and non-work-related conversations. Because they experienced discomfort as their conversations in the social area were easily hearable from the working area that disturbed their colleagues.

4.2 Sense-making

Participants indicated they expected to make sense of the smart concept based on their experience in the office environment, which appeared to influence their satisfaction with the smart office. The components identified within this theme were grouped as "*fundamental*" and "*enrichment"*.

4.2.1 Fundamental. The fundamental components indicate office experiences that are essential, contributing to the sense-making of the smart concept and user satisfaction. These components were classified as "*comfort"*, "*safety"*, "*basic facilities"* and "*belongingness"*.

Some participants seemed to have negative emotional reactions (e.g. anger) when fundamental components were dissatisfying for them. One participant even appeared to discredit the smart office concept as she had discomfort with the indoor climate. Participants highlighted the importance of *basic facilities* (i.e. a printer, coffee machine and convenient workstation) while describing their initial experiences in the office environment. *Comfort with indoor climate* was noted as significant by several participants. One stated that he could comprehend that comfort with indoor climate could be challenging for all office types, not only for smart offices. Furthermore, several participants implied that *feeling safe* is a fundamental need in the office environment by noting their experiences and doubts about the current security of the building entrance, the safety of the elevators and the fire emergency plan. A few thought that some of these problems could be temporary because of

the ongoing renovation activity in the building. Some participants referred to the importance of *being around colleagues* while describing an ideal smart office environment. One participant said that interaction with his colleagues is essential and can be even considered more important than the physical office environment.

4.2.2 Enrichment. The enrichment components refer to distinctive office experiences expected in smart offices, leading to exciting and attractive workplace experiences while contributing to the sense-making of the smart concept. These components were grouped as *innovativeness*, *meaning*, *usability*, *adaptiveness*, *familiarity* and *inspiration (and liveliness)*.

In terms of *smart* aspects, most participants implied *innovative office features,* providing distinctive and different office experiences compared to their previous (and regular) office experiences, enabling them to experience and acknowledge the smart concept. Most participants noted a need for a *definition of a smart office concept* to understand the smart concept and associate it with relevant office features. In particular, some participants were confused when they could not associate the meaning of the smart office concept with an office feature. Further, one questioned whether the smart concept was only about the technical level and could not be experienced from a user perspective. Regarding usability aspects of the office environment, several participants expected smart offices to provide *easy to use and supportive office features*, such as employee platforms or workplace booking applications. A few noted that they would acknowledge an office environment as smart as long as it provides easy set-up and supportive office tools in meeting rooms. Several participants expected smart offices to adapt to their needs by providing *available workplaces and tools for an immediate need*. Some underlined that smart offices should offer *a diversity of places* for either work or resting.

Some participants stated that a (smart) office should provide more than a (plain) working environment. For instance, one participant expected inspiring workplaces in smart offices since she found the current office plain and uninspiring because of the lack of colour and art objects (e.g. paintings). Several participants referred to *inspirational elements* that can create inspiration and liveliness in smart offices, such as playful elements (e.g. ping-pong table) and pleasant seats (for resting and working). Some participants believed that *inspirational elements* could positively affect their work motivation and productivity as they spent long hours in the office environment. While describing an ideal smart office environment, several participants expected *homey features* in smart offices (i.e. plants, colours, hominess, cosy sofas), which can be related to the need for familiarity. Also, one participant expressed that he is content with plants in the current office as they create a warm, cosy and homey atmosphere.

5. Discussion

This case study aimed to investigate the meaning of smart office environments from a user perspective. The results revealed that users expect smart offices to facilitate *enhanced interaction* with their social and physical environment and *sense-making* of the smart concept, equipped with *smart* and *basic* aspects. In particular, the findings suggest that users can be dissatisfied and even discredit the smart concept when *basic* or *smart* aspects are not fulfilling. Thus, this study suggests a holistic approach when designing a smart office environment, in which office designers, developers and managers should consider both *basic* and *smart* aspects.

As this topic needs a deeper understanding for a definition of smart office concepts, this study contributes to the literature in two ways: by showing the value of the qualitative method, which was particularly useful in revealing user perspectives for smart office concepts; and by indicating the relevance of understanding emotional and behavioural

responses when habituating a smart office building, showing the relationship between experiences, emergent expectations, preferences and needs. Practitioners, real-estate managers and smart office developers should use and further develop the results of this study to design and manage successful user-centric smart office designs.

5.1 Basic and smart aspects

The findings suggest that users seek *basic* and *smart* aspects. Both aspects appear to impact user experiences in smart office environments, aligning with Maslow's hierarchy of needs for human motivation (Maslow, 1970) (Figure 2). One can claim that an individual seeks *smart* aspects when *basic* aspects are fully or partly satisfied. *Basic* aspects coincide with *deficiency needs* (*physiological, safety, belonging and love, esteem needs),* which are not necessarily related to smart office concepts or technology but are considered essential and can be found in regular (non-smart) office types. As an extension of *basic* aspects, *smart* aspects align with *growth needs*, referring to distinctive, added-value and inspiring office experiences related to smart concepts.

It is worthwhile to compare the results of this study with Den Heijer (2011)'s suggestion for workplaces on campus based on Maslow's hierarchy. *Smart* aspects revealed in this study align with their "*representative"* factors, referring to inspiring and attractive workplaces enhancing user motivation. *Basic* aspects found in this study coincide with their "*meeting place"* and "*plain and efficient"* factors, referring to plain workplaces fulfiling fundamental needs. Additionally, it is also noteworthy to look at the classification for regular workplaces (*basic*, *proportional* and *bonus* factors) by Kim and de Dear (2012b) in comparison to the results of this study. The *basic* aspects identified in this study coincide with their "*basic"* factors, where both are expected fundamentally in offices and affect user experience and satisfaction. *Smart* aspects align with their "*bonus"* factors, referring to a potential to create excitement and attractiveness and add value to (smart) offices. Unlike "*bonus"* factors, the findings of this study suggest that users explicitly expect *smart* aspects from smart office designs. Future studies can further investigate whether there are aspects of smart offices that can coincide with their "*proportional"* factors.

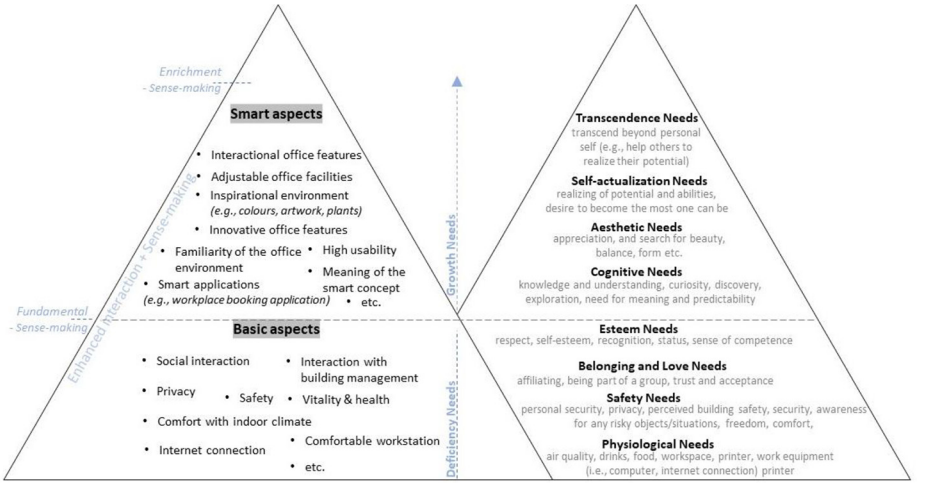

Figure 2.
Conceptual representation of basic and smart aspects (left) and interpreted equivalences on Maslow's hierarchy of needs (right)

From a usability point of view, the findings suggest that smart office developers should pay attention to *smart* aspects that correspond to user needs and provide inspirational, innovative, state-of-the-art workplaces. These *smart* office aspects can enhance usability and user satisfaction, aligning with the suggestions by usability studies (Blakstad *et al.*, 2008). Thus, one can claim that smart applications (e.g. workplace booking applications, controllable temperature and lighting systems) can provide high usability in smart offices. Furthermore, the findings suggest that smart office developers should consider *basic* aspects by supporting other studies showing the importance of the interrelationship between users and office environments, such as privacy (Haans *et al.*, 2007, social interaction (Kim and de Dear, 2013), light comfort (Despenic *et al.*, 2017), safety (Preiser and Vischer, 2005), sense of belonging (Inalhan, 2009); office appearance (Hongisto *et al.*, 2016) and layout and configuration (Lee, 2010).

5.2 Enhanced interaction

The findings suggest that users expect an enhanced interaction in smart office environments, referring to greater interaction with their social and physical environments. Thus, this study suggests that smart office designers and developers should consider not only social interaction among office users but also the interaction between users and their smart office environment. Design and technology implementations should facilitate the relationship between users and their (smart) office environments. In particular, the findings suggest that these implementations should support user activities and be easy to use, in line with the usability studies in workplaces (Alexander, 2006; Blakstad *et al.*, 2008; Hansen *et al.*, 2011; Windlinger and Tuzcuoglu, 2021).

To enhance interaction between users and their environments, smart office developers should consider designing (smart) technology implementations (e.g. interactive screens, workplace booking systems) and user applications (e.g. enhancing social interaction, application for suggesting a sitting plan). Regarding the interaction between users and their workplaces, the findings show that users still expect to control their working environments in smart offices, which appear to influence their satisfaction, aligning with other studies in other (non-smart) office types (Kwon *et al.*, 2019; Lashina *et al.*, 2019). Providing available workplaces can respond to different user needs while enhancing the interaction with their office environment, which is in line with the suggestion by other researchers for other (non-smart) office types (Appel-Meulenbroek *et al.*, 2011; Babapour *et al.*, 2018; De Been and Beijer, 2014; Haapakangas *et al.*, 2018). The findings show the importance of social interaction in smart offices, which broadly support the work of other studies in other (non-smart) office types (Danielsson *et al.*, 2009; Haans *et al.*, 2007; Haapakangas *et al.*, 2018). To enhance social interaction, the findings suggest (smart) applications can be used to foster interaction among colleagues, especially when the physical office layout is limited. Overall, the findings suggest smart office developers should consider that smart office concepts can evoke an expectation for responsive workplaces, aligning with the literature on smart technology developments in offices (Ghaffarianhoseini *et al.*, 2016; Jadhav, 2016; Kua and Lee, 2002; Marsá-Maestre *et al.*, 2006). Future studies should further investigate how different office features and technology can affect the levels of perceived interaction between users and their smart office environment.

5.3 Sense-making of the smart concept (perceived smartness)

The findings indicate that users expect to make sense of the smart concept by experiencing the smartness of the office environment. As depicted in Figure 2, the findings suggest a holistic approach for sense-making of the smart concept from a user perspective that can be

experienced through *basic* and *smart* aspects. Alongside the fulfilment of *basic* aspects, the findings suggest *smart* aspects should be fulfilled and add value to office experiences, create excitement and attractiveness for users, aligning with the suggestion by Den Heijer (2011) with representative factors. This finding also coincides with esteem, cognitive and aesthetic needs in Maslow's hierarchy of needs (Maslow, 1970).

The findings suggest that smart office developers and managers should consider that the smart office concept can evoke an expectation of workplaces that are always up-to-date from a user point of view. The findings further suggest a need for a clear definition of the smart concept, designating particular office features; otherwise, users can get confused and stressed if they cannot associate any office features with the smart concept. Therefore, this definition can lead users to make sense of their experiences and associate with smart technology and tools, aligning with the suggestion of the use of meaning in usability studies (Blakstad *et al.*, 2008; Hansen *et al.*, 2011) and coinciding with the symbolism suggested by Vilnai-Yavetz *et al.* (2005) in other (non-smart) office environments. Additionally, one can claim that this definition can contribute to the development of new workplace attachments while habituating to a smart office environment, as suggested in the relocation studies in other (non-smart) office types (Inalhan, 2009).

5.4 Limitations and future directions

This study broadens the existing definitions of smart office concepts from a user point of view. Given that our study is the first to examine drivers that underlies user perspectives on the meaning of the smart office concept, it should be regarded as an initial exploration that naturally has limitations in the context of qualitative research with a small sample of office users (n = 11) from one smart office building. However, this small sample enabled us to make an in-depth analysis, as Hennink *et al.* (2011) suggested.

During the coding process, intra-coder reliability was considered (Bryman, 2012); however, there is still a possibility of missing relevant themes. Some parts of this sample may have similar attitudes rather than a random sample, considering four out of eleven participants joined this study through other participant referrals. In some parts of the data, participants shared their memories months after the relevant experiences in the smart office environment. Thus, caution must be applied to this part as the reported perspectives could be subject to bias, such as fading affect bias (Gibbons *et al.*, 2011). During the time of the study, not all floors were not occupied, and some installations were not fully operational, which may be likely to lead to deficient data for user opinions based on their experiences. This study did not control individual differences in preferences, personality factors and work tasks. Further research can replicate and extend these findings by considering individual differences.

Even though the findings have drawn a distinction between *basic* and *smart* aspects, they were not fully evaluated as this information only emerged during the analysis. Future research should further investigate this distinction to elaborate on how particular office features belong to each aspect and how basic and smart aspects can influence user experience and satisfaction in smart office environments. It is also noteworthy that this study did not investigate user opinions about their (digital) privacy and personal data security, considering technology implementations in offices. Thus, future research should examine these factors and investigate their possible effects on user experiences and preferences. Even though the results suggest that smart offices should provide a distinctive office experience, the determinants of the perception of smartness of the office environment were not investigated in detail. Future studies should elaborate on the findings and investigate the fit between the technology and user expectations and their relevance to user

experience (e.g. vitality, liveliness, innovativeness, personalisation). As the scope of this study was limited to the exploration of user perspectives, it was not examined how office features can influence the level of perceived smartness of the office environment as time progresses, considering the expected up-to-date office technology and features. Thus, future research should conduct a longitudinal study to investigate whether the perceived smartness differs in time and what this would mean to the design and management process of smart offices.

6. Conclusion

Smart office concepts can have a wide range of definitions, and this study broadens the existing definitions from a user point of view. This study suggests that users expect smart office environments to facilitate "*enhanced interaction*" with their social and physical office environment and "*sense-making*" of the smart concept through their experiences. In particular, this study reveals that users expect to be fulfilled with both *basic* and *smart* aspects; thus, a holistic approach for both aspects is suggested when designing a smart office environment. As smart office concepts can evoke an expectation of up-to-date workplaces through state-of-the-art technology and design, the need for a continuous enhancement of the working environments should be considered from a management point of view. Users can have different perspectives and expectations for smart concepts; thus, this study suggests that a clear definition of the smart concept should be provided clearly to the users, referring to the particular features. Overall, this study provides new insights for understanding the meaning of smart office environments from a user perspective. Real-estate managers, organisations, smart office designers and environmental psychologists should use and further develop the results of this study to design successful user-centric smart office environments.

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