Smart Offices: A productivity and well-being perspective

Abstract

The rapid development of information communication technology has led towards the emergence of the "connected world" characterised by the pervasive embeddedness of smart technologies. Smart technologies have a transformative impact on different domains of life. The application of smart technologies redefines the way people live, interact and conduct business. To date, the attention of the scholarly community has been paid primarily to smart cities, smart manufacturing and smart homes. However, despite numerous studies discussing the benefits of advanced technologies in the workplace, there is a lack of research on smart offices and how they affect productivity and employee well-being. This opinion paper argues that office spaces constitute a distinctive type of space, and research on smart homes or manufacturing does not suffice to capture its essence. Therefore, the aim of this paper is to propose a research agenda that can advance the current literature on smart and information communication technologies in relation to workplace spaces and the potential implications these could have on productivity.

Keywords: smart offices, smart technologies, workplace, productivity, well-being, research agenda

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1. Introduction

Recent advances in information communication technologies have increased the application of smart technologies in all domains of life. The term "smart" has become widely used to conceptualise innovative technologies, especially those that are embedded with artificial intelligence. The main purpose of smart technologies is to collect data from the surrounding environment and assist users in day-to-day activities (Chan, Estève, Escriba, & Campo, 2008). A lot of research revolves around the implications of smart technology in the home, urban and industrial contexts, putting forward such concepts as smart cities, smart homes and smart manufacturing (Ismagilova, Hughes, Dwivedi, & Raman, 2019; Israilidis, Odusanya, & Mazhar, 2019; H. S. Kang et al., 2016; Marikyan, Papagiannidis, & Alamanos, 2019; Zhuhadar, Thrasher, Marklin, & de Pablos, 2017). The development of these concepts has been facilitated by the growing need to offset environmental, economic and social challenges. For example, the main aim of smart cities is to face challenges related to gradually increasing urbanisation. The embeddedness of smart information communication technologies in cities makes it possible to boost the transportation system, improve environmental sustainability, the economy and the quality of life (Kitchin, 2014). Similarly, the utilisation of smart technologies in home settings can potentially bring health-related, environmental, financial and psychological benefits for users (Nazmiye Balta-Ozkan, Amerighi, & Boteler, 2014; N. Balta-Ozkan, Davidson, Bicket, & Whitmarsh, 2013). Those benefits are made possible by promoting independent living, reducing the consumption of resources and improving socialisation (Cheek, Nikpour, & Nowlin, 2005; Coughlin, D'Ambrosio, Reimer, & Pratt, 2007; Ehrenhard, Kijl, & Nieuwenhuis, 2014; Elkhorchani & Grayaa, 2016). The application of smart technologies in manufacturing is discussed in terms of the automation of production and the benefits that this can bring due to the reduction of operational costs, human error and waste, which consequently increases the productivity (H. S. Kang et al., 2016; Trebuna, Pekarcıková, & Kronová, 2018).

The adoption of smart technologies in work settings is an inevitable process, as the transformation of traditional workplaces into smart ones is important to accommodate the changing lifestyle (Attaran, Attaran, & Kirkland, 2019). Potentially, smart technologies could make it possible for organisations to monitor and underpin the productivity of employees, sales volume and the satisfaction of consumers (Burnett & Lisk, 2019). However, empirical research lacks evidence on the application and outcomes of smart technologies in workplace settings. Although research from other contexts may offer insights as to how technology may be implemented and utilised, the findings cannot be directly transferable. Different contexts imply the diversity of user roles and the activities that they perform, which require specific configurations of technologies (Brown, Venkatesh, & Bala, 2006; A. Venkatesh, 1996). When it comes to the office environment, research tends to discuss the utilisation and benefits of single stand-alone devices (e.g. smart wearables, smart clothes) by employees, rather than considering the overall work environment embedded with smart technologies (Bootsman, Markopoulos, Qi, Qi, & Timmermans, 2019; Elnaga & Imran, 2013; Jacobs et al., 2019; V. Venkatesh & Speier, 1999). In addition, the benefits are mostly examined in relation to employees' satisfaction (Bootsman et al., 2019; Dahmen, Wöllecke, & Constantinescu, 2018), while the effect on organisational performance is yet to be empirically confirmed. Given the gaps, the objective of this paper is to propose a research agenda for smart offices by synthesising the findings in the literature on the benefits that smart technologies may provide for organisations in terms of productivity, as well as discussing the factors and conditions that contribute to it.

2. Methodology

The starting point of this opinion paper was to explore the state of the art in the research on the effect of smart technology on productivity. The systematic approach was adopted at the stages of planning

and conducting the literature review, and reporting findings (Tranfield, Denyer, & Smart, 2003). Prior to conducting the review, preliminary scoping and scanning of the literature was undertaken to develop the review protocol. The proposed protocol outlined the criteria which guided the selection process of papers and the methods of conducting the analysis.

The selection of the literature search was two-phased. The purpose of the first phase was to generate the overall pool of literature that discusses productivity in office settings. The purpose of the second phase was to select the documents, focusing on the implications of implementing and using smart and advanced communication technologies in offices. We embarked on the first phase by identifying the target academic database and the list of keywords. The electronic database Scopus was selected, because it is the largest database of academic documents (articles, conference proceedings, reports, reviews and research notes), providing extensive coverage of the topics of interest (Bar-Ilan, 2008). Keyword selection for the literature search revolved around "office" and "productivity" terms. The keyword selection started from a broader topic (e.g. "productivity", "performance", "output", "efficiency", "productiveness", "potency", "office", "working space", "office space", "workplace", "work place") and narrowed down to more specific keywords ("office" and "workplace"). During the search, advanced filtering options were used to limit documents to "articles", "articles in press" and "reviews" published in the English language in relevant domains. The search resulted in 1761 documents. After reviewing titles, abstracts and keyword, the papers that were not related to smart offices were excluded (they were interested in other aspects such as ergonomics, office design, quality of air, bringing pets to work or having plants in the office, etc), which reduced the scope to 44 papers. The selected papers discussed technology and smart devices and their implications for organisations. A backward and forward citation search technique was utilised to increase the number of documents and the coverage of the topic. This technique was proposed by Croom (2009) and Thomé, Scavarda, and Scavarda (2016) to retrieve deeper insight into the selected topic. The backward and forward citation search made it possible to broaden the scope of the literature by examining the papers cited in the selected documents and the papers that cited the selected documents (Hu, Rousseau, & Chen, 2011).

Quantitative content analysis tools, namely QDA Miner and its extension Wordstat, were utilised for the analysis. The quantitative approach of analysing the literature made it possible to produce robust results across a large amount of data (Silver, 2014), while the utilisation of the software tools helped deduce statistically significant concepts without compromising on the reliability and objectivity of the findings (Riff, Lacy, Fico, & Watson, 2019). In the first instance we derived the frequency of keywords in the selected documents by manually excluding non generic concepts (e.g. journal, study etc.). The second step was to cluster topics based on the analysis of relationships between different words in the document. The third step was to map identified keywords by analysing their relative co-existence within paragraphs. Finally, the clusters and themes identified were reviewed and reported before a number of research gaps in the form of an agenda were proposed.

3. Results

The list of most-frequent terms extracted from the literature is presented in Table 1. The widely discussed practices in relation to ICT were communication, automation, monitoring and management. When it comes to devices, the research focuses on computers, sensors, energy, temperature and lighting systems.

Table 1: Term frequency

Term	FREQUENCY	% TOTAL	NO. CASES	% CASES	TF • IDF
OFFICE	*1717*	*0.75%*	*44*	*100.00%*	*0*
EMPLOYEE	*1538*	*0.67%*	*40*	*90.91%*	*63.7*
ICT	*1456*	*0.63%*	*41*	*93.18%*	*44.7*
ORGANIZATION	*1425*	*0.62%*	*41*	*93.18%*	*43.7*
WORK	*1024*	*0.45%*	*42*	*95.45%*	*20.7*
SYSTEM	*898*	*0.39%*	*38*	*86.36%*	*57.2*
PRODUCTIVITY	*815*	*0.35%*	*41*	*93.18%*	*25*
INFORMATION	*782*	*0.34%*	*41*	*93.18%*	*24*
MANAGEMENT	*600*	*0.26%*	*40*	*90.91%*	*24.8*
COMMUNICATION	*511*	*0.22%*	*31*	*70.45%*	*77.7*
MONITORING	*417*	*0.18%*	*32*	*72.73%*	*57.7*
TASK	*406*	*0.18%*	*30*	*68.18%*	*67.5*
SOCIAL_MEDIA	*389*	*0.17%*	*8*	*18.18%*	*288*
PERFORMANCE	*381*	*0.17%*	*36*	*81.82%*	*33.2*
DESIGN	*354*	*0.15%*	*32*	*72.73%*	*49*
AUTOMATION	*348*	*0.15%*	*21*	*47.73%*	*111.8*
OVERLOAD	*293*	*0.13%*	*7*	*15.91%*	*233.9*
ENVIRONMENT	*283*	*0.12%*	*35*	*79.55%*	*28.1*
MANAGERS	*259*	*0.11%*	*29*	*65.91%*	*46.9*
TEAM	*259*	*0.11%*	*17*	*38.64%*	*107*
MOBILE	*253*	*0.11%*	*15*	*34.09%*	*118.2*
KNOWLEDGE	*252*	*0.11%*	*24*	*54.55%*	*66.3*
FACTORS	*238*	*0.10%*	*32*	*72.73%*	*32.9*
INTERNET	*235*	*0.10%*	*17*	*38.64%*	*97.1*
VIRTUAL	*219*	*0.10%*	*12*	*27.27%*	*123.6*
TOOLS	*211*	*0.09%*	*26*	*59.09%*	*48.2*
DIGITAL	*198*	*0.09%*	*17*	*38.64%*	*81.8*
PROCESS	*197*	*0.09%*	*31*	*70.45%*	*30*
CONTROL	*192*	*0.08%*	*34*	*77.27%*	*21.5*
COMPUTER	*190*	*0.08%*	*27*	*61.36%*	*40.3*
WINDOW	*186*	*0.08%*	*8*	*18.18%*	*137.7*
SUPPORT	*180*	*0.08%*	*37*	*84.09%*	*13.5*
BENEFITS	*174*	*0.08%*	*29*	*65.91%*	*31.5*
SOFTWARE	*172*	*0.07%*	*22*	*50.00%*	*51.8*
QUALITY	*166*	*0.07%*	*35*	*79.55%*	*16.5*
SERVICE	*163*	*0.07%*	*29*	*65.91%*	*29.5*
LAYOUT	*152*	*0.07%*	*12*	*27.27%*	*85.8*
PRODUCTION	*149*	*0.06%*	*16*	*36.36%*	*65.5*
ENGAGEMENT	*145*	*0.06%*	*13*	*29.55%*	*76.8*
HEALTH	*140*	*0.06%*	*19*	*43.18%*	*51.1*
TRAINING	*134*	*0.06%*	*25*	*56.82%*	*32.9*
PERCEPTION	*132*	*0.06%*	*14*	*31.82%*	*65.6*
SATISFACTION	*132*	*0.06%*	*24*	*54.55%*	*34.7*
ONLINE	*130*	*0.06%*	*22*	*50.00%*	*39.1*
ACTIVITY	*126*	*0.05%*	*22*	*50.00%*	*37.9*
DECISION	*124*	*0.05%*	*22*	*50.00%*	*37.3*
COMFORT	*123*	*0.05%*	*7*	*15.91%*	*98.2*
BEHAVIOR	*114*	*0.05%*	*16*	*36.36%*	*50.1*
ENGINEERING	*113*	*0.05%*	*18*	*40.91%*	*43.9*
ENERGY	*111*	*0.05%*	*14*	*31.82%*	*55.2*
SENSORS	*110*	*0.05%*	*5*	*11.36%*	*103.9*
SMART	*109*	*0.05%*	*12*	*27.27%*	*61.5*
TEMPERATURE	*93*	*0.04%*	*8*	*18.18%*	*68.9*
EFFICIENCY	*92*	*0.04%*	*26*	*59.09%*	*21*

SHARING	*87*	*0.04%*	*15*	*34.09%*	*40.7*
CYBERSLACKING	*85*	*0.04%*	*1*	*2.27%*	*139.7*
SOCIAL_NETWORKING	*85*	*0.04%*	*8*	*18.18%*	*62.9*
COLLABORATION	*79*	*0.03%*	*13*	*29.55%*	*41.8*
WELLBEING	*79*	*0.03%*	*12*	*27.27%*	*44.6*
LIGHTING	*77*	*0.03%*	*7*	*15.91%*	*61.5*
ERGONOMICS	*66*	*0.03%*	*5*	*11.36%*	*62.3*
INNOVATION	*55*	*0.02%*	*17*	*38.64%*	*22.7*
GREEN	*47*	*0.02%*	*8*	*18.18%*	*34.8*
AIR	*46*	*0.02%*	*9*	*20.45%*	*31.7*
SPEED	*20*	*0.01%*	*13*	*29.55%*	*10.6*

Table 2 presents keywords clustered into six main topics: ICT system design, virtual teams, social networking, mobile devices and cyberslacking, office environment control, office layout and productivity. These topics were grouped into two bigger themes, namely the productivity related topics (i.e. ICT system design, virtual teams, using social networking and mobile devices for work purposes and cyberslacking) and office space (environmental control and layout), which relates to the physical space and the control those working in it have.

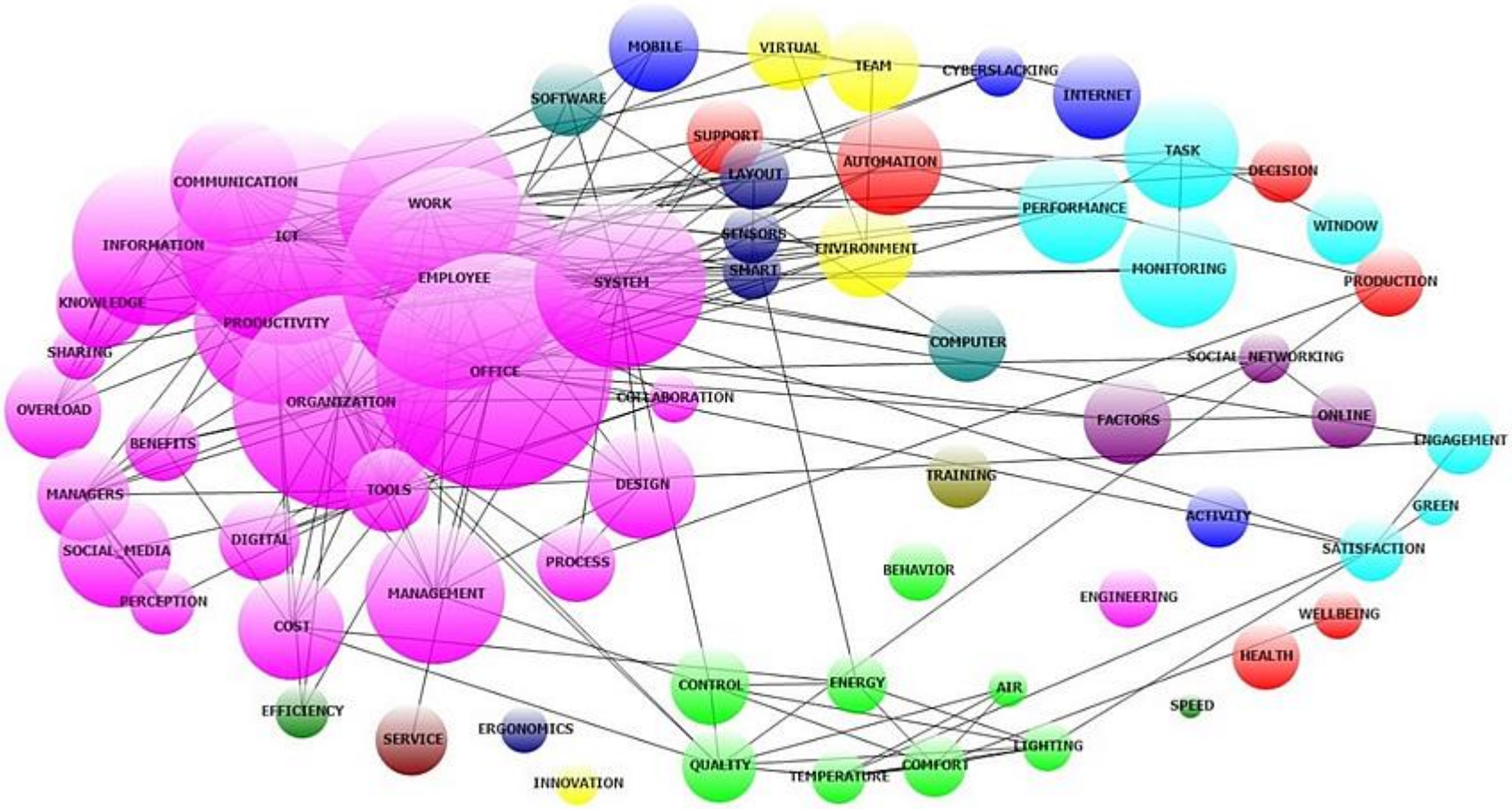
Table 2: Topic clusters

TOPIC	KEYWORDS	COHERENCE	FREQ	CASES	% CASES
ICT SYSTEM DESIGN	SYSTEM; PRODUCTION; AUTOMATION; PROCESS; DESIGN; MANAGEMENT; INFORMATION; QUALITY; INFORMATION TECHNOLOGY; SYSTEM DESIGN; OFFICE AUTOMATION;	0.366	1337	44	100.00%
VIRTUAL TEAMS	VIRTUAL; TEAM; COMMUNICATION; ICT; ENVIRONMENT; OVERLOAD; VIRTUAL TEAM; TEAM MEMBERS; VIRTUAL TEAMS; COMMUNICATION OVERLOAD; TECHNOLOGY OVERLOAD; VIRTUAL TEAM MEMBERS; SYSTEM FEATURE; INFORMATION OVERLOAD; SYSTEM FEATURE OVERLOAD; COMMUNICATION TECHNOLOGIES; DIMENSIONS OF TECHNOLOGY OVERLOAD; INFORMATION AND COMMUNICATION; KNOWLEDGE WORKER PRODUCTIVITY; COLLABORATIVE SOFTWARE;	0.379	1223	42	95.45%
SOCIAL NETWORKING	SOCIAL_MEDIA; PERCEPTION; MANAGERS; TOOLS; PUBLIC MANAGERS; SOCIAL MEDIA TOOLS; PERCEPTIONS OF SOCIAL MEDIA; POSITIVE PERCEPTIONS OF SOCIAL MEDIA; SOCIAL MEDIA; POSITIVE SOCIAL MEDIA PERCEPTION; SOCIAL MEDIA	0.354	919	31	70.45%

	USE FOR WORK; UTILIZE SOCIAL MEDIA; PUBLIC ORGANIZATIONS; TECHNOLOGICAL CAPACITY; WORK PURPOSES;				
MOBILE DEVICES & CYBERSLACKING	MOBILE; CYBERSLACKING; COLLABORATION; ORGANIZATION; EMPLOYEE; INTERNET; DIGITAL; MOBILE DEVICE; MOBILE DEVICES; CYBERSLACKING ACTIVITIES; DIGITAL WORKPLACE; EMPLOYEE PRODUCTIVITY; POTENTIAL FOR PRODUCTIVITY; MOBILE CYBERSLACKING ACTIVITIES; COLLABORATION TOOLS; MOBILE DEVICE CYBERSLACKING;	0.379	1483	43	97.73%
OFFICE ENVIRONMENT CONTROL	TEMPERATURE; COMFORT; LIGHTING; AIR; ENERGY; SATISFACTION; QUALITY; THERMAL COMFORT; VISUAL COMFORT; AIR QUALITY; OCCUPANT COMFORT; ENERGY CONSUMPTION; ENERGY COSTS; ENERGY SAVINGS; ENVIRONMENTAL CONDITIONS;	0.425	336	25	56.82%
OFFICE LAYOUT & PRODUCTIVITY	LAYOUT; PRODUCTIVITY; EMPLOYEE; OFFICE; SMART; WORK; SOCIAL_NETWORKING; FACTORS; OFFICE LAYOUT; EMPLOYEE PRODUCTIVITY; SMART WORK; WORKER PRODUCTIVITY; EVIDENCEBASED HRM; FLEXIBILITY THROUGH ICT; HR PRACTICES AND OFFICE LAYOUT;	0.416	2709	43	97.73%

Figure 1 presents the mapping of extracted keywords based on their co-occurrence and the relative distance of each word against others. The number of links between concepts (words) represents the frequency of co-occurrence, while the distance between concepts represents the proximity of concepts in paragraphs. The closest by meaning words are represented by the same colours. The concept map reflects the six topics that are outlined in Table 2.

Figure 1: Concept map



4. Discussion

4.1 Digital Workplace

The utilisation of information technology has brought about the concept of digital workplaces. A number of studies used practical reports to conceptualise and define digital workplaces (Köffer, 2015; Lestarini, Raflesia, & Surendro, 2015; Meyer von Wolff, Hobert, & Schumann, 2019; White, 2012). White (2012) conceptualised the digital workplace based on the services provided: *"A digital workplace enables any employee to complete a task, share information and work as a member of a team with other employees in the organisation and in any partner organisation on a totally location-independent basis for all the parties concerned"*. Köffer (2015) viewed the digital workplace as an environment where employees have the opportunity to utilise advanced information communication technology, thus increasing the quality of communication, engagement, work output and efficiency. Recently Meyer von Wolff et al. (2019) stated that the *"workplace combines (IT)- technologies, processes and people for information processing in and between enterprises. Therefore, the focus lies on working with information and includes a high relevance of communication and collaboration among the involved people and/or application systems".* Given the focus of such definitions, digital workplaces result from the extensive utilisation and use of advanced information communication systems and technologies in workplaces, which improve the employees' engagement, communication and collaboration. Thus, the aim of the digital workplaces is to encourage the sharing of knowledge, efficient work implementation and collaboration for the benefit of the company and all stakeholders involved (Meyer von Wolff et al., 2019; Ravenscroft, Schmidt, Cook, & Bradley, 2012). This implies that the definitions are more interested in "work" as opposed to the "workplace". Still ignoring the space within which work takes place and the role that technology can play in controlling it and managing it can be limiting and affect productivity and well-being.

The focus on "work" as opposed to "workspaces" is reflected in the literature on digital workplaces, which revolves around three key themes. The first one is the company's strategy. The digital workplace is the result of the strategy to develop optimal technological and infrastructural solutions for employees. Strategies emerge from the need to align workplaces to new developments in technology, regulations and laws to fulfil long-term organisational goals (White, 2012; Williams & Schubert, 2018). The second dimension relates to the employees. The development of digital workplaces revolves around the needs of employees and the creation of conditions to ensure productive and intelligent work (Williams & Schubert, 2018). By digitising work, company management expects to increase employee engagement, to speed up the achievement of outcomes, to facilitate the efficiency of employees' engagement and encourage the reduction of costs (Attaran et al., 2019). The main services through which the productivity in digital workplaces is achieved are collaborations/communications, mobility, compliance management and stress/overload management (Attaran et al., 2019; Köffer, 2015). The third dimension is technology. This enables the implementation of work requirements and organisational needs through the integration of various internal and external ICT platforms and solutions, such as video conferencing, online meetings, big data analytics to name but a few (Williams & Schubert, 2018). However, there is little empirical insight into the deployment of smart technologies in the workplace and their role in company performance.

4.2 Productivity

4.2.1 ICT system design

The major focus of the literature revolves around ICTs and how they transform work-related processes (Bresnahan, Brynjolfsson, & Hitt, 2002; Brynjolfsson, 1994; Soltani, Zareie, Milani, & Navimipour, 2018; White, 2012; Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007). The literature showed that the employment of advanced technologies makes it possible to cater to the needs of organisations

and increase productivity in three ways: (1) by providing immediate benefits, (2) by creating affordances resulting from the interrelationship between technology and employees, and (3) by redefining labour mix and organisation structure.

Immediate benefits include efficiency gains and the technology service quality brought about by ICT functionalities. The main functionalities include the automation of processes, access to information and real-time cross-spatial communication (Velicogna, 2007). Office automation improves the efficiency of procedures that are typically carried out by humans. For example, office automation functions can be used for standard and repetitive processes, like filling in documents and the automatic distribution of emails (Velicogna, 2007). Access to information is enabled by the utilisation of big data solutions. The vast amount of information can be used for developing products and increasing consumer brand engagement. With the growing volume of data, cloud computing has become a very handy tool in work (Etro, 2009; Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011). It gives exposure to a vast amount of technological resources without owning physical devices (W. Kim, 2009). For organisations, the ability to process massive market information helps predict, align and develop strategic decisions, while employees enjoy the efficiency of data processing and the ability to come up with innovative solutions for the organisation (White, 2012). The implication of ICT solutions, like social media (ESM) and enterprise social network (ESN) systems, promotes the connectivity of employees with devices. That erases barriers in communication among employees, and it makes remote collaborative work and knowledge sharing easier and more efficient (Kwahk & Park, 2016; Leonardi & Meyer, 2015).

The implication of technology in the organisational setting can be explained through the affordances resulting from the functionality of ICT. Affordances are produced in the process when people orient themselves in relation to possibilities that the technology may bring for productivity (Zammuto et al., 2007). The affordances can be categorised into four types: visualising work processes, product and service innovation, collaboration and simulation (Bresnahan et al., 2002; Zammuto et al., 2007). The technology has made it possible to visualise end-to-end work processes by gaining access to all imagery, visual and textual artefacts. The product or service innovation affordance refers to the ability to enhance existing products to improve the resilience and agility of the company, like the development of a new application catering to the needs of customers (Zammuto et al., 2007). Collaboration affordance is the ability of one-to-one and one-to-many communication with the purpose of sharing and creating knowledge through tools, such as virtual media, instant messaging and list servers (Kwahk & Park, 2016; Leonardi & Meyer, 2015). Simulation affordance relates to the ability to develop hypothetical scenarios to solve complex solutions through the integration of business intelligence and enterprise planning systems (Zammuto et al., 2007).

Efficiency gains can be the result of the increase of highly skilled employees, who are able to complement the technology. The adoption of technology leads to the change in company services and product mix, which contributes to organisation restructuring represented by the reconfiguration of employees' skills, the labour force and the decentralisation of decision-making (Bresnahan et al., 2002; Zammuto et al., 2007). Particularly, since the automation of services takes the load off employees in terms of clerical and routine tasks, the adoption of ICT eliminates the need for low-skilled roles and increases the demand for more complex, creative and judgement-based tasks (David, Levy, & Murnane, 2000). ICT-based firms are becoming more dependent on employees who are high in autonomy and are able to contribute to a larger set of activities (Bresnahan, 1999; Bresnahan et al., 2002). The computerisation of processes entails the production of a larger output of data, which requires a greater reliance on ICT (Bresnahan et al., 2002). Therefore, ICT-drawn productivity is the result of the cyclical process of the interplay between technology and the human factor.

4.2.2 Virtual teams

ICT has made it possible for organisations to utilise and practise the concept of virtual teams (Grenier & Metes, 1995; Jarvenpaa & Leidner, 1999; Lipnack & Stamps, 1997). Virtual teams can be defined as

"*a temporary, culturally diverse, geographically dispersed, electronically communicating workgroup*" (Jarvenpaa & Leidner, 1999). Multinational corporations use virtual teams (Mogale & Sutherland, 2010) due to the flexibility in reorganising them based on market requirements. Employees interacting through virtual teams can be located in different places around the world and have a different cultural background (Kristof, Brown, Sims, & Smith, 1995; Mowshowitz, 1997). The virtual approach of carrying out collaborations makes it possible to reduce the costs associated with travelling and owning/renting physical offices. At the same time, the virtual nature of collaboration brings some challenges in defining role responsibilities and commitment to the job and tasks (O'Hara-Devereaux and Johansen (1994). Also, there is a risk of information overload in virtual teams resulting from the receipt of a large amount of low-quality information (Ellwart, Happ, Gurtner, & Rack, 2015).

The productivity of organisations can be dependent on the degree to which organisations adopt the concept of virtual teamwork. Productivity can be achieved by more efficient maintenance of collaborative work, enhanced opportunities to employ talented individuals and equal opportunities for employees. The performance of virtual teams is contingent on trust between team members, the level of leadership and technology (Barczak, McDonough, & Athanassiou, 2006; Bergiel, Bergiel, & Balsmeier, 2008); (Hughes, Rigtering, Covin, Bouncken, & Kraus, 2018; Katsikeas, Skarmeas, & Bello, 2009; McManus & Mosca, 2015; Tirelli & Goh, 2015). Trust is formed when individuals share common past and future commitments, and a similar cultural background (Bradach & Eccles, 1989; Mayer, Davis, & Schoorman, 1995; Powell, 2003). Therefore, the effectiveness of virtual teams is questioned given the inability to keep up face-to-face interactions, the lack of shared commitments and common geographical/cultural backgrounds among team members (Handy, 1995). However, there is evidence that trust can be formed in virtual groups through repeated communication (Coppola, Hiltz, & Rotter, 2004; Lawley, 2006; Shin, 2004). To maintain trust, it is important to have constant meetings with team members via remote technologies. The second factor that ensures the success of virtual teams is leadership and communication. It is important that employees have the opportunity to maintain communication with each other and with the team leader on a daily basis (Samson, Donnet, & Daft, 2018). Quality communication helps overcome information overload (Ellwart et al., 2015). The third contributor to success is information communication technology, which is an enabling tool of virtual teams (Jarvenpaa & Ives, 1994). Computer-mediated conferencing tools connects geographically dispersed people, while web-based platforms serve as a communication conduit and the server to store and distribute data (Bergiel et al., 2008).

4.2.3 Social networking

One of the domains of research on ICT and productivity refers to social media use for communication and collaboration purposes (Chow & Chan, 2008; Nisar, Prabhakar, & Strakova, 2019). The innovative technologies, such as smart portable devices with social media applications, have facilitated the development of dynamic online connections (Vorderer, Krömer, & Schneider, 2016). The literature provides conflicting findings on the use of social media and productivity. On the one hand, the excessive use of technology entails a number of risks. The utilisation of social media is associated with the cybersecurity threat (Kavanaugh et al., 2012; Khan, Swar, & Lee, 2014), which refers to an unauthorised exposure of confidential information to the public (Featherman & Pavlou, 2003). The leakage of information entails damage to the reputation, legal implications and other adverse consequences (Webber, Li, & Szymanski, 2012). In addition, social networking through mobile devices facilitates addictive activities (Khan et al., 2014), while the use of information technology for non-work-related activities decreases the productivity (Glassman, Prosch, & Shao, 2015; Moody & Siponen, 2013; O'Neill, Hambley, & Chatellier, 2014).

On the other hand, there is a positive correlation between the use of social networking sites and some dimensions of productivity. It is argued that heavy users of social media are better communicators, they are more likely to share information and are higher in technical skills. The use of social media helps refresh the mind during break time, which reduces fatigue and increases work efficiency (Smith, 2013).

The benefit of social media is that it can be used for corporate purposes. The use of social media on portable smart devices can potentially enhance the process of sharing knowledge and communicating information to stakeholders within and across corporate divisions (Chow & Chan, 2008). Interactions with colleagues enable the spread of job-related information and encourage the spontaneous generation of solutions and ideas (Cook, 2017; Dellarocas, 2003). The repeated social interactions strengthen social ties between colleagues, improve the quality of the communication and develop common goals (Dellarocas, 2003)). It has been suggested that the use of social media for informal social interactions beyond the organisation circle helps in acquiring innovative solutions (Goh, Heng, & Lin, 2013; Wu, 2013). The findings also suggest that social media has contributed to presenteeism and serves as a tool through which employees achieve a work-life balance, thus improving their performance (Moqbel, Nevo, & Kock, 2013).

4.2.4 Mobile devices and cyberslacking

The use of personal mobile devices enables constant connectivity through the internet, which redefines the way of doing business and social behaviour. Accessibility through mobile internet allows flexibility in terms of location and time (Bertschek & Niebel, 2016) through instant messenger, video and audio chats and communication applications. These services have introduced the mobile working concept, which corresponds to the interest of almost 80 percent of the younger generation of employees. This means that mobile working reduces the need for static workstations (Appel-Muelenbroek & Haynes, 2011). The use of mobile devices enabling constant access to the internet is beneficial for organisations in three ways. It offers efficient communication and information flow, thus reducing the centralisation of the organisation. The decentralisation and communication efficiency reduces organisational costs (Alharthi, Levy, Wang, & Hur, 2019; Bertschek & Niebel, 2016; Bresnahan et al., 2002; Najarzadeh, Rahimzadeh, & Reed, 2014). In the long run, the reduction of costs contributes to improved organisational performance (Bertschek & Niebel, 2016).

However, there is an unintended effect of the increasing opportunities to instantly access the Internet at the workplace through mobile devices. Prior studies found that employees tend to use information technology for cyberslacking (Glassman et al., 2015; Moody & Siponen, 2013; O'Neill et al., 2014). O'Neill et al. (2014) defined cyberslacking as "*a phenomenon in which employees are distracted by non-work Internet browsing when they should be accomplishing work tasks*". Using technologies for personal needs during work hours distracts employees, which subsequently contributes to the reduction of their productivity (Lebbon & Sigurjónsson, 2016). It was found that up to 80 per cent of employees are cyberslacking during the workday, which lowers their productivity by up to 40 per cent approximately (Jandaghi, Alvani, Zarei Matin, & Fakheri Kozekanan, 2015; Nazareth & Choi, 2015). In addition, cyberslacking in offices increases the risk of spyware and viruses in organisations (Askew et al., 2014; Van Gramberg, Teicher, & O'Rourke, 2014). Evidence suggests that employees' cyberslacking has a negative effect on overall company performance (Betts, Setterstrom, Pearson, & Totty, 2014; Gözü, Anandarajan, & Simmers, 2015). Countermeasures, such as limiting the use of the internet, have proved not to be effective (Glassman et al., 2015; Kulkarni & Bojewar, 2016; Ugrin & Pearson, 2013); (Jamaluddin, Ahmad, Alias, & Simun, 2015; O'Neill et al., 2014). Employees develop distrust toward the organisation, which contributes to the reduction of their morale and productivity (Lee Jr, Warkentin, Crossler, & Otondo, 2017).

4.3 Office Space

4.3.1 Environment control

The literature on digital workplaces disregards the role of technology managing and controlling workspaces, while predominantly focusing on the effect of technologies on the efficiency of work-related processes. However, the introduction of advanced technologies makes it possible to achieve the psychological and physical wellbeing of employees by contributing to environmental comfort, which

is a prerequisite of productivity (Seppanen & Fisk, 2004). The main contributors to environmental comfort are thermal and lighting conditions in workspaces (Huang, Zhu, Ouyang, & Cao, 2012).

Prior literature provides both objective and subjective evidence on the relationship between thermal environmental comfort and productivity. The objective measurement of productivity showed that job performance increases when the temperature does not exceed 21-22 °C. An increase in temperature by one degree from that point decreases the productivity by 8.9% (Niemelä, Hannula, Rautio, Reijula, & Railio, 2002; Seppanen & Fisk, 2004; Seppanen, Fisk, & Faulkner, 2004). A temperature lower than 20 °C leads to a decrease in physical strength and a reduction in mental performance (Seppanen et al., 2004). Although the research provided quantifiable evidence of the relationship between the fluctuations in temperature and the productivity rate, the subjective measurement of the perceived comfort and thermal stress provides a deeper understanding of the correlates of psychological and physical factors and work output. The evaluation of actual temperature, subjective response to temperature fluctuations and perceived productivity confirmed that high and low air temperatures raise thermal discomfort, which consequently has a negative influence on employees' performance (McCartney & Humphreys, 2002). However, the comparative investigation of reported productivity against the subjective and objective measurements of perceived thermal comfort provides conflicting results. It is not the actual temperature itself that affects perceived productivity, but rather the perception of the temperature and associated comfort that increases performance. Due to the adaptive capabilities of people to maintain the level of thermal comfort irrespective of the change in the thermal environment, people may not sense the surges and drops in temperature. Therefore, it can be inferred that perceived thermal comfort facilitates high performance, while thermal stress undermines productivity. Optimal temperature ranges and the threshold at which the productivity drops vary across the population (Maula et al., 2016). This volatility in the perceived optimal temperature range in offices can be explained by the effect of personal and external factors, such as season, location, culture (cultural preferences) and the type of job activity (Al Horr et al., 2016; S. Kang, Ou, & Mak, 2017; Maula et al., 2016). For instance, the optimal temperature in a season when heating is needed is higher (Z. Wang, Zhang, Zhao, He, & Li, 2011). Also, women tend to have a higher thermal comfort level than men (Mallawaarachchi, De Silva, & Rameezdeen, 2017; Silva, Maas, de Souza, & Gomes, 2017; Z.-j. Wang, Wang, & Lian, 2003).

Evidence exists suggesting that the customisation of environmental conditions makes it possible for automated technologies to contribute to employees' wellbeing, which is the main precondition of productivity. The customisation of indoor environmental conditions is possible through the introduction of intelligent control systems (Agarwal et al., 2010; Dounis & Caraiscos, 2009). For example, automation detection systems can gather data through multiple physical sensors embedded in the physical environment; they analyse data and automatically respond to the changing conditions (Agarwal et al., 2010). Control and automation of the thermal environment may potentially address the challenges related to the management of commercial buildings incurred due to the lack of heating and cooling capacity, system overload and improper system design (Seppanen et al., 2004).

Another contributor to employees' wellbeing is light, which leads to productivity. An environment with poor lighting design can become the source of visual discomfort (P. R. Boyce, 2014; Schuster, 2008). There are three conditions that predefine the visual comfort and wellbeing of employees. The most important condition is a sufficient amount of daylight. A lack of daylight is associated with vision quality and depression (Aries, Aarts, & van Hoof, 2015), while exposure to daylight reduces the psychological and physiological discomfort (Aries, Veitch, & Newsham, 2010). Second, glare, which mainly results from natural lighting, causes discomfort, associated with pain in or around the eyes, headache and/or nausea, as well as red, itchy or watering eyes (Aries et al., 2010; P. Boyce & Wilkins, 2018; Schuster, 2008). Third, the colour temperature of fluorescent lighting showed a significant effect on visual comfort and perceived brightness. Visually cooler (5000 K) lighting, which is brighter than visually warmer (3500K) lighting, negatively affects employees' satisfaction and visual comfort (Wei

et al., 2014). In addition, the level of light brightness can be dependent on the task that employees perform, the time of the day and the season (Juslén, Wouters, & Tenner, 2007; S.-Y. Kim & Kim, 2007). Overall, insufficient high solar load, perceived light quality and glare problems create an unsatisfactory working environment that severely affects employees' productivity (Schuster, 2008). Given the above, the implementation of lighting design strategies is important for organisations aiming to create optimal conditions for effective work. The empirical investigation of responses to lighting conditions, perceived satisfaction and productivity has demonstrated that the controllability of light intensity, the degree of natural light and glare plays a crucial role in achieving visual comfort (Fard, 2006; Leaman & Bordass, 1999). A lack of control over the lighting system is considered to be the biggest concern for building occupiers, since it facilitates the perception of visual discomfort (Leaman & Bordass, 1999). Hence, the perception of visual discomfort is sourced both from the objective indicators of lighting design and the cognition associated with a lack of control over those indicators.

The embeddedness of smart and automated lighting systems positively contributes to employees' psychological and physical wellbeing. They provide both physical control over the environmental conditions and psychological assurance that the conditions are adaptable to individual comfort requirements (Day, Futrell, Cox, & Ruiz, 2019; Leaman & Bordass, 1999; Moore, Carter, & Slater, 2002; Nagy, Yong, Frei, & Schlueter, 2015). The technologies make it possible to stabilise lighting in office spaces by automatically calculating the brightness of natural light based on the time of the day and adjusting office lighting accordingly. Employees can regulate the level of natural lighting through automated blinds and rollers to decrease the pressure on their eyes and eliminate glare (Nagy et al., 2015). The empirical evidence demonstrated that employees are satisfied with the quality and quantity of light produced by automated dimmable lighting systems, sustainable lighting solutions and the luminous conditions they produce. Increased control enables individuals to use lower lighting levels without compromising on perceived visual comfort, which leads to lower energy consumption (Linhart & Scartezzini, 2011; Moore et al., 2002; Nagy et al., 2015). The use of advanced technologies in the workplace addresses the challenge of alleviating adverse lighting conditions. They preserve the autonomy of employees by providing full automation of resources. Occupant control of environmental conditions creates adaptive opportunities for employees who are assigned to workstations that feature various microclimates (Day et al., 2019).

4.3.2 Layout and productivity

Office layout can share either standardised traditional or open-plan office features (Brennan, Chugh, & Kline, 2002). Those features define the lighting, sound and thermal performance of the space and predict the degree to which environmental control can be achieved. The benefits of open-plan versus traditional offices (cellular) in relation to employees' satisfaction, wellbeing and productivity have been debates in the literature (Duffy, 2000; Laing, 1991, 1993). Among the benefits of traditional offices are higher perceived privacy and control over indoor conditions, while their downside is a lower perceived efficiency of work and collaboration with colleagues (De Been & Beijer, 2014). Employees having a higher perception of privacy have a higher job satisfaction rate (Brill & Weidemann, 2001; Sundstrom & Sundstrom, 1986) and a lower likelihood of making work errors (Leaman, 1995). In contrast, employees in open or semi-open plan offices have difficulty with concentration resulting from an increased noise level (Banbury & Berry, 2005; P. Boyce, 1974; Sundstrom & Sundstrom, 1986). Due to relative isolation from the rest of the employees, individuals in traditional workspaces can control the temperature in the room and be more protected from spreading viruses inside the building. Consequently, workers in open-plan offices are more subjected to thermal discomfort, and diseases like cold and flu, which might trigger physical and psychological discomfort and decrease performance (Shafaghat, Keyvanfar, Ferwati, & Alizadeh, 2015). The advantages of open plan-offices are that they increase flexibility, facilitate communication intensity and quality among employees and between employees and their supervisors (Banbury & Berry, 2005; Boutellier, Ullman, Schreiber, & Naef, 2008; T. R. Davis, 1984; De Been & Beijer, 2014; Shafaghat et al., 2015; Sundstrom, Burt, & Kamp, 1980). Open space design in offices creates an opportunity for coworking. Coworking is the phenomenon when

individuals share workplaces with employees representing different organisation teams (Bueno, Rodríguez-Baltanás, & Gallego, 2018). Coworking has a positive influence on employees' productivity through social interactions (Bueno et al., 2018), although it makes it difficult to have confidential conversations (Sundstrom et al., 1980).

Apart from office layouts, design attributes within offices can have an effect on employees' comfort, satisfaction and wellbeing (Ashkanasy, Ayoko, & Jehn, 2014; M. C. Davis, Leach, & Clegg, 2011; Lamb & Kwok, 2016). For instance, large windows make it possible for natural light to come in, which has been found to be a predictor of job satisfaction and increased performance (Andargie & Azar, 2019; Day et al., 2019; Garnier, Muneer, & McCauley, 2015). However, lighting creates issues, such as glare, which is the main source of the employees' headaches, potentially leading to reduced productivity and job satisfaction (Basurto, Kämpf, & Scartezzini, 2017; Kent, Altomonte, Wilson, & Tregenza, 2017; Roshan & Barau, 2016). Solutions have been developed that help reduce or eliminate glare and control lighting conditions organisations, such as automated blinds, roller shades, electrochromic glazing. Automated lighting systems and blinds may automatically change the brightness level and control the blinds to create visual comfort for employees and reduce their exposure to glare (Day et al., 2019).

5. Future research

The review of the literature helped identify a number of research gaps that future projects may want to consider.

Focus on workplaces not just the work itself

The current literature focuses on the role of technology in work processes, disregarding the role it plays in managing workspaces for productivity as well as the wellbeing of employees. To address this gap, future research may consider the following suggestions:

- There is a need to test the effect of smart technologies (e.g. controlling thermal conditions and lighting) on the wellbeing of employees at an individual level and not just the space itself. In examining such effects, it is important to take into account that the perception of comfort is a better indicator when examining the perception of temperature due to the adaptability of the body to changing conditions (Maula et al., 2016)..
- Given that employees' satisfaction is partially dependent on the perceived degree of control over environmental conditions (Fard, 2006; Leaman & Bordass, 1999), future studies need to examine the moderating effect that perceived control has on the relationship between technology use and comfort.
- There is a need to adopt a comparative approach to investigate how indoor environment control systems affect satisfaction and productivity, by focusing on the wellbeing of employees in shared vs. traditional offices. While being able to adjust air quality, temperature and humidity to personal requirements may be feasible for closed spaces, in large open spaces it may create conflicts among individuals. Such a case may offer a proxy for studying how the power and control can be negotiated among individuals and groups and how decision making can affect individual (but also group) satisfaction with the technology.
- Evidence suggests that a connection with the outdoor environment and animals has a positive effect on productivity, although pets may cause hygiene issues and allergies (Barker, 2005; Barker, Knisely, Barker, Cobb, & Schubert, 2012). Smart systems can be used to create the effect of being immersed in the outdoor environment, whereby smart walls would simulate live plants and telecommunication tools will enable virtual interaction with pets. This may substitute for the effect of nature and live animals and eliminate the health-related risks that the latter entail. Therefore, future studies could focus on the question as to whether immersion enabled

by smart technologies can have a similar effect on productivity as live pets and plants in offices do.

- Diversity and inclusion in the workplace is positively associated with productivity (Sumner & Brown, 2015). However, the operation and management of diverse workplaces that are open to people with disabilities and special requirements has been a challenge to date (Schur et al., 2014; Shapiro, 2013; Stein, 2003). The agenda for future studies could include research that examines how smart technologies (e.g. smart cameras and wearable smart trackers, integrated with computer dashboards and health surveillance systems) may tackle such challenges and empower employees with various physical conditions in the office environment.
- Future research needs to examine how smart technologies can be used in different settings (formal vs informal, busy vs relaxed) and at different times of the day (during breaks vs work). This will make it possible to identify how smart technologies can adapt to different work requirements and investigate the relationship with wellbeing and productivity.

Remote digital workspaces: Turning a smart home into an office

Working from home has been practised by a number of organisations. It has been argued that remote workplaces have implications for employees and society, such as employees' flexibility, better time management, the opportunity to oversee family members/dependents, the reduction of carbon emissions, saving on energy and infrastructure, as well as the elimination of traffic congestion (Harpaz, 2002). The installation of smart technologies for employees working remotely reflects the heightened responsibility of organisations for employees' wellbeing and societal impact. Given that smart homes may enable organisations to leverage the benefits of home-based offices, future research should look at how smart home technologies are utilised for working and what consequences they bring.

Therefore:

- There is a need to examine the effect that home-based workplaces, controlled and automated by smart technology, has on employees' perceived productivity and wellbeing.
- The productivity of employees may also result from a feeling of commitment and obligation to a firm, due to physical and monetary inputs invested by the organisation (e.g. an employer may subsidise smart home installations and office equipment) to create favourable environmental conditions for employees. Therefore, future research could examine the mediating role of perceived commitment, obligation and loyalty to organisations in the relationship between smart technology utilisation in homes and productivity. To capture the dynamics of the psychological state of employees, it might be worth adopting a longitudinal approach.

Organisational perspective

The current literature mostly provides evidence on the embeddedness of ICT technologies in the workplace (e.g. (Etro, 2009; Marston et al., 2011), while overlooking the impact of smart devices and solutions on organisational performance. The gap is rooted in the low implementation of smart technologies, which can be partially attributed to organisational factors:

- First, organisations may experience a shortage of the resources required for the successful integration of smart devices. Therefore, future studies may investigate the factors, such as labour force skills, the readiness of organisational structure, the compatibility of existing technological infrastructure with smart devices, which can be barriers to or facilitators of smart technology adoption.

- Second, firms might not be ready to adopt smart technologies due to organisation culture, which may be resistant to any changes towards more intelligent buildings. Organisations may feel distrust towards the technology in terms of the benefits that they bring. Firms' management may hold beliefs that smart technologies pose security, privacy, financial and other threats. Therefore, future studies can investigate the degree to which firms' management are aware of smart technology benefits and identify the challenges/concerns associated with the technology installation.

Personalisation: Making users feel at home

Prior literature focused only on the effect of smart mobile technology utilisation on productivity through the engagement in work-related and nonwork-related activities (Kavanaugh et al., 2012; Khan et al., 2014). However, the utilisation of personal smart technologies goes beyond those activities that may trigger different emotions. There are three assumptions on the use of personal smart devices and suggestions on how future research can test their relation to productivity:

- Smart technologies can help with the remote management of personal chores (e.g. monitoring of a house through smart cameras, arranging the provision of food and water for pets), which may reduce stress and bring positive emotions (i.e. the feeling of relaxation). Consequently, it contributes to psychological wellbeing. By limiting the use of personal smart technology in the workplace, employees might lose their concentration on work-related tasks due to raised stress, growing fatigue and dissatisfaction. A comparative approach can be used to investigate the spectrum of emotions that people feel when personal smart technologies are allowed vs. when they are prohibited in the workplace.
- A digital workplace practice that allows employees to connect to their smart home installations actively may help bring the two closer together and mitigate some of the pressure in the work-life balance. For example, visual interaction with family members or responding to one's home activity may reduce the feeling of guilt due to being distant from one's family and eliminate the associated stress.

6. Conclusion

The objective of this paper was to review and analyse the literature on smart technology utilisation in the workplace in order to identify potential benefits that the technology may bring in terms of productivity and employee well-being. Using a quantitative content analysis of the relevant literature six clusters were generated, namely ICT system design, virtual teams, social networking, mobile devices and cyberslacking, office environment control, office layout and productivity. Following the examination of literature pertaining to these clusters, the topics were grouped into two bigger and overarching themes: digital workplace and productivity. In turn, based on the findings and the research gaps identified, the paper proposed four potential directions for future research: (1) focus on the role of technology in managing workplaces and not just the work itself, (2) implications of smart technologies for remote digital workplaces, (3) organisational factors hindering the adoption of smart technologies in the workplace, and (4) the benefits of the personalisation of technology use in workplaces. Future research could consider the above-mentioned areas and tackle the research avenues suggested under them, advancing our theoretical and practical knowledge in this fast advancing area.

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