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by Sherly De Yong

Designing Secure Hybrid Living-Working Interior Spaces in Post-Pandemic Period: A Review

Abstract

Purpose – This paper aims to identify aspects of how work-life interaction has changed in post-pandemic situations and propose strategies of the security concept for living-working patterns in the post-pandemic interior as future disease prevention.

Design/Methodology/Approach - We conducted a systematic literature search and review to select previous research systematically and relate concepts by coding the data and synthesising the data critically. The systematic literature search and review considered 90 papers (35 were studied).

Findings – The findings identify three strategies: hybrid activity patterns, new layout for hybrid and changing behaviour and culture. Each strategy demonstrates the connection between the hybrid living-working interior spaces in post-pandemic period and security-pandemic variables. The results on security design factors focused on interior control, detection, and deterrence; connection to nature creates a safer environment to prevent further variables; and hybrid activity requires more elements to govern users' behaviour and culture.

Research Limitation - Limitations of this study are as follows: excluded papers that are not written in English/Bahasa or do not have gold/green open access; some aspects were not discussed (such as social distancing); the articles included in this review are up to April 2023 (and there is the possibility of recent papers). Future studies can be developed to update building certification for post-pandemic interiors or research with psychological, social equity, or family vitality issues.

Originality/value – The study offers strategies and the holistic relationship between the post-pandemic concept and security-pandemic design variables within the built environment, especially in the users' culture and behaviour context.

Keywords - future, hybrid, interior, living pattern, post-pandemic, workplace, working pattern.

Paper Type - Literature Review

Introduction

People's daily routines were affected by the COVID-19 pandemic, which caused them to reevaluate several habitual behaviours, including changing their built environment. Time spent at home and in virtual digital space has grown because of changes in work-from-office to work-from-home (Sutarto *et al.*, 2021; Yağcı Ergün and Nebioğlu, 2022; Yang *et al.*, 2023). These conditions raise issues regarding security in architectural design and interior spatial settings in the workplace and home that can effectively support the new hybrid living-working needs (work-from-office to work-from-home pattern).

COVID-19 also impacted the interior spatial setting due to users' needs and behaviour changes (Alhusban *et al.*, 2022; Augustin *et al.*, 2009; Megahed and Ghoneim, 2020; Murphy, 2020). Workplace management must also consider the virtual dimension by applying technology and preparing the workplace's interior for better productivity (Hou *et al.*, 2021). The planning for the interior of a hybrid living-working pattern needs to meet the basic physiological, safety, and security demands (Augustin *et al.*, 2009; The American Institute of Architects, 2004). Safety and security requirements in post-pandemic interior designs prevent health threats (Reineholm *et al.*, 2023; Wall *et al.*, 2021). In 2020, Salama revealed a contextual and transdisciplinary paradigm about pandemics in urban environments. The living-working pattern in post-pandemic urban settings has changed due to the isolation conditions caused by the pandemic and rapid technological growth (Salama, 2020). Interior design (especially workplace and home) needs new design concepts and strategies to face complex difficulties related to safety and security needs while promoting health (Karanika-Murray and Ipsen, 2022; Reineholm *et al.*, 2023; Sutarto *et al.*, 2021; Wall *et al.*, 2021).

Salama (2020) explained the ideas regarding the living-working pattern in urban design. Still, he did not describe them in the context of architecture and interior design related to security design variables and strategies. Many documents were published by international organisations and local governments explaining the pandemic protocols and guidelines for organisations (Elskalakany *et al.*, 2022; WHO, 2020), but research on security, safety, and health concepts for hybrid living-working patterns was still limited and not presented holistically. Due to this research gap, this paper aims to identify security concepts and strategies for designing secure hybrid living-working interior spaces in post-pandemic period using a systematic literature search and review. Due to the complexity of security, safety, and health, it is necessary to find the answer to these issues through a systematic literature review and research evidence that can later function as recommendations for practice. We apply a systematic literature search and review method to search, identify, and justify the post-pandemic security, indicators, and measuring variables.

The goals are to fill the research gap for the living-working pattern context for post-pandemic period and

identify the strategies of the security concept for future disease prevention. The novelty of this paper is a strategy for designing hybrid living-working interior spaces in post-pandemic period in terms of security variables. The variables will be actualised based on existing and possible new security variables in the post-pandemic interior.

Living-Working Pattern, Security Design and Built Environment
Living-working patterns at the urban level deal with the significant impacts of home and workplace in the urban environment (Maturana *et al.*, 2021). There are several aspects of the pattern of living and working patterns at the city level (Maturana *et al.*, 2021; Salama, 2020), which are spatial environments for new living-working patterns, standards for new residential settings, attitude-based sub-cultures, work-based life modes for future housing environments, and retrofitting of existing housing stocks. The new living-working patterns need to be flexible, allowing individuals to manage workloads spatially and engage with hybrid workspaces whenever they deem it necessary (Kassem, 2022; Krasilnikova and Klimov, 2016; Lahti and Nenonen, 2021). These needs exist in urban, organisational, and household spaces, are not limited to one place, and transcend mere aggregation, especially within interior spaces (Halford, 2005; Iqbal *et al.*, 2021). The spatial-object scale and the processing time differ between the urban and interior levels (McClure and Bartuska, 2007). Therefore, living and working patterns in interiors are related to the changes and hybrid life-work designs in the home and workplace environments. Based on these aspects, the keywords for the systematic literature review will be "pandemic" "office" and "workplace" "hybrid."

   Solutions for the built environment can be found by fusing proactive safety and security viewpoints with the design professional's commitment to preserving the public's health (O'Shea, 2009). On the other hand, the users' extent of control affects how secure they feel within the built environment. The hybrid living-working pattern must meet the security requirements in post-pandemic architecture to produce a more secure and safer constructed environment. Interior security designs mean designing elements and systems to meet the users' needs, to provide protection and a sense of security for users without sacrificing innovation and intervention, and to keep crime away (Atlas, 2013; O'Shea, 2009; The American Institute of Architects, 2004; Zamani, 2019). Initially, there are seven security variables in interior: access and movement (well-defined routes, spaces, and entrances for easy movement), structure (a structured place to prevent conflict between), surveillance (all publicly accessible areas can be overlooked), physical protection (well-designed security features), activity (appropriate human activities at the location), management maintenance (security management and maintenance), and ownership (places with a sense of ownership, respect, and territoriality) (Briggs, 2005). These variables need to be synchronised with the hybrid living-working needs. Therefore, the next step is to use a systematic literature search and review methodology to categorise the research articles and discuss the results in the following section.

Methodology
This research uses systematic literature searches and reviews focusing on published research articles indexed in the internet databases. This method combines systematic literature search and critical studies to propose synthetic strategies (Grant and Booth, 2009). This method has three steps: systematic literature search and selection, analysis of data through coding and classification, and critical review to culminate in synthesis (Figure 1). The first phase is selection and identification through a literature search. The literature search must clearly explain topics from crucial search terms, databases used, additional search techniques, and inclusion and exclusion criteria for relevant primary sources. The second phase involves coding and categorising, utilising a data analysis technique. The third phase consists of synthesising by using established strategies. We present the results of the reviews and conclusion as the framework.

Step 1: The Selection
The selection process was done by searching for relevant literature through the website https://www.lens.org (an open-source platform that provides patents and scholarly works with data from various partners such as CrossRef, ORCID, Microsoft Academic, etc.) The search criteria comprised peer-reviewed English-language research regarding this article, published between January 2000 and April 2023. The keywords are "pandemic" "office" (n=16.724), "pandemic" "hybrid" (n=7.427), and "pandemic" "workplace" (n=8.218). Based on these keywords, we found n= 32.433. After filtering the field of study using "architecture," "environmental psychology," and "built environment," we found n=40 for "pandemic" "office" (Link: https://link.lens.org/aZ29kTUSw7e) ("Lens Scholarly Search: pandemic office", 2023); n=5 for "pandemic" "hybrid" (Link: https://link.lens.org/AoPpurzMx6h) ("Lens Scholarly Search: pandemic hybrid", 2023); and n=45 for "pandemic" "workplace" (Link: https://link.lens.org/vafoXezhIPg) ("Lens Scholarly Search: pandemic 'workplace", 2023) with a total of 90; and accessible "open access colour Gold and Green" n=45. Exclusion criteria

included duplicated articles not written in English or Bahasa Indonesia and articles written as editorials (n=37). Considering the inclusion and exclusion criteria and semantic filtering, 35 papers were eligible and reviewed independently by the authors, focusing on the living-working interior pattern laid out by Salama (2020), as shown in Table 1.

Placed Here: FIGURE 1. Research Design.

Step 2: The Coding and Classification
The next step is analysing the literature through the coding and classification process. There were 5 aspects of living-working patterns identified at the urban level (Maturana *et al.*, 2021; Salama, 2020). The coding began by reviewing 35 papers and fitting them into sub-aspects. Out of five aspects in the previous research at the urban level, only three were discussed and identified as the living-working pattern in the interior. We explore the coding and classification of the discussion contents from literature sources according to the designing secure hybrid living-working interior spaces in post-pandemic period.

Step 3: The Synthesis
The synthesis process started with a logical argument, breaking down in more detail what aspects of the hybrid living-working pattern for post-pandemic interiors were associated with the security variables in the built environment. The synthesis framework, defined as variables, indicators, and measurements, aims to clarify and create strategies for designing secure hybrid living-working interior spaces in the post-pandemic period framework. We present the results in Table 3.

Results and Discussion
This section describes the selection of the literature process for hybrid living-working designs for post-pandemic interiors, the coding and classification process of variables, and the synthesis of strategies for designing secure hybrid living-working interior spaces in post-pandemic period.

The Selection of Literature for Designing Secure Hybrid Living-Working Interior Spaces in Post-Pandemic Period.
Interior spatial settings in post-pandemic situations must prepare the workplace and home for better productivity yet free from health threats for users. Maturana (2021) discussed post-pandemic considerations for the new-normal living and working patterns in urban design, health as a critical factor, and the rapid adoption of digital technology that affects the new normal and the creation of architecture and urban design in the post-pandemic world (Maturana *et al.*, 2021). Researchers must use various disciplinary theories to consolidate this since no theory holistically evaluates the living-working pattern for post-pandemic interior aspects. This outlining can be developed into strategies for a living-working pattern for post-pandemic interiors through risk assessments and strategies for managing and designing the built environment (Halford, 2005; Iqbal *et al.*, 2021).

Following the conceptual approaches by Maturana et al. (2021), we propose three aspects of the living-working pattern for post-pandemic interiors. Initially, there were five aspects of the living-working pattern for post-pandemic urban. However, after a thorough analysis and literature review of 35 articles (see Table 1), only three elements are related to the interior: (1) pattern for hybrid activity, (2) new layout for hybrid activity, and (3) changing behaviour and culture.

Place Here: TABLE 1. Review Findings and Implications for Research

From the literature review, 30% of articles discussed "Pattern for hybrid activity," 37% discussed "New layout for hybrid activity," and 33% discussed "Changing of behaviour and culture." The summary and explanation of the three aspects are:
1. "Pattern for hybrid activity" means detecting and deterring patterns for hybrid activity due to changes in the user's activities and helping prevent the spread of disease. There are two things related to this aspect: hybrid activity patterns at work (Phapant *et al.*, 2021; Potter *et al.*, 2015) and at home (Dolinger and Marsh, 2020; González *et al.*, 2021; Pasala *et al.*, 2021). Understanding and sensitivity to changes in activity patterns needed due to the pandemic and the need for quarantine have changed human activity patterns.
2. "New layout for hybrid activity" means detecting and deterring activities that impact the space design layout that change due to the users' activity patterns and helping prevent the spread of disease within the interior scope. Interior layouts need to be adaptable and flexible for changes in hybrid activities. Two things are related to this aspect: the standard design for hybrid activities at work and home (Karanika-Murray and Ipsen, 2022;

Reineholm et al., 2023).

3. "Changing of behavior and culture" means detecting and deterring changes in user behaviour and culture in the workplace and residence. Detection of these changes is necessary so that the built environment can adapt and be flexible to users' behaviour and culture changes. This change impacts distance and isolation zones, access to nature, work culture in the digital world, and hygienic behaviour (Sutarto et al., 2021).

The relevant studies from the reviewed paper in Table 1 have shown three aspects of the hybrid living-working pattern within post-pandemic interiors. The findings will support the early identification of the hybrid living-working pattern within post-pandemic interior variables.

The Coding and Classification Aspects for Designing Secure Hybrid Living-Working Interior Spaces in Post-Pandemic Period.

After the systematic literature search, the next step is to review the relevant literature by coding and classifying 35 articles with the abovementioned aspects. The 35 articles were coded and categorised into elements (identifying characteristics of abstract concepts) of hybrid living-working patterns within post-pandemic interior and variables (indicators – measuring variables) of security for post-pandemic interior settings. We present the results of the coding and classification for designing secure hybrid living-working interior spaces in post-pandemic period in the following table (Table 2).

Placed Here: TABLE 2. Hybrid Living-Working Pattern within Post-Pandemic Interior Aspects and Its Relationship to Variables in Interior

Table 2 summarises the characteristics of the hybrid living-working pattern within post-pandemic interiors and the variables identified in the literature:

1. "Hybrid activity patterns at the workplace" is discussed in 14 articles. The characteristics are related to variables access-movement (Nediari et al., 2021), structure, surveillance, physical protection (Phapant et al., 2021), ownership (Maltseva et al., 2022), activity (Potter et al., 2015), users' activity system (Freeman, 2023) and digital activities in the visual world when the user is doing hybrid activities at the workplace (Elskalakany et al., 2022).

2. "Hybrid activity patterns at home" are discussed in 18 articles. The characteristics are related to variables access-movement (Unver and Sungur, 2021), structure (Capasso and D'Alessandro, 2021), surveillance (Salama, 2020), physical protection (Margariti et al., 2021), ownership (Arzumanova and Stasiowski, 2021), activity (Fallatah, 2021), and the existence of living-working flexible activities area at home (Huntsman and Bulaj, 2022).

3. "Standard layout for hybrid activity at the workplace" is discussed in 26 articles. The characteristics are related to variable access-movement (Reshetnikov et al., 2021), structure (Mayer and Boston, 2022), physical protection (Maltseva et al., 2022), ownership, activity (González et al., 2021), management maintenance (Nediari et al., 2021), access to nature (Lee and Park, 2022), digital-virtual activity (Marston, Shore, et al., 2020), sterilisation-hygienic area (Fezi, 2020; Gbadamosi et al., 2020) and spatial diversity (Freeman, 2023).

4. "Standard layout for hybrid activity at home" is discussed in 13 articles. The characteristics are related to variable access-movement (Wandeler et al., 2020), structure (Reshetnikov et al., 2021), physical protection (Reshetnikov et al., 2021), ownership, activity (Pinter-Wollman et al., 2018), management maintenance (Maltseva et al., 2022), flexible life-work activities (Alhusban et al., 2022; Uherek-Bradecka, 2021) and sterilisation-hygienic area (Suryantini et al., 2021).

5. "Changes in behaviour and culture" are discussed in 34 articles. The characteristics are related to variable access-movement (Spiliotopoulou and Roseland, 2020), surveillance (Akter et al., 2021), physical protection (Sartorio et al., 2021), ownership (Zordan and Tsou, 2020), activity (Pinter-Wollman et al., 2018), hygienist behaviour (Atmodiwirjo and Yatmo, 2021; Suryantini et al., 2021), access to nature (Elisputri and Choandi, 2022), digital-virtual activity (Marston, Ivan, et al., 2020; Utomo et al., 2020) and zone isolation-distancing (Dolinger and Marsh, 2020).

This coding and classification have identified that the characteristics of three aspects are related to existing and new security variables. Three and five sub-aspects emphasised the importance of security variables for creating interior spaces that directly and indirectly support changes in living-working patterns in the workplace and home, hybrid activities, and physical-mental health. Most articles discussed security variables (about 8%-12% examined 7 existing security variables). About 1%-6% of articles discussed hybrid, health behaviour, changing activity in the area zone, and connecting with nature and technology. These modalities can also provide efficient productivity and time benefits for users and organisations. We show the connection and detailed variables for aspects of hybrid living-working patterns within post-pandemic interiors and variables of security design in Figure 2 in the synthesis phase.

Placed Here: FIGURE 2. The connection between Aspects-Variables for Designing Secure Hybrid living-Working Interior Spaces in Post-Pandemic Period.

The Synthesis: Strategies for Designing Secure Hybrid Living-Working Interior Spaces in Post-Pandemic Period.

The process of synthesis started by breaking down the variables in more detail to design secure hybrid living-working pattern interior spaces in post-pandemic period framework. We define the framework as variables, indicators, and measurement criteria (quantifying variables). This sub-chapter will explain the indicators and measurement objectives in more detail to clarify the discussion and create strategies. We present the results in Table 3.

Placed Here: TABLE 3. Designing Secure Hybrid Living-Working Patterns Interior Spaces in Post-Pandemic Period - Variables, Indicator, and Measurement Criteria

Based on Table 3, the variables, indicators, and measurement criteria could be used as a strategy to assist future interior design. The provision of security design in interiors plays a fundamental role. The interior must focus on basic security and additional variables for the health environment to prevent future disease spread. Firstly, the results on security design variables mainly focused on control, detection, and deterrence through the interior elements. Therefore, the seven existing security variables were developed to fulfil the post-pandemic need. One example is that access to pathways and object orientation are indicated by "access-movement" indications. This variable is oriented to limit people accessing the building and controlling the movement of people (using physical and social distance). Therefore, the indicator and measurement criteria are based on clearly defined pathways, spaces, entrances, and routes allowing human and disease movement, access, and peripheries. Controlling, detecting, and deterring these aspects will assist in regulating user behaviour and halting the spread of disease in the interior.

Secondly, additional variables are necessary to prevent this by creating a healthier and more secure environment connecting to nature. The new variables are natural environment context (access-links to nature); behaviour context (hygienist behaviour, users' activity systems, flexible life-work activities, sterilisation-hygienic area, spatial diversity, and zone isolation-distancing); and cultural context (digital-virtual activity). One of the examples of additional variables is "indoor environmental climate," which is an indicator that relates to interior air quality and pollution levels. The following indicator and measurement criteria are considered to lessen the spread of infectious disease: CO_2 measurements, occupancy levels, crowd density, room volume, and opening window size and location. Another variable is necessary to prevent and control users' behaviour and culture for hybrid activity such as "digital-virtual activity." The indicator is related to digital-virtual activity through camera distance and angle in the virtual space and physical zoning. The measurement criteria are the camera distance and virtual angle and a well-appropriate digital-virtual activity home and workplace that provides physical zoning in the physical area and a convenient view in the virtual space. We show the rest of the discussion regarding variables, indicators, and measurement in Table 3.

Conclusion

The necessity for security in the interior has been heightened and is expanding quickly concerning aspects of hybrid living-working patterns. The idea of security evolved and living-working patterns after the pandemic required modification. Applying systematic literature search and review, we have identified the changed living and working patterns post-pandemic and strategies that affect the interior in future disease prevention. There are new security variables for hybrid living-working patterns, and some of the security variables from earlier studies must be changed. Below is the conclusion of designing secure hybrid living-working interior spaces in post-pandemic period:

1. Pattern of hybrid activity aspects are related to security variables: access-movement, structure, surveillance, ownership, physical protection, and activity; and new context: user's activity system, digital-virtual activity, and flexible life-work activities.
2. New layout for hybrid activities aspects is related to security variables: access-movement, structure, ownership, physical protection, maintenance management, and activity; and new context: digital-virtual activity, flexible life-work activities, and sterilisation-hygienic area.
3. Changing behaviour and cultural aspects are related to security variables: access-movement, surveillance, ownership, physical protection, and activity; and new context: digital-virtual activity, hygienist behaviour, access to nature, spatial diversity, and zone isolation–distance.

Based on the conclusion, the hybrid living-working pattern aspects can engage in interaction within the interior space, from the office space that can be flexible for various face-to-face interactions through the living room that is not stressful and can be extended for the use of virtual-digital communication (Halford, 2005; Hopkins and Bardoel, 2023; Iqbal *et al.*, 2021; De Yong *et al.*, 2023). The COVID-19 pandemic has shifted from the usual office and forced users to work from home. If users do not have a home office, they will change the lounge, dining room, or bedroom to a home office. This change impacted the interior design for future hybrid home-workplace settings regarding security, safety, and health. Users need to improve both security variables and their spatial qualities in hybrid space to promote safety and a comfortable atmosphere by connecting to nature to promote health and optimise their productivity in the hybrid post-pandemic interior. Before the pandemic, workplaces with open office layouts were widely used because of their productivity enhancement. However, open office layouts are very vulnerable to disease transmission. Therefore, the interior of the open office needs to be altered to be more secure and disease-resilient by adding security features such as physical protection made of tempered glass to reduce the possibility of close contact between employees. This paper summarized that the controlling, preventing, and deterring the interior, hybrid activities, and physical-mental health and optimising users' productivity will support changes in living-working patterns and improve security in the workplace and home.

Another implication of designing secure hybrid living-working interior spaces is creating a more resilient interior with safety assurances and an interior that is capable of controlling, preventing, and deterring the spread of infectious diseases. The interior, stakeholder, and building management must work together to make disease control interior effective in the workplace. Future interior designs need to accommodate flexible living-working activities with more functional hybrid spaces and touchless smart technologies in design. The control interior environment needs to be reoriented with a focus on eliminating sources of infection and blocking the pathways of disease spread. These new activity and behaviour standards should be developed as guidelines established by the health authority. This guideline will be used to protect the interior environment against future pandemics.

Some limitations of this study are as follows: we exclude some papers that are not written in English/Bahasa or do not have gold/green open access; some interesting aspects were not discussed, such as distancing from the new normal; the articles included in this review are up to April 2023 (and there is the possibility of recent papers). This paper provides a current state-of-the-art review of current research in the field and a strategy for future research to improve understanding of users' culture and behaviour of hybrid living-working patterns in interior design. The concept and variables for designing secure hybrid living-working interior spaces in post-pandemic period offer better flexibility in interior design with more secure assurance in preventing infectious disease spread. Future work for this research can be the development of novel building codes or certificates for post-pandemic interiors or development in other fields, such as how the hybrid living-working interior influenced users' emotional, psychological, work-life balance and performance aspects. Another future research direction is the hybrid living-working interior: finding an optimal composition for more secure and not over-crowding places for working at home vs at the office and interiors that support activity-based working or impact social equity in the workplace and family vitality at home.

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