International Journal of Knowledge Management
Volume 22 • Issue 1 • January-December 2026

Optimizing the Knowledge Work Environment:

Strategies for Enhancing Knowledge Worker Productivity

Annie Mare
https://orcid.org/0000-0002-0890-6945
University of Pretoria, South Africa

Hanlie Smuts
https://orcid.org/0000-0001-7120-7787
University of Pretoria, South Africa
Received: August 22nd, 2025 | **Accepted:** February 3rd, 2026

ABSTRACT

The built environment has a significant impact on knowledge workers' productivity. Work environments should be designed to address the needs of the workers who inhabit the space to ensure optimal effectiveness in executing their work tasks, thereby increasing their productivity. This paper proposes a user-centered process for workspace design that would allow organizations to improve the capabilities of their work environment continually and address the needs of knowledge workers. A structured literature review was conducted to identify principles for effective workplace design as well as dimensions for testing workplace usability. A focus group was facilitated to enrich the findings emanating from the literature review, where the love and breakup letter method (LBM) was implemented to elicit the needs of office workers. The findings determined that the most significant negative impact on knowledge worker productivity was the implementation of a hot-desk system, and suggested a move towards activity-based workspaces.

KEYWORDS

Human Centered Design, Productivity, Information Systems Knowledge Workers, Work Environment

INTRODUCTION

The productivity of knowledge workers in the information systems (IS) industry is significantly influenced by the design and layout of their work environment. Work environments not designed to accommodate the needs of their occupants can lead to reduced effectiveness, job satisfaction, and team communication, thus causing a reduction in organizational efficiency. Although it is costly to improve the design of a work environment, the increase in knowledge workers' productivity would offset the expense by increasing profits for organizations more so than cutting costs on the design and management of the work environment (Redlein et al., 2020; Wineman & Barnes, 2018). The fourth industrial revolution (4IR) has caused an ever-increasing demand for software and technology, which, in turn, requires software producers to increase the productivity of their knowledge-worker teams (Alsunki et al., 2020; Meyer, 2018; Meyer et al., 2017; Murphy-Hill et al., 2019; Radevski et al.,

DOI: 10.4018/IJKM.401369

2015). Redlein et al. (2020) define knowledge workers as employees with a high degree of expertise, education, and experience, whose main work activities involve creating, applying, and distributing knowledge. However, quantifying the productivity of knowledge workers can be challenging since, unlike most industries where output can be measured against quantifiable input and production time, knowledge-work productivity is more subjective and influenced by many factors, including the social-human and technical (Óskarsdóttir et al., 2022; Ruvimova et al., 2022; Smite et al., 2022; Soto Munoz et al., 2022; Wineman & Barnes, 2018).

Scholars suggest that the most effective way to evaluate knowledge workers' productivity is by assessing individual perceived productivity (Girardi et al., 2021; Smite et al., 2022; Soto Munoz et al., 2022; Virtaneva et al., 2021). Perceived productivity refers to comparing current output levels to historic performance levels (Smite et al., 2022; Soto Munoz et al., 2022). Several factors influence workers' perceived productivity levels, including motivation, work satisfaction, capability, commitment, and effective management, among others (Machuca-Villegas et al., 2022).

Scholars have shown that the work environment has a noticeable impact on the perceived productivity of knowledge workers (Aronoff & Kaplan, 1995; Aufegger et al., 2022; Fahim et al., 2023; Redlein et al., 2020; Wineman & Barnes, 2018). Thus, the work environment must be designed to accommodate the day-to-day activities of a knowledge worker effectively. Windlinger and Tuzcuoğlu (2021) describe usability in the work environment as a human-centered approach to ensuring a high-quality physical environment that can effectively support users' or employees' needs and goals, thereby ensuring they achieve the desired activities or outcomes. Aligning the workspace with worker needs also corresponds with the Society 5.0 philosophy, which aims to place humans at the center of the cyberphysical space for the social benefit of all people (Deguchi et al., 2020).

Workspaces that fail to meet the needs of knowledge workers lead to decreased productivity and employee effectiveness, which, in turn, reduces the overall productivity of the organization (Redlein et al., 2020). An undesirable work environment can also produce a lack of job satisfaction, potentially leading to absenteeism or low engagement, both of which can be extremely costly to organizations (Redlein et al., 2020). Organizations with knowledge workers exhibiting reduced productivity levels may lose their competitive advantage and experience reduced customer satisfaction due to lower work quality and delays in project timelines (Graziotin et al., 2018).

The objective of this paper is to identify how human-centered design (HCD) can be applied to create a work environment that enhances the productivity of IS knowledge workers. The paper addresses the following research question: *How can HCD be used to improve work environment productivity?* The findings can inform the workplace management strategies of organizations, such as facility and workplace design. Effectively managing workspaces enables the optimization of knowledge workers' productivity, thereby increasing competitive advantage and profitability for organizations.

BACKGROUND

The built environment significantly impacts effective operations within an organization, as spaces are constructed with a particular focus or purpose in mind (Windlinger & Tuzcuoğlu, 2021). The usability of a workspace refers to an approach that considers the work environment as a tool and resource, acknowledging that the experience of the occupants (or users) of that workspace is crucial (Windlinger & Tuzcuoğlu, 2021). Therefore, the workspace must be maintained based on its contextual requirements, such as task dependence, user characteristics, and social and technical requirements, rather than merely addressing the indoor and outdoor quality, norms, and standards of the physical building (Kim & Yang, 2020; Kwon & Remøy, 2021; Windlinger & Tuzcuoğlu, 2021).

The International Organization for Standardization (ISO; 2018) defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." Although these ISO guidelines were developed mainly in reference to display terminals, the guiding principles can be applied to situations where

users interact with artifacts, such as systems, products, and services, which, in this study, refers to a workspace.

ISO 9241-11 (2018) also indicates three main dimensions of usability to consider: *Effectiveness* refers to the accuracy or completeness with which the desired output is achieved; *efficiency* refers to the amount of resources expended to achieve the desired accuracy and completeness of a goal; and *satisfaction* refers to the acceptable levels of comfort experienced during use, that is, the user-friendliness of a system, product, or service (Windlinger & Tuzcuoğlu, 2021). Holtzblatt (2011) has highlighted a new potential dimension of usability in the built environment and product design space, whereby "coolness," as a characteristic, impacts the overall experience of engagement as it relates to the human need for joy, accomplishment, connection, and identity. Hence, these usability dimensions should be considered when designing for a more productive work environment.

The Workplace

Typically, people spend the majority of their adult lives working (Middlebrook, 2017). Before the outbreak of the COVID-19 virus, which caused a global pandemic and required strict social distancing regulations, most employees worked in person, at a brick-and-mortar building. However, since the pandemic, workers have shown a preference for working from home (Regodón et al., 2021; Smite et al., 2022; Virtaneva et al., 2021). Nevertheless, once social distancing regulations were relaxed, some employers insisted on a return-to-office policy, citing a lack of culture and camaraderie as the primary motivators (Fan & Moen, 2023; Virtaneva et al., 2021). Some organizations established a hybrid work style that allowed employees to work from home for a limited number of days per week, but others aimed for a 100% return to the office (Fan & Moen, 2023; Smite et al., 2022; Virtaneva et al., 2021).

However, managing the growing cost of prime real estate while balancing the functional needs of a workforce is challenging (Wineman & Barnes, 2018). This issue compelled organizations to search for innovative ways of designing their work environments to meet their employees' needs by ensuring workplace satisfaction and well-being while boosting efficiency and productivity (Wineman & Barnes, 2018). Different types of organizational office spaces, such as cell offices, shared room offices, open plan offices, and flexible or combined offices, have been shown to impact employees differently (Vilnai-Yavetz & Rafaeli, 2021).

Table 1 illustrates recommendations by Wineman and Barnes (2018) for requisite activities in workplace zones, including workplace settings, to facilitate business drivers such as productivity, innovation, and efficiency.

Table 1. Workspace Design Should Support Workspace Objectives

Business Drivers	**Activities**	**Workplace Zones**	**Workplace setting**
Productivity *Innovation* *Culture* *Communication* *Service* *Efficiency*	Research Write Review Coordination	Focus	Individual workspaces Private offices Quiet/focus rooms Touchdown spaces
	Consensus Review Coordination Collaboration	Team	Huddle room Team room Conference room Training room
	Culture Connection Collaboration	Community	Central gathering spaces Cafeterias and refreshment stations Wellness and relaxation rooms Open collaboration areas
	Connection	Support	Service centers Personal storage

Note. Adapted from "Workplace Settings," by J. D. Wineman and J. Barnes, 2018, *Environmental Psychology and Human Well-Being*, p. ##. Copyright 2018 by Elsevier.

Team-based activities, such as reaching consensus, group reviewing, team coordination, and collaboration, should take place in huddle/team rooms, conference rooms, and training areas (Wineman & Barnes, 2018). Activities that stimulate organizational culture, team cohesion, and collaboration should be conducted in central gathering spaces, such as cafeterias or refreshment stations, wellness or relaxation rooms, and communal spaces (Wineman & Barnes, 2018). Lastly, support areas, such as service centers and personal storage areas, are needed to enhance worker efficiency and foster connection (Wineman & Barnes, 2018).

The activity-based workplace (ABW) is one of the most current schools of thought in the workplace management sphere (Shivakumar, 2022; Tagliaro et al., 2022; Wineman & Barnes, 2018). An ABW is an office space built around the concept of shared spaces. Under this philosophy, a variety of work areas are provided to employees, each for an employee's discrete task type (Wineman & Barnes, 2018), producing a space-effective layout. However, for the system to work effectively, it must be well executed. One of the main criticisms of ABW is that if executed poorly, employees might lack the necessary equipment to perform their tasks effectively. The successful implementation of an AWB also depends on the culture, norms, governance, and structure of the organization (Wineman & Barnes, 2018). This shift toward more informal workspaces fosters creativity and productivity in organizations, and the creation of stress-free zones moves an organization toward becoming more mindful of its employees' well-being (Tagliaro et al., 2022).

Social Sustainability and the Society 5.0 Philosophy

The need for ever higher levels of productivity is taking a toll on the well-being of workers (Bonello et al., 2023; Velasco et al., 2022; Vilnai-Yavetz & Rafaeli, 2021; Wineman & Barnes, 2018). The need to safeguard the workforce engendered the Society 5.0 philosophy, encouraging approaches such as sustainability (including social, economic, and environmental sustainability), human-centeredness, and resilience (Bonello et al., 2023; Deguchi et al., 2020). This philosophy not only benefits many able-bodied workers but also empowers people with disabilities. Disability inclusion forms part of the United Nations 2030 Sustainable Development Goals.

Employee Experience and Well-Being

Employee well-being focuses on aspects such as physical health, happiness, and comfort levels, whereas employee experience refers to the effectiveness, efficiency, and satisfaction of an employee concerning their work and work environment (Mohezar et al., 2021; Velasco et al., 2022; Vilnai-Yavetz & Rafaeli, 2021; Wineman & Barnes, 2018). Redlein et al. (2020) mapped employee workplace needs onto Maslow's hierarchy of needs, as shown in Figure 1. The authors plotted employee needs on a scale ranging from well-being to wellness against the traditional five segments of Maslow's hierarchy: physiological needs, the need for safety, belonging, esteem, and self-actualization.

Figure 1. Maslow's Hierarchy of Needs in the Workplace

Note. Adapted from "Workplace Management," by A. Redlein, C. Höhenberger, and P. Turnbull, 2020, Modern Facility and Workplace Management: Processes, Implementation and Digitalisation, Copyright 2020 by Springer.

The physiological needs of a worker include good air quality, thermal comfort, appropriate lighting, physical comfort, sound and noise management, access to healthy food and an acceptable space and time to consume it, adequate movement, a connection to nature through biophilic designs that reduce carbon dioxide levels and improve productivity, views of the outdoors, natural daylight, sufficient artificial lighting, and employee health (Redlein et al., 2020).

Safety in the workplace correlates with employees' need for stable and predictable work environments where certain rituals and routines can be maintained. Treating all workers fairly emphasizes this principle, along with clear work instructions and realistic work schedules (Redlein et al., 2020). The author further stresses the following aspects:

- Strict boundaries concerning after-work activities prevent burnout.
- Programs that encourage employees to grow, learn from failures, build resilience, and improve their performance provide them with the opportunity and ability to manage work-related stress.
- Virtual and physical privacy is essential.
- Ergonomic furniture and equipment ensure employees are safe both physically and mentally.
- Office layout should enable downtime from work activities and be optimized for task-based work.

Redlein et al. (2020) further state that belonging concerns the need for employees to feel connected with their coworkers and the organization they work for. Open

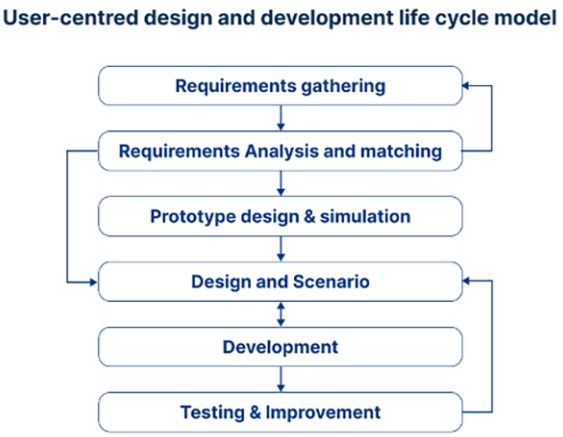
communication drives team and office culture and should be mindfully maintained for remote workers, who often feel left out. Self-managed work requires effective and honest communication from both employees and management. Community gathering spaces foster camaraderie and help coworkers connect. Team members should also be stationed within a minimal walking distance, preferably with visual access to foster better communication (Redlein et al., 2020).

Moreover, achievements must be acknowledged and praised to satisfy the need for self-esteem, because it positively impacts employee well-being, and work should be conducted in task-based work zones that offer variety and engage employees' senses (Redlein et al., 2020). The author emphasizes trust, respect, and transparency between employees and management to encourage a culture of openness within the organization (Redlein et al., 2020). Employees should be involved in decisions, especially if they affect the workers' well-being and workloads.

Lastly, Redlein et al. (2020) state that self-actualization refers to the feeling of fulfilment and empowerment an employee experiences from working at an organization. This aspect includes an employee's ability to dictate their work setting or location, the abolishment of hierarchy and role-based privileges, employees' perception that their work is impactful beyond organizational profits, as well as shared values, goals, and aspirations between employees of the organization (Redlein et al., 2020).

In their study on designing work environments for people with disabilities, Kbar et al. (2016) implemented a five-stage, iterative design process to ensure formulation of the work environment with human-centeredness in mind. The five stages included requirements gathering, analysis and matching; prototyping and simulation, designing and scenario testing, environmental development, and testing and improvement (Kbar et al., 2016). Figure 2 illustrates the user-centered design (UCD) and development life-cycle model used in that study.

Figure 2. User-Centered Design and Development Life-Cycle Model



Note. Adapted from "Utilizing Sensors Networks to Develop a Smart and Context-Aware Solution for People with Disabilities at the Workplace (Design and Implementation)," by G. Kbar, A. Al-Daraiseh, S. H. Mian, and M. H. Abidi, 2016, International Journal of Distributed Sensor Networks, 12(9), Article 1550147716658606. Copyright 2016 by Sage.

Achieving synergy between the knowledge worker and their work environment requires the inclusion of HCD, which considers the social, physical, psychological, and biological impact of the work environment on the individual (Velasco et al., 2022). Ensuring that the work environment

accommodates knowledge workers' needs can enhance the productivity and effectiveness of the workforce in an IS organization.

Ergonomics

Ergonomics is the science and technology of molding tasks, activities, and environments to match people's capabilities, thereby enhancing comfort as well as the individual's health and safety (Mohezar et al., 2021). Ergonomically designed workplaces are proven to improve productivity and increase the quality of work produced because they minimize musculoskeletal discomfort and maximize well-being (Chim, 2019; Silva e Santos & Soares, 2016; Felekoglu & Ozmehmet Tasan, 2022; ISO, 2018; Mohezar et al., 2021; Velasco et al., 2022). Ergonomics should apply to both work and nonwork areas, including overall office layout and the design of workstations, storerooms, restrooms, canteens, and so on (Chim, 2019).

Ergonomics can be divided into three dimensions: physical, cognitive, and organizational. Physical ergonomics assesses the physical workload during a worker's workday, including muscle fatigue, postural comfort, and physical stress, which can be managed through thoughtful work environment design and the availability of resources that support healthy posture (Mohezar et al., 2021; Velasco et al., 2022). Cognitive ergonomics considers the mental processing and perception a worker engages in to complete a task. These can be managed by mitigating task complexity or creating capabilities that reduce the probability of human error and dependency on worker memory or level of expertise (ISO, 2018; Velasco et al., 2022). Organizational ergonomics concerns optimizing sociotechnical systems, such as structures, policies, and processes. The latter is the least-studied dimension of ergonomics, although some topics investigated in the past have included work design and work time design (Velasco et al., 2022).

The management of ergonomic risk to maintain employee health and well-being is crucial for sustaining high efficiency and enhancing commercial gain (Felekoglu & Ozmehmet Tasan, 2022). Workstations should be suitably furnished according to the relevant task to be accomplished; wheelchair access should be provided, and individuals with permanent or temporary disabilities should be considered (Chim, 2019). In addition, workstations should account for both left- and right-handed individuals, pregnant women, individuals outside of the fifth and 95th physical percentile, and any other potential user group (Chim, 2019). The potential occupants of a workspace should constantly be analyzed and included in the continual, iterative design to ensure effective workspace design for all employees.

RESEARCH APPROACH

This interpretive, qualitative study followed a two-step approach to data collection (Oates et al., 2022). First, the researcher conducted a structured literature review (SLR) to gain a deeper understanding of the current body of knowledge on how HCD can be utilized to design workspaces that enhance knowledge-worker productivity. Second, the study convened a focus group to enrich the findings of the SLR by using the love and breakup letter method (LBM) to collect knowledge workers' perceptions of which elements and characteristics of their work environments positively or negatively impact their productivity, per the methods applied by Laughey et al. (2021) and Timár (2023). LBM is a qualitative data gathering technique that requires the research participant to personify an object, such as an office, which helps uncover preferences, emotional attachments, unmet needs, and likes and dislikes by allowing the participant to write reflectively (Cirucci & Pruchniewska, 2022; Gerber, 2011; Laughey et al., 2021; Timár, 2023).

SLR

An SLR aggregates, assesses, and synthesizes information within the existing academic body of knowledge; it evaluates peer-reviewed research to reduce potential bias and increase the overall

validity of the research (Lame, 2019; Nightingale, 2009; Oates et al., 2022). The systematic approach to literature search and analysis framework (search, appraisal, synthesis, and analysis) is a method for conducting an SLR, allowing for accurate data gathering through an exhaustive search of existing literature (Grant & Booth, 2009; Mengist et al., 2020). However, this study utilized the methodology recommended by Kitchenham and Charters (2007) and Boland et al. (2017), namely the planning, conducting, and reporting stages.

A researcher defines the research questions and establishes the review protocol during the planning stage, and the search strategy is defined along with the search criteria in the review phase. In this stage, a study establishes the quality assessment criteria and specifies the data extraction strategy. Thereafter, the data are analyzed and evaluated for quality. During the reporting stage, the data analysis findings are discussed, finalized, formatted, and evaluated to ensure rigor (Boland et al., 2017).

This study included literature written from 2011 to 2024 in the planning stage, which was the start of the 4IR (Taiwo & Vezi-Magigaba, 2021). The reason for using 4IR as an exclusion method is that the fast-paced evolution of technology enabled the implementation of these technologies in the workspace. This evolution compelled digital transformation and became pervasive in business processes, automation, and customer engagement (Taiwo & Vezi-Magigaba, 2021). During the conducting stage, the search terms were as follows: [Title] "Workplace" OR "Work environment," [Key Words] "Human-centred" OR "Human-centered" AND "Work environment design" OR "Workplace design" AND "Productivity." One hundred and sixty-six papers were identified by searching the electronic database Google Scholar. The study chose Google Scholar since it searches across multiple relevant databases that reference business and organizational management (Alotaibi & Johnson, 2020).

The study applied the following exclusion criteria to evaluate the records:

- articles not available in English
- articles not published in peer-reviewed journals or conference proceedings
- articles not relevant to the IS industry, to prevent analyzing literature related to different primary subject matter
- research not focused on the impact of the physical environment on productivity but rather on remote work

The study excluded 110 papers for being theses, lacking relevance to the research questions, or focusing on the architecture of physical structures, leaving 56 papers to examine. Those 56 papers were published in the following journals: *Association for Computing Machinery* (*ACM*), Springer, *IOS Press*, *Journal of Industrial Engineering and Management* (*JIEM*), *Multidisciplinary Digital Publishing Institute* (*MDPI*), Elsevier, Sage Publishing, Taylor & Francis, *Management Information Systems Quarterly* (*MISQ*), *Emerald*, and ProQuest, as depicted in Table 2.

Table 2. Articles Identified per Database

Database	Records identified	Records included	Records excluded
ACM	1	0	1
Elsevier	9	4	5
Emerald	3	3	0
Frontiers	1	0	1
IOS Press	6	2	4
JIEM	1	0	1

continued on following page

Table 2. Continued

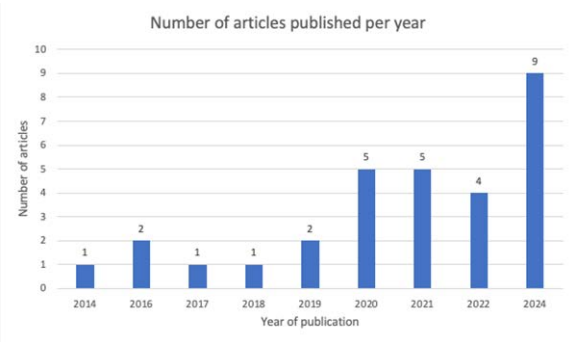
Database	Records identified	Records included	Records excluded
MDPI	6	1	5
MISQ	1	1	0
MPER	1	1	0
ProQuest	1	1	0
Routledge	2	2	0
SAE	1	0	1
Sage Pub	4	3	1
Springer	15	9	6
Taylor & Francis	4	3	1
Grand Total	**56**	**30**	**26**

Note. ACM = Association for Computing Machinery; IOS = International Organization for Science; JIEM = *Journal of Industrial Engineering and Management*; MDPI = Multidisciplinary Digital Publishing Institute; MISQ = *Management Information Systems Quarterly*; MPER = *Management and Production Engineering Review*; SAE = *Society of Automotive Engineers*; Pub = Publishing.

The researcher examined the article abstracts for relevance to the research question and excluded 26 articles. The remaining 30 articles were examined and coded, and thematic analysis was performed. The themes in the literature were identified using a combination of open and descriptive coding. Open coding allows researchers to assign meaning to data vis-à-vis observations of phenomena, whereas descriptive coding allows researchers to synthesize concepts and phrases captured during the data-gathering process without the context attached (Leedy et al., 2014; Pandey & Pandey, 2021, p. 15; Strauss & Corbin, 1998, p. 101).

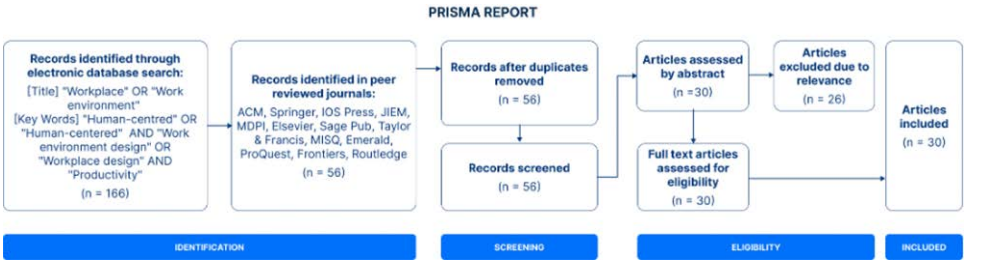
Of the included articles, the highest number of publications were from 2021, as five articles related to work environment improvements for increased productivity, depicted in Figure 3. The second-highest number of publications was from 2020, with four articles identified. In 2016, 2019, and 2022, respectively, two publications emerged. Only one relevant article was identified for 2014, 2017, 2018, and 2024.

Figure 3. Publication Years of Included Records



This SLR used the preferred reporting items for systematic reviews and meta-analyses (PRISMA) reporting guidelines. Figure 4 depicts the PRISMA diagram for this study.

Figure 4. Preferred Reporting Items for Systematic Reviews and Meta-Analyses Diagram



Note. ACM = Association for Computing Machinery; IOS = International Organization for Science; JIEM = Journal of Industrial Engineering and Management; MDPI = Multidisciplinary Digital Publishing Institute; Pub = Publishing MISQ = Management Information Systems Quarterly.

The last step of the SLR, namely the reporting stage, included the findings from the analyzed literature and the focus group, discussed in Sections 4.1. and 4.2, respectively.

Focus Group

A focus group allowed the researcher to obtain the perspectives of a group of individuals with similar experiences on a specific phenomenon within a defined environment (Mwilongo, 2025; Smithson, 2008; Susanto et al., 2024). Focus groups allow researchers to collect many perspectives and opinions on a specific topic in a short period (Mwilongo, 2025; Smithson, 2008; Susanto et al., 2024). This focus group aimed to enrich the literature review findings by utilizing the LBM to elicit the perspectives of IS industry partitioners on the elements and characteristics of their work environments that they perceive as either positively or negatively influencing their productivity. As suggested by the literature review findings, the process of designing and improving a workspace must include the users throughout; thus, the qualitative data gathered during the focus group could enable the implementation of HCD processes for improving IS work environments.

The study selected the focus-group participants based on their knowledge of the subject matter (Mwilongo, 2025; Smithson, 2008; Susanto et al., 2024). The following selection criteria were used to identify potential participants:

- The participant identifies as an IS knowledge worker.
- The participant works from a physical office location regularly.
- The participant's work objectives include creating IS artifacts or managing teams that produce IS artifacts.

A typical focus group consists of 6 to 12 participants, with an interviewer facilitating the discussion by asking questions stipulated in the focus-group protocol and follow-up questions based on the discussion to gain more clarity (Mwilongo, 2025; Smithson, 2008; Susanto et al., 2024). For this study, nine users were selected through a combination of convenience and purposive sampling. Table 3 presents the participants' role distribution.

Table 3. Roles of Participants Selected for the Focus Group

Role	Rationale for inclusion	Number of participants
Software developers	Software developers play a critical role in IS product delivery. Optimizing their work environment for increased productivity could result in a significant competitive advantage for IS organizations.	3
Designers	This role includes user experience and user interface designers, who play a major part in the initial development and continual improvement of the IS product. Maintaining high productivity in these roles ensures high quality and reduces the risk of project bottlenecks.	3
Service delivery	This role includes sales, client relations, and project management. Although these roles are not directly involved in the production of IS products, they ensure products are delivered on time and to an agreed-upon standard. Thus, their productivity is critical to overall project success.	3

Note. IS = information systems.

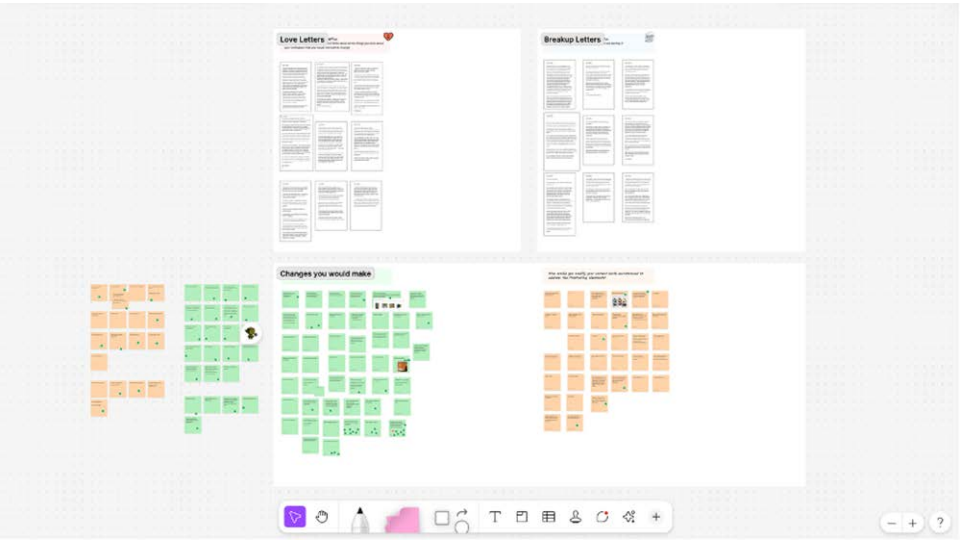
A focus-group protocol was created to keep the discussion focused on the phenomenon being investigated. The discussion points for this focus group aimed to gather insights into elements of IS work environments that knowledge workers perceived as positively or negatively impacting their productivity, as well as to validate the findings from the literature. Table 4 represents the focus-group protocol containing three discussion points created for this study.

Table 4. Focus-Group Protocol

Focus-group questions
Write a "love letter" and a "breakup letter" to your current work environment. In these letters, list all the things you currently like or dislike about your work environment, considering the impact on your productivity.
How would you modify your current work environment to address the frustrating elements?
How would you enhance the features of the work environment that you like?

The researcher conducted the two-hour, in-person focus group at a location convenient for all participants and that posed minimal risk of disruption. The session was facilitated on a FigJam board (https://www.figma.com/figjam), which is a digital whiteboard designed by Figma (https://www.figma.com/) that allows participants to collaborate digitally by adding images, sticky notes, or comments and voting or reacting to other participants' comments with symbols such as stars, hearts, or plus-one votes, as illustrated in Figure 5.

Figure 5. Screenshot of the Collaboration Tool Used for the Focus Group (FigJam)



Note. This figure is for illustrative purposes only. The section below discusses the content in detail.

The FigJam board was set up beforehand, designating a particular location on the whiteboard for addressing each discussion point in the focus-group guide. The researcher provided the focus-group protocol (Table 4) to the participants and asked them to complete the informed consent forms before the session commenced. The session was recorded to allow for richer data analysis. The data from the session recording and the *FigJam* contributions were cleaned and thematically analyzed.

DATA ANALYSIS AND FINDINGS

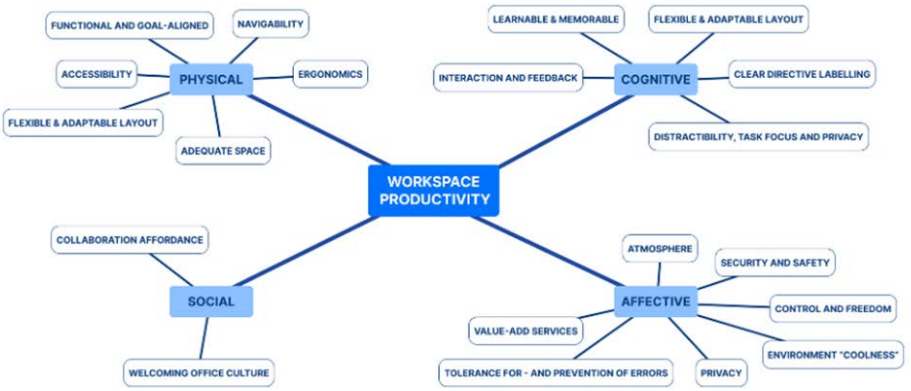
The following section discusses the findings that arose from the literature review and focus group.

SLR

The researcher conducted this literature review to identify themes in the existing literature that point to effective ways to design a workspace for enhancing productivity. The findings from the SLR also informed the questions and discussion points in the focus group, as discussed in Section 3.2.

The study identified four main themes and 20 subthemes through the SLR, visualized in Figure 6 as a network diagram (Kruskal & Seery, 1980). These themes relate to how knowledge workers are affected by the workspace design, including physically, cognitively, socially, or affectively, that is, their moods, feelings, and attitudes. Each of these influences is subdivided into the components of the work environment and their effect on the knowledge worker's productivity. The appendix contains the data extraction table representing the visualization in Figure 6.

Figure 6. Visual Mapping of Workplace Productivity Influencers and Their Related Components



The work environment components that physically affect workers include workspace functionality and goal alignment, accessibility, flexibility, and adaptability to accommodate different usage needs, navigability, ergonomic capacity, and adequate space for them to perform their tasks and rest as needed. The identified cognitive influences included that the workspace must be easy to learn and memorize, with a flexible and adaptable layout to prevent cognitive overload, increase privacy, provide clear and directive labels if needed, minimize distractions, optimize task focus, and allow for privacy, and, lastly, facilitate adequate interaction and feedback to optimize environmental usage. The SLR identified social influencers within an office environment, namely its utility for collaboration and the cultivation of a welcoming office culture within the work environment. The findings of the SLR further identified environmental elements that influence knowledge workers' affective state, such as the capability of a workspace to provide adequate privacy and the tolerance for and prevention of errors. Workers are also affected by the capacity of a work environment to provide safety and security, as well as their ability to control environmental elements, such as temperature and lighting, to match their preferences. The availability of quality-of-life benefits and the perceived coolness of the working environment also positively influence workers.

Focus-Group Thematic Analysis

The focus group aimed to enrich the findings of the SLR by eliciting requirements and needs within an IS organization by using LBM. The participants were then asked to extract the main themes from their letters, pointing to what they would do to enhance the elements of their work environment that positively impact their productivity and what they would change regarding the elements that negatively impact productivity. A combination of open coding, themes identified from the focus-group data itself, and closed coding, based on the productivity influencers identified in the literature (Figure 6), was used to identify themes from the focus-group data.

The participants indicated that the hot desk system implemented in their office had a significant impact on their productivity. They found it disruptive to their productivity when they could not find a workstation that suited their needs or was in an uncomfortable position, such as a desk facing a wall, with excessive lighting, or in a noisy section of the office. This aspect corresponded to the findings derived from the SLR, which indicated that workers preferred workspaces where they had control over the environmental elements of their workstations and the need for privacy.

The hot desk system also meant the participants had to find working equipment for their workstations, which they felt wasted time and impeded their productivity. They also indicated that a lack of adequate

equipment was an issue, with poorly implemented ABW (Kim & Yang, 2020; Shivakumar, 2022; Tagliaro et al., 2022; Wineman & Barnes, 2018), suggesting that organizations should primarily focus on providing their staff with adequate and easily accessible equipment. This aspect aligns with the SLR findings, proposing that the work environment should be functional and goal oriented. The participants recommended dedicated workstations with assigned equipment, such as keyboards, mice, and monitors. This arrangement would allow them to personalize their workstations, which researchers have shown to impact productivity positively (Ronald & Jan, 2020; Sari, 2020).

If a hot desk system is the only available option for managing seating arrangements, the participants recommended implementing a workstation booking system so employees could know which workstations were available and reserve their workstation for the day. This recommendation correlates with the need for appropriate interaction and feedback in the work environment, as identified in the SLR findings. An apt solution like this could also enhance the navigability of the work environment and reduce the mental toll of having to identify an available workstation upon arrival at work.

Having a dedicated location where equipment is stored or a team that can manage the distribution of equipment can speed up the process of locating equipment. This feature would also increase accessibility, improve the flexibility and adaptability of each workstation, and reduce the frustration of searching for work equipment.

Similar to the SLR findings, the focus group also indicated that noise negatively impacted knowledge workers' productivity and focus levels. Hence, the participants suggested adding indoor plants and acoustic furniture to help absorb noise. The participants further required adequate space for conducting meetings, attending to quiet, solo work, and collaboration between coworkers. Boardrooms should preferably be managed with a booking system to ensure employees know when the meeting space is available. The participants further stated that the availability of indoor and outdoor relaxation areas for unwinding and resting between work ensured effective management of mental and physical well-being, which might lead to increased productivity. This aspect aligns with similar findings in the literature, stating that happy workers are more productive workers (Azizi & Lemski, 2020; Girardi et al., 2021; Graziotin et al., 2013; Johnson et al., 2019; Redlein et al., 2020).

The focus group identified employee comfort as a positive influence on knowledge workers' productivity. Having comfortable, ergonomic chairs and desks, acceptable office hygiene measures, adequate natural light, and a comfortable temperature contributed to improved productivity levels. Similar to the SLR findings, the participants indicated that access to beneficial amenities, such as office snacks or subsidized food, increased their job satisfaction and added to the coolness factor of the organization, thus increasing worker productivity. These factors correlate with Redlein et al. (2020), who have found that workers' physiological needs, such as quality thermal comfort, lighting, physical comfort, sound and noise management, access to healthy food, among other things, form the basis of their workspace requirements.

The participants also mentioned office layout and departmental positioning as productivity influencers due to their impact on the collaborative utility of the work environment. Team members should be positioned sufficiently closely for effective communication, but the intermingling of department members, such as designers and developers, might lead to distracting conversations around differing work goals. The focus group discussed designated locations for certain activities, such as meetings, collaborative or solo work, and lunch breaks, as a solution that would align the goals of the individuals using a specific space. This solution suggests that the ABW would be an effective workspace design framework to follow because it aligns with the need to create a functional and goal-oriented work environment.

Based on the focus-group data, the literature review findings align with the needs of practitioners in the IS industry. These insights can assist in developing strategies for implementing measures within IS work environments to enhance knowledge-worker productivity.

DISCUSSION

The previous section integrated data from the SLR and focus group, thereby informing the recommended strategies for implementing improvements to the design of a work environment to increase knowledge-worker productivity. Table 5 presents the strategic objectives for optimizing a productive knowledge-work environment along with a roadmap to guide the implementation of the strategic components through the UCD life cycle, as shown in 2.

Table 5. Strategic Objectives for the Optimization of a Productive Knowledge-Work Environment

Strategy	**Objective**	**Strategic Action**	**Justification**
Focus on Accessibility	To ensure the work environment is accessible to all staff members, the following should be addressed: reducing the risk of physical injury, mental fatigue, or visual strain; evaluating the work environment regarding adherence to accessibility regulations; acquiring furniture and tools that adhere to ergonomic standards; exploring possibilities for providing employees with more freedom and control regarding their environment; evaluating the work environment to ensure a high tolerance for errors and taking precautions to prevent employee errors	Ensure the work environment is accessible to individuals with auditory, motor, cognitive, or psychological impairments. Ensure adequate safety regulations and error prevention mechanisms are in place. Optimize workspace ergonomics by examining the regular behaviors of the workforce, evaluating the risks to musculoskeletal health, and providing procedures and equipment to facilitate improved ergonomics. Identify and implement methods and tools through which a worker could gain greater control over the characteristics of their work environment. Identify and implement well-considered systems that can provide insightful and impactful feedback to the worker regarding their environment.	Addresses the following productivity influencers: accessibility ergonomics control and freedom interaction and feedback tolerance for and prevention of errors clear directive labeling
Refine atmosphere	To ensure safe and pleasant working conditions for staff, the atmosphere within the work environment must be regulated to maintain adequate quality and standards	Ensure proper ventilation by providing access to fresh air through access points, such as windows, or by implementing a ventilation system to control the air quality inside the building. Implement acoustics and noise control through furniture, building architecture, or sound-absorbing materials. Provide access to greenery through decorative placement inside the building. Provide access to an outside common area. Provide visual stimuli through interior design. Ensure employees feel at ease by ensuring adequate safety and security protocols are in place.	Addresses the following productivity influencers: atmosphere security and safety
Optimize office layout	To manage the dispersion of office occupants strategically for optimizing focus and minimizing distractions while maintaining collaborative capabilities between team members and preserving individuals' privacy	Evaluate the typical behavior between office occupants within the current office layout. Engage with office occupants on their needs and requirements in terms of collaboration, distraction, and privacy. Use codesign to plan the distribution of teams, workstations, and other coworking areas. Implement the suggested office layout and test for effectiveness.	Addresses the following productivity influencers: distractibility, task focus, and privacy functional and goal-oriented work environment collaboration affordance

continued on following page

Table 5. Continued

Strategy	**Objective**	**Strategic Action**	**Justification**
Implement Activity-based workspaces	To ensure optimal usage of the work environment and facilitate the various types of work activities conducted within the organization, and to set out activity-specific work areas adequately provided with equipment to ensure functionality and usefulness	Identify the core tasks of staff members, such as collaborative activities, solo work, quiet or focus work, relaxation, and socialization. Designate areas where these activities will take place. Adequately supply each area with equipment and furniture that best fit the usage needs. This action could include private meeting pods, movable and flexible furniture for ad-hoc layout changes, boardrooms, or smaller breakout rooms for collaborative sessions, among other things. Stipulate and demarcate the rules of engagement for each designated area to ensure the workforce understands their purpose and what behavior is acceptable within these areas.	Addresses the following productivity influencers: functionality and goal-alignment flexible and adaptive layout navigability collaboration affordance learnable and memorable adequate space
Solidify organizational culture	To cement a people-centered, caring organizational culture to ensure that all strategic activities advocate for the needs of the people within the organization.	Determine the shared values and beliefs guiding organizational practices. Ensure staff well-being is considered. Provide value-adding, quality-of-life amenities that increase employee satisfaction, retention, and loyalty. Build an organizational brand and ensure it permeates the workspace. Create a cool atmosphere and environment that inspires connection, accomplishment, identity, satisfaction, and comfort within the workforce.	Addresses the following productivity influencers: value-adding amenities environmental coolness welcoming office culture

The strategies above were proposed based on the themes identified during the SLR and focus group. The actions emanating from the strategies deconstruct the various tasks and activities recommended by the literature and focus-group participants to address the identified themes upon which the strategies are based and justified by the subthemes illustrated in Figure 6. The strategic objectives for optimizing a productive workspace include focusing on accessibility within the work environment to ensure that all individuals have equal access and opportunities; refining the atmosphere within the workplace to ensure safe and pleasant working conditions for staff by maintaining quality and safety standards; enhancing the office layout by strategically managing the distribution and dispersion of office occupants and workstations to minimize distraction while optimizing collaboration; implementing ABW to ensure the optimal usage of available space and that employees can perform all their work activities at maximum efficiency; and, lastly, solidifying a people-centered organizational culture to meet the needs and well-being of the people within the organization, thereby ensuring job satisfaction, retention, and loyalty.

The strategic objectives and their accompanying strategic actions can be implemented iteratively by applying a user-centered process for workspace design based on the UCD lifecycle (refer Figure 2). The user-centered process for workspace design consists of six stages: requirements gathering, requirements analysis and matching, prototyping and simulation, design, development, and evaluating the effectiveness of the solutions.

The first step in the user-centered process for workspace design involves requirements gathering, as users must be involved early-on in the design process (Bauer et al., 2019; Chim, 2019; Dery et al., 2017; Doussard et al., 2024; Silva e Santos & Soares, 2016; Felekoglu & Ozmehmet Tasan, 2022; Kbar et al., 2016; Kim & Yang, 2020; Kwon & Remøy, 2021; Mohezar et al., 2021; Nappi & de Campos Ribeiro, 2020; Panariello et al., 2021; Papetti et al., 2022; Regodón et al., 2021; Windlinger & Tuzcuoğlu, 2021; Wineman & Barnes, 2018). The LBM proved a highly effective tool for eliciting design requirements and other qualitative prerequisites from the research participants, such as the desired office culture, social factors, group cohesion, and emotional needs; therefore, it is recommended as a requirements elicitation method for this step. The participants felt freer to

express their concerns since writing a letter to their office felt like a playful activity. Thus, this technique can be used during the requirements-gathering phase to determine the needs and prerequisites of office occupants. Other qualitative data-gathering methods, such as surveys and interviews, can also be used (Myers & Avison, 2002; Myers & Newman, 2007).

Next, the paper analyzes and plots the list of the office occupants' needs in order of priority to match the business drivers and activities, such as productivity, innovation, culture, communication, service, and efficiency, to align with the strategic objectives of the organization (Bauer et al., 2019; Doussard et al., 2024; Silva e Santos & Soares, 2016; Kim, 2014; Kim & Yang, 2020; Kwon & Remøy, 2021; Mohezar et al., 2021; Nappi & de Campos Ribeiro, 2020; Panariello et al., 2021; Redlein et al., 2020; Regodón et al., 2021; Windlinger & Tuzcuoğlu, 2021; Wineman & Barnes, 2018). Once a subset of needs has been selected for improvement, the current capability of the office to address such needs should be measured.

After determining the current office performance metrics, the simulation and prototyping phase can begin. During this phase, designers should apply lateral thinking to find creative, effective solutions to the identified problems, within the limitations and capabilities of the organization. Once a collection of potential solutions has been identified, the effectiveness of each solution should be tested to determine its capacity to solve the identified problem. The prototype should undergo iterative improvements until the desired results are achieved (Kbar et al., 2016; Kwon & Remøy, 2021).

Subsequently, the prototype should be used to design the implementation of the chosen solution. Continuous user testing ensures alignment with the users' needs and goals (Chim, 2019; Dery et al., 2017; Doussard et al., 2024; Felekoglu & Ozmehmet Tasan, 2022; Kbar et al., 2016; Kwon & Remøy, 2021; Mohezar et al., 2021; Nappi & de Campos Ribeiro, 2020; Panariello et al., 2021; Papetti et al., 2022; Regodón et al., 2021; Windlinger & Tuzcuoğlu, 2021; Wineman & Barnes, 2018). Once the design phase is completed and the organization has signed off on the selected solution, the development phase can start (Kbar et al., 2016; Kwon & Remøy, 2021). At the conclusion of the development phase, the capability of the workspace to address the users' needs should be reevaluated by measuring the dimensions used during phase two. Based on the findings of these tests, iterative improvements can be made to enhance workspace performance and better address the office occupants' needs (Chim, 2019; Dery et al., 2017; Doussard et al., 2024; Felekoglu & Ozmehmet Tasan, 2022; Kbar et al., 2016; Kwon & Remøy, 2021; Mohezar et al., 2021; Nappi & de Campos Ribeiro, 2020; Panariello et al., 2021; Papetti et al., 2022; Regodón et al., 2021; Windlinger & Tuzcuoğlu, 2021; Wineman & Barnes, 2018).

This process can guide the design of a human-centered work environment for improved productivity in IS workspaces. Organizational endorsement is critical for the successful implementation of the design process.

CONCLUSION

The built environment significantly impacts knowledge workers' productivity. Implementing effective workplace management and designing the correct workplace setting for knowledge workers to thrive is a critical business function that could help increase organizational productivity. This study aimed to understand how UCD could be applied to create work environments that enhance IS knowledge workers' productivity. This aim was achieved by performing an SLR to understand the current body of knowledge around the design of productive IS workspaces; thereafter, a focus group was conducted to enrich the literature review findings by using the LBM as a requirements-gathering tool to identify office occupants' needs.

The SLR identified four dimensions in which the characteristics of a work environment could influence a knowledge worker's productivity. The worker can be physically influenced by the following work environment components: alignment between functionality and goals, accessibility, flexibility and adaptability of the layout, navigability, ergonomic quality, and adequate space. Workers can be

cognitively influenced by the learnability and memorability of the workspace, as well as the flexibility and adaptability that prevent them from becoming overwhelmed and increase the perception of privacy. In addition, clear directive labeling, the ability to focus on tasks, and the interactions within and feedback received from the workspace influence cognition. The collaboration affordance or the workspace layout can influence workers socially, and office culture can affect them either positively or negatively. Workers' perception of privacy can also influence their affective state, as well as the tolerance for and ability to prevent errors in the work environment; a sense of safety and security; their ability to control the work environment; the quality of the atmosphere in the workplace, such as smells, air quality, and noise; the added benefits provided by the organization; and, lastly, how cool the worker perceives the work environment to be.

The focus-group participants found the LBM method highly effective as a requirements elicitation tool, since it allowed them to comment on the physical characteristics of their workspaces that affected their productivity either positively or negatively, as well as the social and human factors, such as office culture, group cohesion, and other emotional needs, that impacted their productivity. The participants expressed a desire to move away from the hot desk system, as it affected their productivity negatively. They stated the need for a designated work area with resources such as keyboards, mice, and monitors, and indicated that access to sufficient quiet meeting areas was another need, which ABW can address adequately.

The participants identified employees' comfort, such as ergonomic chairs and desks, acceptable office hygiene, natural light, a comfortable temperature, healthy food, and indoor and outdoor relaxation areas as needs enabling knowledge workers' effectiveness, mentioning that happy workers are more productive workers. Positioning coworkers in relation to others also impacts productivity since team members should be sufficiently close to facilitate collaboration but not distract other team members.

Based on the findings emanating from the literature review and focus group, the study identified five strategic objectives along with activities to address them. The first objective was to focus on the accessibility of the work environment. Attaining this goal would ensure fair and equal access to facilities and equipment, the implementation of ergonomics monitoring and facilitation to minimize the risk of physical strain or injury, and more control and freedom to manage their work environment for all employees. The second objective was to refine the workplace atmosphere by ensuring safe and pleasant working conditions, which could be accomplished by adhering to quality standards and regulations regarding air quality, noise control, temperature, light, and so on. The third objective involved optimizing the office layout to minimize distractions while maintaining collaboration capabilities. The fourth objective was to implement ABW as the primary workspace management method, which would require designating specific areas for specific activities to optimize the usage of the work environment while providing dedicated spaces for individuals performing particular tasks. Lastly, organizational culture should be solidified insofar as following a people-centered approach. Administering to employee well-being increases job satisfaction, productivity, retention, and loyalty.

The study developed a user-centered process for workspace design based on the UCD lifecycle, which can be used to implement the identified strategic objective iteratively. The process comprises six steps: first, requirements are gathered on the needs of office occupants using the LBM; second, the identified needs are analyzed, and a priority list that aligns with the needs and objectives of the organization is created. The current capabilities of the work environment to address the occupants' needs should also be measured to allow benchmarking once improvements have been made. Third, a collection of potential solutions should be designed and tested for effectiveness. Once the most effective design has been identified, the fourth step would be creating a final design for the selected solution, and the fifth step involves developing the chosen design. The final step is testing the improved capabilities of the work environment to address its occupants' needs against the capabilities measured in step two. After gathering the new benchmark data, iterative improvements can be made to the work environment. Organizations can utilize this process as part of their workplace management strategy

to enhance their work environment and better address the needs of their workforce, ultimately leading to improved productivity.

The researcher acknowledges that these recommendations are focused on the IS industry and that further research from other industries is needed to allow for generalization. Future studies could include an exploration of the effectiveness of these strategies in other industries and a longitudinal study to examine the effectiveness of implementing strategic objectives within an organization. Furthermore, the strategy objectives should be tested for competitive effectiveness within small to medium enterprises versus larger corporations.

COMPETING INTERESTS

The authors of this publication declare there are no competing interests.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. Funding for this research was covered by the authors of the article.

CORRESPONDING AUTHOR

Correspondence should be addressed to Annie Mare: mareannie@gmail.com

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Annie Mare is a software consultant with a Master of Science degree in information and communication technology management and is currently pursuing a PhD focused on designing productive information systems workspaces through user-centered design. With a strong background in business analysis and systems analysis and design, she brings both strategic and technical expertise to projects in her career, where she applies the user-centered design philosophy to create intuitive, memorable, and effortless user experiences. Passionate about optimizing work environments for knowledge workers, she blends research, design, and technology to enhance productivity and well-being in the modern workplace.

Hanlie Smuts is an academic and industry expert specializing in business transformation, knowledge management, and digital transformation. She is the head of the Department of Informatics and chair of the School of Information Technology at the University of Pretoria. Her career spans both academia and industry, with a strong background in information and communication technology, particularly in enterprise architecture, artificial intelligence for knowledge management, big data management, and digital decarbonization. She previously led product and digital development at MTN South Africa and was instrumental in establishing telecommunications company insurance ventures across Africa. She is a C2-NRF rated researcher whose research focuses on the organizational impact of information technology, human-computer interaction (user experience design), applied artificial intelligence, Society 5.0, and sustainable digital transformation. She has published extensively in academic and industry journals. She is also committed to cultivating young leaders, supervising postgraduate students, and driving impactful collaborations between academia and industry.