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Dynamics in post-pandemic architecture: Integrative literature review in response to post-pandemic built environment

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Abstract
"Dynamics in post-pandemic architecture" refers to dynamics in architecture as implication of disease spread in a building for averting a future pandemic. The highly contagious and rapid spread of COVID-19 has caused changes in the architecture and way of life. The built environment needs proper strategies to act as a facilitator for averting the spread of disease in the future. The implications of disease spread and strategies for dynamics in post-pandemic architecture will be reviewed and discussed in this study. Integrative literature review used in this article is a systematic method to define previous research, relate concepts and relevant studies by reanalyses the data for future research. The first step is systematically clear selection; the second step is coding; the third step is synthesis. The integrative review considered 102 papers (of which 40 were reviewed). It was discovered that there were no articles that incorporated previous study findings comprehensively. Six strategies for future dynamics in architecture post-pandemic are revealed: control of architectural density, control of peripheries and spread, control of interaction, control of mobility, control of access, and new protocols and standards for spatial. Each strategy demonstrated the interaction between dynamics in post-pandemic architecture and security-pandemic variables in built environment. The findings: identification of the dynamics in architecture post-pandemic strategies that affect the built environment in preventing disease spread in the future. This will support future research in defining appropriate future research designs and understanding the need for holistic analysis of the integrated effects of diverse dynamics in post-pandemic architecture.

Keywords
Dynamics, Pandemic, Public space, Future, Interior.

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1. Introduction

The COVID-19 (SARS-CoV-2) pandemic altered the everyday routines of millions of people and thus led them to re-evaluate many routine behaviors, including changes in our built environment. During the recent COVID-19 pandemic, time spent at home has increased noticeably, while daily mobility has decreased (Yağcı Ergün & Nebioğlu, 2022). Such circumstances call into question certain fundamental needs of the security concept of architecture, the dynamics of architecture and the use of spatial contexts. New requirements are needed for new security systems, protocols, and standards for spatial use.

Considering past events, epidemics, pandemics, and infectious diseases led to important advancements in urban planning, sanitary systems, and architectural designs (Megahed & Ghoneim, 2020). Several epidemics (including the recent three of tuberculosis, cholera, and ebola) highlight the importance of architects and designers in preventing disease spread when we consider their primary modes of transmission: surfaces, water, and air (Murphy, 2020). The COVID-19 pandemic will undoubtedly have an impact on architectural designs and the rapid changes in users' needs, behaviors, and daily lives in the future (Alhusban et al., 2022).

Safety and security needs are ranked second after physiological needs in Maslow's hierarchy of needs (Augustin et al., 2009). Therefore, safety and security (including security for users' health) become a fundamental need for concept and design features within the built environment. Security issues for the built environment are related to the prevention and detection of threats carried out and motivated by humans (The American Institute of Architects, 2004). When humans are present in space, security is expected to detect threats, mitigate danger, and protect. Security in the built environment is also needed in the context of a pandemic to help detect, reduce the risk, and prevent viruses.

To meet the complex challenges associated with the dynamics in post-pandemic architecture, a concept and strategy based on various disciplines related to movement, change and adaptability within architecture and the built environment design must be developed. Salama (2020) reveals a contextual, transdisciplinary framework that explains pandemics in urban settings (Salama, 2020). One of the aspects discussed in this framework is architecture with urban dynamics related to: (1) environmental density and the spread of disease; (2) traveling and transportation; and (3) global-local tensions (including urban science and human geography, urban planning, and transportation engineering). Although there are two more aspects (distancing and living-working patterns), this paper focuses on the dynamics in post-pandemic architecture.

In order to prevent pandemic spread, changing socio-spatial needs require implicit development and implementation not only at the urban planning level of design, but also in architectural design in the context of a smaller built environment (interior-structure). Structures are organized collections of defined spaces that are made of products, have an interior space, and an exterior form. While interior spaces are enclosed within a structure and defined by an organized arrangement of products (McClure & Bartuska, 2007). Therefore interior-structure in built environment is grouping of spaces and products to enhance human activities and have both exterior form and interior spaces. The interior-structure built environment is becoming one of the ways to prevent its spread, as it is more optimal, more liveable, and more pervasive, and it forms healthy behavior in humans.

The goal of this paper is to identify the dynamics in post-pandemic architecture strategies that affect the built environment in future disease prevention. The spatial problems and user need that arise with the change in post-pandemic architecture constitute the main starting point of this paper. To answer the objectives of the research in this paper, an integrative system literature review method will be used to classify, identify characteristics, justifying the post-pandemic security

variables for built environment, including indicators, factors, and criteria for measuring the variables, to develop a preliminary strategy for dynamics in architecture post-pandemic.

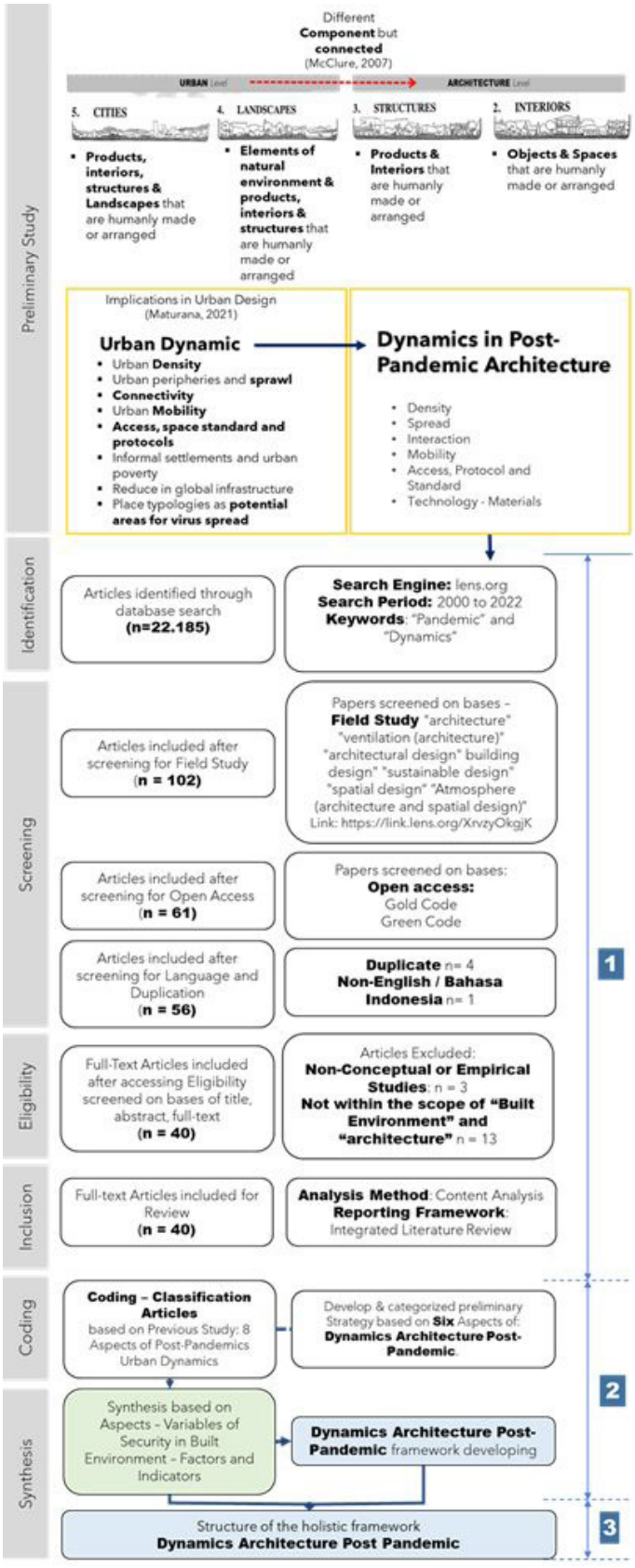

Figure 1. *Research design.*

There is a research gap for dynamics in architecture context between the pre-pandemic and post-pandemic eras. Since the dynamics in post-pandemic architecture context is based on abstract ideas, security variables in the built environment are needed. Security variables in the built environment can help improve public space safeguarding (including pandemic protection and user control within the environment). The novelty in this paper is a strategy for "dynamics in post-pandemic architecture" in terms of security variables. The dynamics in post-pandemic architecture variables will be actualized based on existing variables of security in the built environment (such as access and movement, surveillance, ownership, and so on) and the new variables for security architecture post-pandemic.

2. Methodology

This integrative systematic review focuses on published research articles indexed in online databases. The process of an integrative review used to relate concepts and relevant theories using systematic review. This includes studying the concept of dynamics in post-pandemic architecture, exploring the potential for built environment security variables to develop a synthesis of strategy for reducing the risk by developing dynamics in post-pandemic architecture through built environment (Haigh & Amaratunga, 2010; Marion E. Broome, 2000; Torraco, 2005; Y. Zhang et al., 2019).

Two existing research (in preliminary study) on the dynamics of post-pandemic architecture exist prior to the steps for an integrative systematic review. The first study is regarding how the post-pandemic has affected urban dynamics. The second study is about how existing safety and security strategies become fundamental concepts and design features in the built environment for prevention and detection of threats. These two studies examined how urban planning and safety-security measures were altered in the built environment during the pandemic. These studies are crucial for

comprehending the scope and basic information of the dynamics concept and security strategies before the pandemic. The integrative review presented in this paper intends to propose a strategy for dynamics in post-pandemic architecture in terms of security variables.

The connection between preliminary study and three steps for this integrative systematic review: the selection, the coding and classification, and the synthesis, as shown in Figure 1. The first step is a clear selection and identification of the problem that the review using literature search. Literature search should clearly address issues such as search terms, the databases used, additional search strategies, and the inclusion and exclusion criteria for determining relevant primary sources. The second step is the coding and classification using data analysis process, data from primary sources are ordered, coded, categorized. The third step is the synthesis by summarized and creating strategy of dynamics in post-pandemic architecture. Finally, conclusion of reviews can be reported in a table or diagram.

2.1. Step 1: The selection

The selection process was carried out by searching for sources of literature or writing data from books, proceedings, journals, and articles through the website lens.org. The search criteria included research articles written in English, peer-reviewed, and published between January 2000 and August 2022. The keywords used are "pandemic" and "dynamics". Based on these keywords, we found n = 22,185 in lens.org. The next step is filtering the field of study using: "architecture" "ventilation (architecture)" "architectural design" "building design" "sustainable design," "spatial design," "Atmosphere (Architecture and spatial Design)" n=102 and accessible "open access colour Gold and Green" n=61. Exclusion criteria included articles not written in English or Bahasa Indonesia and articles that were written as editorials (n=56). In light of the inclusion and exclusion criteria, A total of 40 articles were eligible for review using the integrative method. Each of the 40 articles was reviewed independently by the authors, focusing on the dynamics aspects of the urban built environment and interior structures that have been laid out by Salama (2022). Forty of these articles were not researched and thus were eliminated. Forty articles were recommended for inclusion in this review, as shown in Table 1.

2.2. Step 2: The coding and classification

The next step is the coding and classification process. There were 7 sub-aspects of urban dynamics (Maturana et al., 2021; Salama, 2020). From the seven sub-aspects in the previous research in urban design, only six were discussed and identified as the dynamics in post-pandemic architecture. Therefore, only six sub-aspects are discussed, which are: density; peripheries and sprawl; interaction; mobility; access, space standards and protocols; and the placement of technology and materials. The coding process included screening and reviewing 40 papers to determine which articles fit into which sub-aspects using the Microsoft Excel program. The coding and classification of the contents of the discussion from literature sources are explored according to the dynamics aspect framework and sub-aspects for interior-structure.

2.3. Step 3: The synthesis

The process of synthesis started by breaking down in more detail what sub-aspects of the dynamics in post-pandemic architecture were associated with the security variables in the built environment. There are seven existing security variables (Briggs, 2005) and the possibility of new additional sub-aspects. 40 sources of literature were identified from the perspective of dynamics' aspects, then sorted and grouped into similar topics to create "dynamics in post-pandemic architecture" framework. The framework was defined in terms of variables, indicators, and factors. The existence of indicators, factors, and measurement objectives aim to clarify the discussion of the variables that appear and create strategies for dynamics in post-pandemic

architecture. The results are presented in Table 3.

3. Preliminary study

Urban Dynamics in a Pandemic World addresses both the larger global perspective and the ramifications of virus transmission at the city scale (Maturana et al., 2021). Dynamics in post-pandemic architecture deal with the architectural (interior-structure) ramifications of virus transmission. There are several sub-aspects of dynamic aspects at the urban level as they relate to virus spread and urban health (Maturana et al., 2021; Salama, 2020), including: (1) user density and the effectiveness of density management; (2) peripheries and spread; (3) interaction and connectivity; (4) mobility concerning to pollution, carbon emissions, and mortality rate; (5) access, standard space, and protocol for the use of public facilities; (6) environmental density; and (7) pathways in areas with the high distribution. The difference between the urban level and the interior-structure level is in the spatial-object scale and the processing time (McClure & Bartuska, 2007). Then, from these topics, there are six sub-aspects related to dynamics in post-pandemic architecture in interior-structure scale, which are as follows:

1. Density
2. Peripheries and spread
3. Interaction
4. Mobility control
5. Access control and prevention through standards and protocols
6. Prevention through technology and materials

Combining proactive safety and security viewpoints with the design professional's dedication to safeguarding the public's health (like preventing a pandemic), safety, and welfare can open solutions for the built environment (O'Shea, 2009). The extent to which users can change, alter, or control their environment, on the other hand, has an impact on their sense of security and control within the built environment. Dynamics in terms of post-pandemic architecture needs to be synchronized with the aspect of security to create a more secure and safer built environment.

Controlling in security architecture is a feature, structure, or method of designing a physical product, software, building, town planning, or system for interaction with users that aims to impose or limit user behavior (Atlas, n.d.; Hopper, 2009; O'Shea, 2009; The American Institute of Architects, 2004; Zamani, 2019). Before the pandemic of COVID-19, the theory of security architecture is always concerned with crime and CPTED. The theory of security has discussed the prevention of pandemics and health problems at spatial border needs such as airports and harbours. Now the prevention of pandemics and health problems needs to be applied in most places (from the residential, workplace, and public places) in the built environment.

Briggs in O'Shea (2009) describes how the design of a built environment as expected to be able to provide user needs, provide protection and a sense of security for users without sacrificing innovation and intervention, and can keep crime away. This should be a priority in design strategies' development (Lockton & Stanton, 2010). There are 7 variables that are the basis for consideration in applying the concept of security in a built environment (Briggs, 2005; O'Shea, 2009; The American Institute of Architects, 2004). There are seven security variables: (1) access and movement (well-defined routes, spaces, and entrances for easy movement); (2) structure (structured place to prevent conflict between); (3) surveillance (all publicly accessible places can be overlooked); (4) physical protection (well-designed security features); (5) activity (appropriate human activity for the location); (6) management and maintenance (security management and maintenance). (7) Ownership (places with a sense of ownership, respect, and territoriality) (Briggs, 2005).

The next step is to categorize the research articles published in the online database using an integrative systematic review method. Based on the explanation above, there are six keywords regarding the dynamics of post-pandemic architecture based on existing research written by Salama (2020). Using the six keywords above, the next

step is to review the findings and implications of the 40 articles with keywords in bold and code the articles based on the six keywords from the dynamics' aspects. From the results of this coding, an in-depth analysis and synthesis process is carried out by deepening the coding into various variables of the post-pandemic dynamics architecture, indicators, factors, and measurement criteria, which will then summarize the findings of this research strategy in the "Discussion" section.

4. Results and discussion

This section describes: the selection of the literature process for dynamics in post-pandemic architecture; the coding and classification process of variables, and the synthesis of strategies in dynamics in post-pandemic architecture.

4.1. The selection of literature for dynamics in post-pandemic architecture

To consolidate the state of the art, researchers have explored the theory regarding dynamics in post-pandemic; security for health outcomes in the built environment to describe building design features that influence the dynamics in post-pandemic architecture. The use of various disciplinary theories is justified because there is no theory evaluates dynamics in post-pandemic architecture aspects holistically. Outlining this can be developed into strategies for dynamics in post-pandemic architecture in the form of risk assessments as well as strategies for managing and designing the built environment.

Salama et al. (2020) discuss post-pandemic architectural considerations as well as the nature of the new normal living and working patterns in urban design as a result of the COVID-19 pandemic. According to Salama (2020), future design and planning studies should focus on several key issues, including urban dynamics from the perspectives of human geography, transportation, and urban design; socio-spatial effects and urban life from the perspective of environmental psychology; and new environ-

Table 1. *Review findings and implications for research.*

No	Reference	Citing Works Count	Review findings and implications for research with keywords in bold (selected)
P1	(Mittal et al., 2020)	306	The movement of the COVID-19 virus plays an important key role, starting from the **movement of liquid droplets** to the **evaporation of the COVID-19 virus in the air**. This virus can settle, touch almost any area and the air.
P2	(W. Yang & Marr, 2011)	185	Precipitation is important for removing virus present in droplets, while ventilation and inactivation are relatively more important for removing **virus with droplets** <5 m or **in airborne particles**.
P3	(Kummitha, 2020)	102	Five practical observations to control virus transmission during a pandemic, including: government needs to ensure the **protection of information and privacy** of its citizens; needs to actively share the information; coordinate with each other to minimize the impact; need to **control pandemic info** shared with the public; **sharing technology and information**
P4	(Azuma et al., 2020)	63	Environmental factors influence in reducing virus transmission. In Japan, the focus on the 3Cs is (1) **enclosed places with poor ventilation, crowded places with lots of people and close contact.**
P5	(Knibbs et al., 2011)	59	Room ventilation is a major determinant of **airborne disease** transmission. Through this simple model, the risk of contracting influenza is **reduced by a significant** increase in air exchange rates (eg by **leaving the door open**).
P6	(Dbouk & Drikakis, 2021)	52	The position of the air inlet and outlet significantly **affects the flow circulation and droplet** dispersion. Air purifiers do not eliminate the possibility of airborne transmission.
P7	(Jarvis, 2020)	44	Corona virus can be transmitted and survive in the **air in the form of aerosol particles and droplets / deposits** on surfaces. The way to control the transmission is through **good ventilation; sunlight / UV rays**. masks are able to inactivate this virus in the air;
P8	(Nasir et al., 2016)	44	Factors affected by the transmission of airborne communicable diseases in the transportation environment (such as trains, planes, boats): (1) In **Design and Construction** (2) **Operation and Management**
P9	(Kumar & Morawska, 2019)	40	Three-way approach to help reduce the spread of coronavirus: (1) **government (2) built space (ventilation system) (3) community**
P10	(Foster & Kinzel, 2021)	40	The **use of masks, a good HVAC system and duration of exposure** and number of occupants were found to be more effective than physical distancing.
P11	(Pinter-Wollman et al., 2018)	40	The built environment affects health directly and indirectly. In the building scale there are 4 themes that play an important role for physical activity: **(1) building access and circulation systems (2) building elements (3) organization of the building (4) activities in space**
P12	(Gao et al., 2016)	29	Increasing **natural ventilation** into buildings is a relatively effective strategy for airborne diseases
P13	(Sadrizadeh & Holmberg, 2014)	29	**Air movement** in horizontal laminar **ventilation systems** works better than vertical in reducing the transmission of viruses and bacteria in the operating room.
P14	(Smieszek et al., 2019)	23	**Ventilation** effectively reduces outbreaks as effectively as vaccinating half the population.
P15	(He et al., 2021)	19	The air purifier fan box is considered to be more effective than simply UV-C increasing the horizontal flow rate of the **ventilator unit (HUV)**
P16	(Cheshmehzangi, 2020)	16	The key to the city stage for environmental aspects is the **density and level of accessible green areas, the nearest transit location**
P17	(Gbadamosi et al., 2020)	9	Airborne disease transmission: (1) **short-distance transmission** - through small droplets (2) **long-distance transmission** - through small particles in airborne transmission.
P18	(Brittain et al., 2020)	9	Building design strategies to improve **indoor air quality and** reduce dispersion through good air quality with **adequate ventilation**, good air circulation, specifications of **materials used** and reducing additional pollution from heating and air conditioning
P19	(Srivastava et al., 2021)	8	The strategy to reduce infection in buildings is to use a combination of 100% **outdoor air and UV-C** in circulation, ventilation and air conditioning ducts with disinfection by UV-C RM3 unit.
P20	(Anghel et al., 2020)	8	The control strategy is to optimize ventilation by increasing outdoor air use and air change rates, reducing **air recirculation and using air filters such as HEPA filters.**
P21	(Laddu et al., 2021)	7	(1) **interior - associated air quality** (2) housing - house density (3) **public spaces - key to social interaction** (4) **green areas - enduring goals (5) work - downsizing and deployment** (6) shopping - approaching and scaling down (7) transportation - pedestrians, cycling, small shared mobility and robot taxis (8) city scale - mixed use environment
P22	(Singh & Tripathi, 2020)	6	**Ventilation systems (**temperature distribution, airflow and aerosol and droplet distribution).
P23	(Frumkin, 2021)	6	Risk factors for transmitting COVID-19 in the built environment can include **crowds, poverty, racism in residential areas, poor circulation in spaces, and air pollution.**
P24	(Sopeyin et al., 2020)	5	The Covid-19 virus is transmitted through **droplets and can be aerosolized.**
P25	(Huang et al., 2021)	4	**Natural ventilation** with the help of fans in residential buildings can increase the risk of infection.
P26	(Shenton et al., 2019)	4	6 Steps to understanding and preventing mosquito-borne disease transmissionn, one of them is **changes to the built environment** can provide health benefits
P27	(Grydaki et al., 2020)	3	This study demonstrates general susceptibility to **airborne disease transmission**.
P28	(Mueller et al., 2021)	2	The **output of talking droplets and coughing** is more than that of aerosols in the vent.
P29	(Crawford et al., 2021)	2	**Bed orientation** of the placement of additional **air treatment units** can increase 40% the number of particles extracted and reduce 25% the number of particles deposited on the surface 45 seconds after and.
P30	(Bakhtiyari et al., 2020)	2	The stability of the COVID-19 virus depends on **environmental conditions, including temperature and humidity**. Prevention and control of COVID-19: (1) **public health promotion and social distancing** (2) **control**. this precaution is taken by everyone everywhere.
P31	(Duill et al., 2021)	2	Parameters that influence and take into account the spread of disease: **duration of stay, particle concentration in the air, respiratory rate, viral life span, ventilation flow interval efficiency, volumetric flow and room size**
P32	(Ronchi et al., 2020)	1	Basic relationship of human movement due to the COVID-19 Pandemic: (1) **human movement** (2) **interaction between road users**
P33	(Zhang & Ryu, 2021)	1	The factors that affect the pattern of **air flow** in the room are the effect of **ventilation** on the dew rate.
P34	(Abbas & Gursel Dino, 2021)	1	A **higher indoor air temperature** can help reduce infection. Multiple window openings have a higher impact on reducing the risk of infection than changing the opposite configuration.
P35	(Tang et al., 2021)	1	Human movement in the area around the home environment has an impact on the high daily transmission.
P36	(Y. Yang et al., 2021)	1	Factors that make the environment resilient to pandemics: decentralized urban activities, decent housing, resilient building typologies, **proximity between work and home, limited travel time,** diverse travel options and city allocations and facilities according to population density
P37	(Zordan & Tsou, 2020)	0	There is a relationship between **behavioral contagion** theory and activities, preferences and **psychological dynamics** in urban spaces, especially shopping centers and green spaces
P38	(Sharghi & Asadi, 2020)	0	We found a relationship between **behavioral orientation and physical-environmental aspects** that influence disease prevention and promote health-related behaviors. In the interior design scale, elements that affect control, reduce anxiety and improve health: **surface area, furniture, color, openings and exits, density, access and common spaces, windows and ventilation for natural light and ventilation, open space for movement, activities physical and contact with nature**. Different age groups need different places to reduce stress
P39	(Papadaki et al., 2020)	0	There are three criteria to be considered: (1) parameters related to **walking design** (connectivity, safety, etc.) (2) **anthropometric us**er characteristics (3) application principles of user movement and intervention in cities with high use of public transportation.
P40	(Fezi, 2020)	0	Architecture and cities are needed to prevent and mitigate future pandemics through **air control, housing approaches, public spaces, green area design, work areas, transportation and a mix** of neighbourhood.

ments to accommodate contemporary living and working styles from an ethnographic angle (Salama, 2020)

Maturana et al. (2021) focus on the implications of urban dynamics and COVID-19. The authors discussed the contagious coronavirus public health crisis and how health is a key factor in the creation of architecture and urban design. The effect of virus propagation on the urban environment (urban dynamics), the method used to reduce social and physical distance are put into practice, and how rapid adoption of digital technology affects a new normal life are just a few implications highlighted by the authors. To establish a new norm that incorporates flexibility and adaptability, the writers also mentioned the necessity of adoption and redesign (Maturana et al., 2021)

Following the conceptual approaches of Salama et al. (2020) and Maturana et al. (2021), we propose six aspects of dynamics in post-pandemic architecture. Originally there were seven aspects of dynamics in urban space (Maturana et al., 2021), but after a thorough analysis and literature review of 40 articles (see Table 1), only six aspects are related to the interior-structure.

From the literature review, 20% of articles discussed "Density", 20% of articles discussed "Peripheries and Spread", 5% of articles discussed "Interaction", 32% of articles discussed "Mobility", 20% of articles discussed "Access, spatial standard and protocols" and 3% of articles discussed "Antivirus Building Materials". The summary and explanation of the six aspects are:

1. Density – Density control that exists within the interior-structure scale. There are two things related to density, namely the density of air in the room to prevent disease spread and occupancy density. Air density control is necessary because of the potential for post-pandemic diseases to spread via aerosols in the air. The way to control it is by improving the air quality in the room (for example, by providing a HEPA filter on artificial air and providing openings to allow natural air movement in the room). Control of occupancy density is necessary because of the potential for the spread of infectious diseases through humans via droplets. The way to control the rate of spread is by settling the amount of occupancy density in one room.

2. Peripheries and spread – controlled through testing and reducing the possible spread within the interior-structure scope. There are two things related to boundaries and distribution, namely: limits and distribution of air in space and boundaries in user activities and occupancy. Airborne control and distribution limits are necessary because of the potential for post-pandemic diseases to spread via aerosols in the air. The way to control it is by peripheries the dirty air using several tools and improving the indoor air quality by creating peripheries' element for improving natural air movement in the room. The potential for infectious disease transmission through humans via droplets, therefore user activity must be limited and distributed. The way to control the rate of spread is through creating interior-structure's elements to limit user's activity and capacity in area before entering the interior-structure.

3. Interaction - is the closeness of the interaction between users within the interior-structure scope. There are two things related to interaction, namely, close interaction and not-close interaction. What is meant by "close interaction" is interaction that occurs between two or more people who know each other and have a special relationship (such as husband and wife, parents and children, close friends, etc.). The control this close interaction is provided by providing a separate area for this user. What is meant by "not close interaction" is an interaction that occurs between two or more people who do not know each other. Control in these close interactions through the completion of user activities and behavior. This is necessary because of the tendency of human psychology to imitate and follow the behavior of fellow human beings.

4. Mobility control - is control of user mobility, mobility of diseases in the air, mobility of dew rate and humidity in the room, mobility of natural sunlight entering, mobility of UV-C rays in the room, and mobility of disease mobility on the elements. ele-

ments that are within the scope of the structure-interior. Control of human mobility/movement within the interior-structure is necessary to limit the possibility of spreading disease among users through a mutual contact. Control of the mobility of airborne diseases is needed to help reduce the spread of these diseases. This is done by increasing the rate of air movement in the room and increasing the entry of fresh air into the room. Controlling dew rate and indoor humidity is necessary to help reduce disease spread caused by humidity and mold indoors. This is done by improving air quality by controlling air humidity and dew levels in the room. Controlling the movement of natural sunlight indoors is necessary to help reduce disease by killing disease by using natural UV rays and increasing the body's immunity (through natural UV-C rays and vitamin D). Prevention through the mobility of UV-C rays, which are obtained naturally through sunlight and unnaturally through UV-C rays. Control of disease movement through droplets on the surface of objects is carried out by using antiviral building materials.

5. Access control and prevention through standards and protocols - is user access control and prevention through new built-environment standards, humidity-temperature indoors, and health protocols for self-protection in interior structures. Control over user access is carried out by limiting user access within the interior structure.

6. Prevention through technology and materials – is prevention via technology derived from antivirus materials used indoors. This is necessary because of the possibility of disease spreading through droplets present on the surface of the material within the interior structure.

The relevant studies from the reviewed paper, shown in Table 1, have shown that there are six aspects of dynamics in post-pandemic architecture. The findings in these steps are required to support the early identification of dynamics in Post-Pandemics Architecture's variables.

4.2. The coding and classification aspects of dynamics in post-pandemic architecture

After the literature review of the aspects of dynamics in post-pandemic architecture identified and carried out in the literature, as shown in Table 1, the next step is the coding and classification of 40 articles. Based on the initiative's findings in the previous chapter, there are six aspects of dynamics in post-pandemic architecture at the abstract concept level. These aspects (abstract ideas) need to be developed as variables so they can be used in built-environment design (Barrett et al., 2015; Y. Zhang et al., 2019). Variables mean identifying characteristics of abstract aspects, while indicators are ways of measuring or quantifying variables. Therefore, the coding and classification of these papers were carefully carried out up to variables and indicators in order to develop framework strategies for dynamics in post-pandemic architecture.

The coding and classifications were evaluated on the basis of aspects of dynamics in post-pandemic architecture by using 40 articles. These articles were coded and classified into variables of dynamics in post-pandemic architecture using Microsoft Excel. Through a process of coding the potential variables and classifying the characters in more detail regarding variables of the dynamics aspect associated with the security's variables in the built environment.

As mentioned in preliminary study, the concept of security has not yet discussed the form of prevention from pandemics and health issues, hence, it is important that the dynamics in post-pandemic architecture characteristics are considered in relation to each other and security variables. The identification and coding of dynamics in post-pandemic architecture characteristics described in the extant literature were used to develop strategies further, discussed below. The security variables (Briggs, 2005; O'Shea, 2009; The American Institute of Architects, 2004) namely: physical elements: (1) access movement; (2) structure; (3) supervision; (4) physical protection; pat-

Table 2. *Dynamics in post-pandemic architecture charactheristics identified in previous studies and its relationship to variables in built environment.*

Urbanism Post-Pandemic **(Previous)**	**Structure-Interior** Post-Pandemic **Aspect**	**Detail Discussion Structure-Interior Post Pandemic**	**Category of Security**	**Variables for Dynamics in Architecture Post-Pandemic** (connect to security design aspects)	
				Previous Security Aspects	**New**
Urban **Density**	**Density**	**Density on diseases on air** P1, P2, P4, P5, P6, P8, P10, P12, P13, P14, P15, P17, P18, P19, P20, P21, P22, P23, P24, P25, P27, P28, P29, P30, P31, P32, P33, P34, P38, P40,	Control	-	Indoor environmental climate
		Density on users and human activity P3, P4, P8, P10, P11, P16, P23, P31, P32, P35, P36, P37, P38, P39,	Control	Access and movement	-
				Surveillance	-
				Activity	-
				Management Maintenance	-
Urban peripheries and **sprawl**	**Peripheries & Spread**	**Peripheries & Spread on diseases on air** P1, P2, P4, P5, P6, P7, P8, P10, P12, P13, P14, P15, P17, P18, P19, P20, P21, P22, P23, P24, P25, P27, P28, P29, P30, P31, P32, P33, P34, P38, P40,	Containment	-	Indoor environmental climate
		Peripheries & Spread on human activity P3, P4, P8, P9, P10, P11, P23, P31, P32, P35, P36, P37, P38, P39,	Containment	Access and movement	-
				Surveillance	-
				Activity	-
				Management Maintenance	-
Connectivity	**Interaction**	**Close: Interaction between users** P4, P9, P10, P11, P21, P30, P32, P35, P37, P38, P39, **Not Close: User's behavior that imitating other users** P4, P9, P11, P21, P30, P32, P35, P36, P37, P38, P39,	Control	Access and movement	-
				Ownership	-
				Activity	-
Urban **Mobility**	**Mobility**	**Mobility on users** P3, P4, P8, P11, P21, P30, P31, P32, P35, P37, P38, P39,	Control	Access and movement	-
				Structure	-
				Surveillance	-
				Activity	-
				Management maintenance	-
				-	hygienist behavior
		Mobility on indoor air system P1, P2, P4, P5, P6, P7, P8, P12, P13, P14, P15, P17, P18, P19, P20, P21, P22, P23, P24, P25, P27, P28, P29, P30, P31, P32, P33, P34, P38, P40,	Control	-	Indoor environmental climate
		Mobility on humidity system P1 P8, P15, P17, P18, P19, P23, P24, P30, P33, P38,		-	Humidity
		Mobility on natural light system P8, P18, P23, P24, P30, P34, P38,		-	Natural Light
		Mobility on UV-C system P7, P19, P34, P38,	Containment	-	Physical Protection
			Control	-	UV-C System
		Mobility on droplets on building material surface P1, P4, P7, P8, P17, P18, P28, P38,	Prevent	-	Hygienist building materials
Access, space standard and protocols	**Access, Protocol and Standard**	**Access , spatial standard and protocols: user's access** P3, P4, P8, P9, P11, P21, P30, P32, P35, P36, P37, P38, P39,	Prevent	Ownership	-
				Activity	-
		Access , spatial standard and protocols: self-protection P1 P9, P10, P30, P38,	Prevent	-	hygienist behavior
		Access , spatial standard and protocols: new standards for built environment P1, P2, P3, P8, P9, P11, P23, P26, P30, P31, P34, P38, P39, P40,	Prevent	Access and movement	-
				Structure	-
				Surveillance	-
				Management Maintenance	-
		Access , spatial standard and protocol new standard for humidity and temperature P8, P9, P15, P19, P24, P26, P30, P31, P32, P33, P34, P38,	Control	-	Humidity & temperature
Place typologies as **potential areas for virus spread**	**Technology - Materials**	**Antvitirus Building materials & Droplets on surface of building materials** P1, P7, P17, P18, P28, P38,	Prevent	-	Hygienist building materials
Informal settlements and urban poverty	-				
Reduce in global infrastructure	-				

tern context: (5) activity; (6) management and maintenance; psychological context: (7) existing ownership and the possibility of new additional variables. The results of the coding and classification based on sub-aspects of the dynamics in post-pandemic architecture are presented in the following table (see Table 2).

The characteristics of sub-aspects dynamics identified in Table 2. summarize the variables identified in the literature. The integrated review papers presented in Table 1 were coded and classified according to the impact of particular variables. Below are the details finding of sub-aspects dynamics in post pandemic architecture (see Table 3).

1. “Density regarding the disease on air” discussed in 29 papers, impacted in a variable "indoor environmental climate," which controlling air movement, lowering pollutant levels, and improving indoor air quality become critical to preventing virus density in the air. This can be done by taking CO2 measurements, counting the occupancy levels, crowd density, observed mitigations, opening windows, and room volume.

2. “Density on users and human activity” discussed in 16 papers, impacted the variable ‘Access and Movement’ which controls user density; the variable of ‘surveillance’ where controlling visibility in layout and in user’s density; variable of ‘activity’ where controlling the user’s activity and variables ‘management maintenance’ in space become important. These four variables are impacted by the wide and visibility of the room, the pathway, the wall and furniture pattern, and the quality of checkpoints (for fever checkpoints, forced closure, quarantines) in reducing density.

3. ‘Peripheries & Spread of the disease on air’ discussed in 30 papers were impacted by a variable "indoor environmental climate." The indicators are similar to the aspect of disease density on air, where containment and control of air movement, reduction of pollutant levels, and improvement of indoor air quality become important to the periphery and prevent virus spread on air. This can be done by taking CO2 measurements, counting the occupancy levels, crowd density, observed mitigations, opening windows, and room volume.

4. ‘Peripheries & Spread based on Human Activity’ discussed in 14 papers. The variables "access and movement," which concern containment of the user's activity and movement; "surveillance," which controls visibility in layout and the user's activity

and movement; "ownership," which concern allowing the user's hierarchy, territory, and sense of ownership; "activity," which concern appropriate boundaries for the user's activity; and "management and maintenance," which concern providing peripheries in space, which be These six variables are impacted by the width and visibility of the room, the pathway, the wall, and furniture pattern, and the quality of checkpoints (for fever checkpoints, forced closures, and quarantines) in improving perimeters and containing the spread.

5. 'Close Interaction Between Users' discussed in 13 papers, and 'not close interaction: user's behavior that imitates other users' discussed in 11 papers. These two sub-aspects were influenced by the variables "access and movement," where containment of the user's close interaction between families and friends, and non-close interaction between strangers in the pathway and corridor become important; variable "ownership," where allowing the user's hierarchy, territory, and sense of ownership changes the interaction between families and friends; and variable "activity," where concern appropriate interaction as user's activity between families, friends, and strangers.

6. "Mobility on Users" discussed in 12 papers. The variables "access and movement," which is concerned with containing the user's movement; "structure," which is controlling the user's mobility through the structure in the built environment (walls, furniture, signage); "surveillance," which is controlling the user's mobility through natural visibility in space; "activity," which is concerned with creating appropriate user's mobility and activity; "management and maintenance," which is concerned in providing peripherals in space and 'hygienist behavior' which is concerned with the user personal protection (using mask or face mask, hand sanitizer, etc). These six variables are impacted by the width and visibility of the room, the pathway, the wall and furniture pattern, the quality of checkpoints (for fever checkpoints, forced closures, and quarantines), and individual protection.

7. 'Mobility of air in indoor air system' discussed in 30 papers were impacted in variable 'Indoor Environmental Climate' where controlling the mobility of disease, decreasing the pollutant levels and improving the condition indoor air quality become important to prevent the virus spread on air. This variable is connected to the variable density and periphery-spread of density on air.

8. 'Mobility of natural system' is divided into 3 parts. 'Mobility on humidity' discussed in 11 papers; Mobility on natural light' discussed in 7 papers and 'mobility on UV-C System' discussed in 4 papers. This mobility on the natural system was impacted by variable 'Indoor Environmental Climate', variable 'humidity' and variable 'natural light'. The need of controlling natural systems can be done by controlling humidity in the indoor air quality, improving the natural light, and improving of the natural UV-C in the built environment can help reduce the mobility of disease in the built environment.

9. 'Mobility of droplets on building material surface' discussed in 8 papers were impacted in variable 'hygienist building materials' by controlling the choice of building materials and coatings of indoor surface on walls, floor and furniture can prevent the virus spread on air.

10. 'Access, spatial standard, and protocols: Users' access discussed in 12 papers. The variable "ownership," where allowing the user's hierarchy, territory, and sense of "activity" changes the access and protocols of users.

11. 'Access, spatial standard and protocols: self-protection' discussed in 5 papers were impacted in variable 'hygienist behavior' where the degree with varied protection to improve hygienist behavior using diversity and a number of tools.

12. 'Access, spatial standard, and protocols: new standards for built environment' discussed in 14 papers. The variables "access and movement," which is concerned with containing the user's access and following protocols; "structure," which is controlling the user's access through the structure in the built environment (walls, furniture, signage); "surveillance," which is controlling the user's access through

Table 3. *Findings of sub-aspects dynamics in post-pandemic architecture charactheristics and its relationship to variables in built environment.*

		Density	Peripheries & Spread	Interaction	Mobility	Access , spatial standard and protocols	Antivirus Building materials
Previous Security Variables	Access and Movement (7%)	(Abbas & Gursel Dino, 2021; Azuma et al., 2020; Dull et al., 2021; Fezi, 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; F. Zhang & Ryu, 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Bakhtiyari et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; V. Tang et al., 2021; Zordan & Tsou, 2020).	(Abbas & Gursel Dino, 2021; Bakhtiyari et al., 2020; Dull et al., 2021; Fezi, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Mittal et al., 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Sharghi & Asadi, 2020; Shenton et al., 2019; W. Yang & Marr, 2011)	
	Structure (2%)				(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; V. Tang et al., 2021; Zordan & Tsou, 2020).	(Abbas & Gursel Dino, 2021; Bakhtiyari et al., 2020; Dull et al., 2021; Fezi, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Mittal et al., 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Sharghi & Asadi, 2020; Shenton et al., 2019; W. Yang & Marr, 2011)	
	Surveillance (5%)	(Abbas & Gursel Dino, 2021; Azuma et al., 2020; Dull et al., 2021; Fezi, 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; F. Zhang & Ryu, 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; Zordan & Tsou, 2020)		(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; V. Tang et al., 2021; Zordan & Tsou, 2020).	(Abbas & Gursel Dino, 2021; Bakhtiyari et al., 2020; Dull et al., 2021; Fezi, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Mittal et al., 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Sharghi & Asadi, 2020; Shenton et al., 2019; W. Yang & Marr, 2011)	
	Ownership (6%)		(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Bakhtiyari et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Laddu et al., 2021; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Zordan & Tsou, 2020)		(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; V. Tang et al., 2021; Zordan & Tsou, 2020)	
New Variables	Activity (8%)	(Abbas & Gursel Dino, 2021; Azuma et al., 2020; Dull et al., 2021; Fezi, 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; F. Zhang & Ryu, 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Bakhtiyari et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Laddu et al., 2021; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; V. Tang et al., 2021; Zordan & Tsou, 2020).	(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; V. Tang et al., 2021; Zordan & Tsou, 2020)	
	Management Maintenance (5%)	(Abbas & Gursel Dino, 2021; Azuma et al., 2020; Dull et al., 2021; Fezi, 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; F. Zhang & Ryu, 2021; Zordan & Tsou, 2020)	(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; L. Tang et al., 2021; Y. Yang et al., 2021; Zordan & Tsou, 2020)		(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; V. Tang et al., 2021; Zordan & Tsou, 2020).	(Abbas & Gursel Dino, 2021; Bakhtiyari et al., 2020; Dull et al., 2021; Fezi, 2021; Frumkin, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Mittal et al., 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Sharghi & Asadi, 2020; Shenton et al., 2019; W. Yang & Marr, 2011)	
	Indoor environmental climate (41%)	(Abbas & Gursel Dino, 2021; Anghel et al., 2020; Azuma et al., 2020; Bakhtiyari et al., 2020; Brittain et al., 2020; Crawford et al., 2021; Dlouši & Drikakis, 2021; Dull et al., 2021; Fezi, 2021; Foster & Kinzel, 2021; Frumkin, 2021; Guo et al., 2016; Gbadamosi et al., 2020; Grydaki et al., 2020; He et al., 2021; Huang et al., 2021; Knibbs et al., 2011; Laddu et al., 2021; Mittal et al., 2020; Mueller et al., 2020; Nasir et al., 2016; Ronchi et al., 2020; Sadrizadeh & Holmberg, 2014; Sharghi & Asadi, 2020; Singh & Verma, 2021; Smieszek et al., 2019; Sopeyin et al., 2020; Srivastava et al., 2021; W. Yang & Marr, 2011; F. Zhang & Ryu, 2021)	(Abbas & Gursel Dino, 2021; Anghel et al., 2020; Azuma et al., 2020; Bakhtiyari et al., 2020; Brittain et al., 2020; Crawford et al., 2021; Dlouši & Drikakis, 2021; Dull et al., 2021; Feiz, 2021; Foster & Kinzel, 2021; Frumkin, 2021; Guo et al., 2016; Gbadamosi et al., 2020; Grydaki et al., 2020; He et al., 2021; Huang et al., 2021; Jarvis, 2020; Knibbs et al., 2011; Laddu et al., 2021; Mittal et al., 2020; Mueller et al., 2020; Nasir et al., 2016; Ronchi et al., 2020; Sadrizadeh & Holmberg, 2014; Sharghi & Asadi, 2020; Singh & Verma, 2021; Smieszek et al., 2019; Sopeyin et al., 2020; Srivastava et al., 2021; W. Yang & Marr, 2011; F. Zhang & Ryu, 2021)		(Abbas & Gursel Dino, 2021; Anghel et al., 2020; Azuma et al., 2020; Bakhtiyari et al., 2020; Brittain et al., 2020; Crawford et al., 2021; Dlouši & Drikakis, 2021; Dull et al., 2021; Feiz, 2021; Foster & Kinzel, 2021; Frumkin, 2021; Guo et al., 2016; Gbadamosi et al., 2020; Grydaki et al., 2020; Huang et al., 2021; Jarvis, 2020; Knibbs et al., 2011; Laddu et al., 2021; Mittal et al., 2020; Mueller et al., 2020; Nasir et al., 2016; Ronchi et al., 2020; Sadrizadeh & Holmberg, 2014; Sharghi & Asadi, 2020; Singh & Verma, 2021; Smieszek et al., 2019; Sopeyin et al., 2020; Srivastava et al., 2021; W. Yang & Marr, 2011; F. Zhang & Ryu, 2021)		
	hygienist behavior (3%)			(Azuma et al., 2020; Dull et al., 2021; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Kummitha, 2020; Nasir et al., 2016; Papadaki et al., 2020; Pinter-Wollman, Jelić, et al., 2018; Ronchi et al., 2020; Sharghi & Asadi, 2020; V. Tang et al., 2021; Zordan & Tsou, 2020).	(Bakhtiyari et al., 2020; Foster & Kinzel, 2021; Kumar & Morawska, 2019; Mittal et al., 2020; Sharghi & Asadi, 2020)	
	Humidity & temperature (10%)			(Bakhtiyari et al., 2020; Brittain et al., 2020; Frumkin, 2021; Gbadamosi et al., 2020; Mecenas et al., 2020; Mittal et al., 2020; Nasir et al., 2016; Sharghi & Asadi, 2020; Sopeyin et al., 2020; Srivastava et al., 2021; F. Zhang & Ryu, 2021)	(Abbas & Gursel Dino, 2021; Bakhtiyari et al., 2020; Dull et al., 2021; He et al., 2021; Kumar & Morawska, 2019; Mecenas et al., 2020; Nasir et al., 2016; Ronchi et al., 2020; Sharghi & Asadi, 2020; Shenton et al., 2019; Sopeyin et al., 2020; Srivastava et al., 2021; F. Zhang & Ryu, 2021)	
	Natural Light (3%)				(Abbas & Gursel Dino, 2021; Bakhtiyari et al., 2020; Brittain et al., 2020; Frumkin, 2021; Nasir et al., 2016; Sharghi & Asadi, 2020; Sopeyin et al., 2020).		
	UV-C System				(Abbas & Gursel Dino, 2021; Jarvis, 2020; Sharghi & Asadi, 2020; Srivastava et al., 2021)		
	Hygienist building materials (6%)				(Azuma et al., 2020; Brittain et al., 2020; Gbadamosi et al., 2020; Jarvis, 2020; Mittal et al., 2020; Mueller et al., 2020; Nasir et al., 2016; Sharghi & Asadi, 2020)		(Brittain et al., 2020; Gbadamosi et al., 2020; Jarvis, 2020; Mittal et al., 2020; Mueller et al., 2020; Sharghi & Asadi, 2020)

natural visibility and protocols in space; "management and maintenance," which is concerned in providing access, spatial standard and protocols in space.

13. 'Access, spatial standard and protocols new standards for humidity and temperature' discussed in 12 papers, were impacted in variable 'humidity and temperature' where the need of controlling of natural systems can be done by controlling humidity and temperature in the indoor air quality (warm and wet climates seem to reduce the spread of virus).

14. 'Antivirus Building Materials & Droplets on Surface of Building Materials' discussed in 6 papers were impacted in variable 'hygienist behavior' where the degree with varied protection to improve hygienist behavior using diversity and number of tools.

According to these findings, there are 7% of articles discuss the variable 'Access and Movement', 2% of articles discuss the variable 'structure', 5% of articles discuss the variable 'surveillance', 6% of articles discuss the variable 'ownership', 8% of articles discuss the variable 'activity', 5% of articles discuss the variable 'management maintenance', 41% of articles discuss the variable 'indoor environmental climate, 3% of articles discuss the variable 'hygienist behavior', 10% of articles discuss the variable 'humidity and temperature', 3% of articles discuss the variable 'natural light', 2% of articles discuss the variable 'UV-C System' and 6% of articles discuss the variable 'hygienist building materials' (see Figure 2)

4.3 The synthesis: Strategies for dynamics in post-pandemic architecture

The process of synthesis started by breaking down in more detail the perspective of dynamics in post-pandemic architecture, coding, and classifying and grouping similar topics to create a "dynamics in post-pandemic architecture" framework. The framework was defined in terms of "variables," "indicators," and "factors." The "variables" have been explained in a previous sub-chapter. In this sub-chapter, we will explain in more detail the existence of indicators, factors, and measurement objectives to clarify the discussion of the variables that appear and create strategies for a dynamics in post-pandemic architecture. The results are presented in Table 4.

Based on these findings, below is a synthesis of variables, indicators, and factors:

- "Access and Movement": The indicator is the presence of access to pathways and orienting objects. The factor and measurement criteria are

based on well-defined routes, spaces, entrances, and pathways that provide movement, access, and peripheries to humans and disease.

- "Structure": The indicator is the degree to which places are structured and do not cause conflict. The factor and measurement criteria are the zoning, orientation, and structure of the room (wall, floor, furniture) that structure human mobility without causing conflict.
- "Surveillance"—The indicator is the degree to which surveillance provides appropriate natural visual visibility through the layout. The width of the room and the spaces overlooked for visibility are the factors and measurement criteria.
- "Ownership"—The degree to which the built environment provides a hierarchy, a sense of ownership, boundaries, and personalization is the indicator. The layout, floor area, and furniture layout are the factors and measurement criteria to promote a sense of ownership, personalization, and territoriality.
- "Activity"—The indicator is the degree to which users have an appropriate activity, mobility, access, and spatial configuration of space. The factor and measurement criteria are appropriate elements of the built environment that facilitate user activity and are appropriate to the location.
- "Management maintenance"—The indicator measures the extent to which management has provided appropriate space maintenance. The factors and measurement criteria are control and quality, and they are designed with management and maintenance in mind.
- "Indoor environmental climate"—the indicator is related to the pollutant level and air conditions. The factors and measurement criteria are CO2 measurements, occupancy levels, crowd density, room volume, and opening window size and position to reduce or prevent the spread of infectious disease.
- "Hygienist behavior"—The indicator is related to varied protection to improve hygienist behavior. The factors and measurement criteria are the amount of diversity and the tools to help improve hygienist behavior.
- "Humidity and temperature"—The indicator is related to the degree of central humidity and cooling system in the room. The thermostat and air conditioner central control are the factor and measurement criteria.
- "Natural light"—The indicator is related to the control, quantity, and quality of natural lighting in the room. The natural light orientation and glazing area with no direct sunlight but a larger window are the factor and measurement criteria.
- "UV-C System"—The indicator is related to the degree of control of the UV-C system in the room. The better qualities of UV-C lighting power are the factor and measurement criteria.
- "Hygienic building materials"—The indicator is related to the choice of building materials and the coatings of indoor surfaces on walls, floors, and furniture. The factor and measurement criteria are the quality and quantity of building materials used to help improve room hygiene.

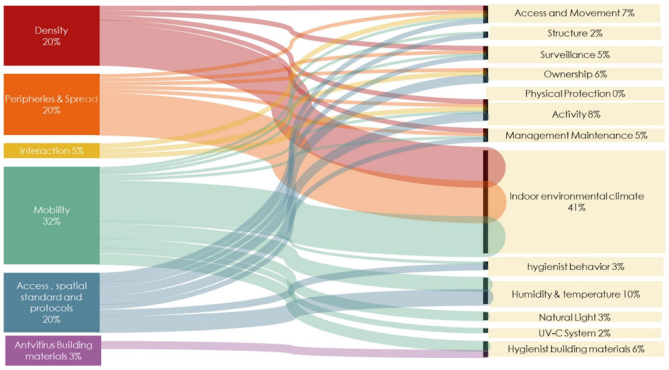

Figure 2. *Relationship between aspects dynamics in post-pandemic architecture.*

Based on the result, there are some adjustments, changed and new security variables for dynamics in post-pandemic architecture. The conclusion of the changed and strategies of Dynamics in post-pandemic architecture as mentioned below:

- Density aspects related to security context (variables: access and movement, surveillance, activities, maintenance management) and

Table 4. *Dynamics in post-pandemic architecture variables, indicator, factors and measurement criteria.*

Dynamics in Post-Pandemic Architecture Aspect (Structure-Interior)		Sub-Aspect Security-Pandemic	Variables of Security-Pandemic Theory	Indicators of Security-Pandemic Theory	Factors of Security-Pandemic Theory	Measurement Criteria
DENSITY	**CONTROL** Density on diseases on air	Indoor environmental climate (NEW)	Indoor air quality (air pollution, odours, fresh air supply, ventilation)	The Indoor Air Quality related to pollutant levels (e.g. dust, Volatile Organic Compounds (VOCs) etc.) and air conditions (e.g. CO2 and humidity)	CO2 measurements, occupancy levels, crowd density estimates and observed adherence to mitigations (e.g. wearing face coverings) Room Volume Opening window size and position	to reduce or prevent the spread of infectious diseases through different modes of disease transmission by using of plants or other organism to absorb the pollutants, introduce new air and purify the air
	CONTROL Density on users and human activity	Physical Elements (OLD)	Access and movement	The presense of access of pathway and orienting objects with identifiable destinations	The Wide of pathway and orienting pathway	Well-defined routes, space and entrance that provide convenient movement without compromising security;
			Surveillance	The degree to which the surveillance provides appropriate visual layout supporting density of users	The Wide of room and visibility	all publicly accessible spaces are overlooked
		Pattern Context (OLD)	Activity	The degree to which the users have an appropriate density and activity on space	Appropriate structure-interior elements (eg. Walls, floor pattern and furniture pattern) to ease users density (eg. reducing capacity, fever checkpoints, forced closure, voluntary quarantines)	level of human activity is appropriate to the location
			Management maintenance	The degree to which the management have an appropriate maintenance of space to prevent density	Control and the quality of checkpoint and users' density	Designed with management and maintenance in mind
Peripheries & Spread	**CONTAINMENT** Peripheries & Spread of disease on air	Indoor environmental climate (NEW)	Indoor air quality (air pollution, odours, fresh air supply, ventilation)	The Indoor Air Quality related to pollutant levels (e.g. dust, Volatile Organic Compounds (VOCs) etc.) and air conditions (e.g. CO2 and humidity)	CO2 measurements, occupancy levels Room Volume Opening window size and position	to reduce or prevent the spread of infectious diseases through different modes of disease transmission (indirect contact with pathogens and contaminated object, direct person to person contact, droplet spread)
	CONTAINMENT Peripheries & Spread based on human activity	Physical Element	Access and movement	The presense of access of pathway and orienting objects with identifiable destinations	The Wide of pathway and orienting pathway	Well-defined routes, space and entrance that provide convenient movement without compromising security;
			Surveillance	The degree to which the surveillance provides appropriate visual layout supporting density of users	The Wide of room and visibility	all publicly accessible spaces are overlooked
		Psychological Context	Ownership	The degree to which the structure-interior allows to provide hierarchy, sense of ownership	layout, floor area, furniture layouting	promote a sense of ownership, respect, territorial, responsibility and community
		Pattern context	Activity	The degree to which the users have an appropriate boundaries and activity on space	appropriate structure-interior elements (eg. Walls, floor pattern and furniture pattern) to ease users density (eg. reducing capacity, fever checkpoints, forced closure, voluntary quarantines)	level of human activity is appropriate to the location
			Management maintenance	The degree to which the management have an appropriate maintenance of space to provide peripheries and spread	Control and the quality of checkpoint and users' density	Designed with management and maintenance in mind
Interaction	**CONTROL** Close: Interaction between users	Physical Element	Access and movement	The presense of access of pathway and orienting objects with identifiable destinations	The Wide of pathway and orienting pathway	Well-defined routes, space and entrance that provide convenient movement without compromising security;
	Not Close: User's behavior that imitating other users	Psychological Context	Ownership	The degree to which the structure-interior allows to provide hierarchy, sense of ownership, boundary, personalization	layout, floor area, furniture layouting	promote a sense of ownership, respect, territorial, responsibility and community
		Pattern context	Activity	The degree to which the users have an appropriate boundaries; activity on space and the pattern of close and social contact	appropriate structure-interior elements (eg. Walls, floor pattern and furniture pattern) to ease users mobility (eg. forced closure, voluntary quarantines)	level of human activity is appropriate to the location

Table 4. *(continued).*

Dynamics in Post-Pandemic Architecture Aspect (Structure-Interior)	Sub-Aspect Security-Pandemic	Variables of Security-Pandemic Theory	Indicators of Security-Pandemic Theory	Factors of Security-Pandemic Theory	Measurement Criteria
Mobility	**CONTROL** Mobility on users	Access and movement	The presense of access of pathway and orienting objects with identifiable destinations	The Wide of pathway and orienting pathway	Well-defined routes, space and entrance that provide convenient movement without compromising security;
		Structure	The degree to which the user have places that are structured - different users do not cause conflict	The zoning in the room and orienting of the room	level of human mobility structured without causing conflict and appropriate to the location
		Surveillance	The degree to which the surveillance provides appropriate visual layout supporting mobility of users	The Wide of room and visibility	all publicly accessible spaces are overlooked
		Activity	The degree to which the users have an appropriate mobility and spatial configuration of space	Appropriate structure-interior elements (eg. Walls, floor pattern and furniture pattern) to ease users density (eg. reducing capacity, fever checkpoints, forced closure, voluntary quarantines)	level of human activity is appropriate to the location
		Management maintenance	The degree to which the management have an appropriate maintenance of space to control mobility	Control and the quality of checkpoint and users' mobility	Designed with management and maintenance in mind
		hygienist behavior	The degree to which the room allows varied protection to improve hygienist behavior	visual diversity and number of tools to help improve hygienist behavior	well-defined rooms for hygienist behavior
	CONTROL Mobility on indoor air system	Indoor air quality (air pollution, odours, fresh air supply, ventilation)	The Indoor Air Quality related to pollutant levels (e.g. dust, Volatile Organic Compounds (VOCs) etc.) and air conditions (e.g. CO2 and humidity)	CO2 measurements, occupancy levels Room Volume Opening window size and position	to reduce or prevent the spread of infectious diseases through different modes of disease transmission (indirect contact with pathogens and contaminated object, direct person to person contact, droplet spread)
	CONTROL Mobility on humidity system	Indoor Humidity and the temperature of the room	The degree to which the central humidity and cooling system can be controlled	Air Conditioner central control	Termostat in the room give better control
	CONTROL Mobility on natural light system	Natural Light (NEW)	Light	The quality and quantitiy of natural light in the room can receive	Natural Light orientation	Larger windows with direct sunlight but not creating glare
				The degree to which the lighting level can be controlled	Glazing area	More and better quality
	CONTROL Mobility on UV-C system	Physical Element	Physical Protection	Well-designed security features for UV-C System	Number of UV-C System	More and better quality
		UV-C System (NEW)	UV-C System	The degree to which the UV-C level can be controlled	UV-C Lighting power	UV-C system with better quality
	PREVENT Mobility on droplets on building material surface	Hygienist building materials (NEW)	Hygienist building materials on surface	The choice of building materials and coatings of indoor surface on walls, floor and furniture.	number of building materials to help improve hygienist materials	More and better quality
Access, Protocol and Standard	**PREVENT** Access , spatial standard and protocols: user's access	Psychological Context	Ownership	The degree to which the structure-interior allows to provide hierarchy of access, sense of ownership, boundary, personalization	layout, floor area, furniture layouting	promote a sense of ownership, respect, territorial, responsibility and community
		Pattern context	Activity	The degree to which the users have an appropriate boundaries; activity on space and the pattern of close and social contact	appropriate structure-interior elements (eg. Walls, floor pattern and furniture pattern) to ease users mobility (eg. forced closure, voluntary quarantines)	level of human activity is appropriate to the location
	PREVENT Access , spatial standard and protocols: self-protection	Hygienist behavior (NEW)	hygienist behavior	The degree to which the room allows varied protection to improve hygienist behavior	visual diversity and number of tools to help improve hygienist behavior	well-defined rooms for hygienist behavior

Dynamics in Post-Pandemic Architecture Aspect (Structure-Interior)	Sub-Aspect Security-Pandemic	Variables of Security-Pandemic Theory	Indicators of Security-Pandemic Theory	Factors of Security-Pandemic Theory	Measurement Criteria
	PREVENT Access , spatial standard and protocols: new standards for built environment	Access and movement	The presense of access of pathway and orienting objects with identifiable destinations	The Wide of pathway and orienting pathway	Well-defined routes, space and entrance that provide convenient movement without compromising security;
		Structure	The degree to which the user have access places that are structured - different users do not cause conflict	The zoning in the room and orienting of the room	level of human accessed structured without causing conflict and appropriate to the location
		Surveillance	The degree to which the surveillance provides appropriate visual layout	The Wide of room and visibility	all publicly accessible spaces are overlooked
		Pattern Context	Management maintenance	The degree to which the management have an appropriate maintenance of space to control mobility	Control and the quality of checkpoint and users' mobility	Designed with management and maintenance in mind
	CONTROL Access , spatial standard and protocol new standard for humidity and temperature	Humidity & temperature (NEW)	Indoor Humidity and the temperature of the room	The degree to which the central humidity and cooling system can be controlled	Air Conditioner central control	Termostat in the room give better control
Technology - Materials	**PREVENT** Antvitirus Building materials & Droplets on surface of building materials	Hygienist building materials (NEW)	Hygienist building materials on surface	The choice of building materials and coatings of indoor surface on walls, floor and furniture.	number of building materials to help improve hygienist materials	More and better quality

new variable: Climate and Nature (Indoor Air Quality)

- Aspects of peripheries and spread related to security context (variables: surveillance, activity, access - movement, maintenance, and ownership management) and new variable: Climate and Natural (Indoor Air Quality)
- Aspect of interaction related to the previous security context (variables: activity, access-movement,

and ownership)
- Aspect of mobility is related to the security context (variables such as structure, supervision, activities, maintenance management, physical protection, and ownership) and new variables (behavioral, hygienic behavior, climate, and nature) (indoor air quality, humidity, room temperature, natural lighting, UVC-System, hygienic surfaces of building materials, and so on).
- Aspects of access, spatial standards, and protocols related to the security context (variables: structure, supervision, activities, access and movement, management of care, and ownership) and new variables (Hygienic behavior, humidity and room temperature, hygienic building material surfaces)
- Behavior of Antivirus Building Materials in the new variables (Hygienic Building Materials)

5. Conclusion

The literature review on the dynamics in post-pandemic architecture is growing rapidly. The relationship between the dynamics' aspects and the need for security in the built environment has been elevated and is growing rapidly. Before the pandemic, security as a built environment helped improve the public space by safeguarding it from crime. But during and after the pandemic, the concept of security changed and needed adjustment. The aspect dynamics in post-pandemic architecture also need to be adjusted based on this need.

After some study and a literature review, this paper has identified the changed dynamics in post-pandemic architecture and strategies that affect the built environment in future disease prevention. Some of the security variables in previous studies need to be adjusted, and there are new security variables for dynamics in post-pandemic architecture. The previous security variables are having adjustment and still used in dynamics in post pandemic architecture. For example: "access and movement" variable is orientating to limit people accessing the building and controlling the movement of people (using physical and social distance). The new variables in dynamic(s) post-pandemic architecture are in natural environment context (indoor environmental climate, humidity and temperature, natural light, UV-C System) and behavior context (hygienist behavior form the users and usage of hygienic building materials). In conclusion, there are adjustment in previous security variables and additional strategies for Dynamics in post-pandemic architecture.

Some limitations of this study are as follows: some papers not written in English or Bahasa were excluded; some interesting aspects such as distancing and the pattern of living and working in the new normal are not discussed; the articles included in this review are up to August 2022 (and there is the possibility of new articles). This paper provides a current state-of-the-art review of current research in the field, as well as a strategy for future research in the field to improve understanding of the dynamics aspect in design-related fields.

References

Abbas, G. M., & Gursel Dino, I. (2021). The impact of natural ventilation on airborne biocontaminants: a study on COVID-19 dispersion in an open office. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ECAM-12-2020-1047

Alhusban, A. A., Alhusban, S. A., & Alhusban, M. A. (2022). How the COVID 19 pandemic would change the future of architectural design. *Journal of Engineering, Design and Technology*, *20*(1), 339–357. https://doi.org/10.1108/JEDT-03-2021-0148/FULL/HTML

Anghel, L., Popovici, C. G., Stătescu, C., Sascău, R., Verdeș, M., Ciocan, V., Șerban, I. L., Mărănducă, M. A., Hudișteanu, S. V., & Țurcanu, F. E. (2020). Impact of HVAC-Systems on the Dispersion of Infectious Aerosols in a Cardiac Intensive Care Unit. *International Journal of Environmental Research and Public Health*, *17*(18), 1–17. https://doi.org/10.3390/ijerph17186582

Atlas, R. (2013). *21st Century and CPTED: Designing for Critical Infrastructure Protection and Crime Pre-*

vention. New York: Taylor & Francis Group.

Augustin, S., Frankel, N., & Coleman, C. (2009). *Place advantage: Applied psychology for interior architecture*. New Jersey: John Wiley & Sons, Inc.

Azuma, K., Yanagi, U., Kagi, N., Kim, H., Ogata, M., & Hayashi, M. (2020). Environmental factors involved in SARS-CoV-2 transmission: effect and role of indoor environmental quality in the strategy for COVID-19 infection control. *Environmental Health and Preventive Medicine*, *25*(1). https://doi.org/10.1186/s12199-020-00904-2

Bakhtiyari, S., Mirzaei, A., Jalilian, M., Mazlomi, S., Nourmoradi, H., & Kakaei, H. (2020). The effects of personal, environmental, and genetic factors on epidemic of coronavirus disease-19: A review of the current literature. *Open Access Macedonian Journal of Medical Sciences*, *8*(T1), 250–257. https://doi.org/10.3889/oamjms.2020.5098

Barrett, P., Davies, F., Zhang, Y., & Barrett, L. (2015). The impact of classroom design on pupils' learning: Final results ofaholistic, multi-level analysis. *Building and Environment*, *89*, 118–133. https://doi.org/10.1016/J.BUILDENV.2015.02.013

Briggs, R. (2005). *Invisible Security: The impact of counter-terrorism on the built environment*. Retrived from: http://www.cedus.it/files/impact-of-counter-terrorism.pdf

Brittain, O. S., Wood, H., & Kumar, P. (2020). *Prioritising indoor air quality in building design can mitigate future airborne viral outbreaks*. https://doi.org/10.1080/23748834.2020.1786652

Broome, M.E. (2000). Integrative Literature Reviews for the Development of Concepts. In B. L. Rodgers & K. A. Knafl (Eds.), *Concept Development in Nursing: Foundations, Techniques and Applications*. Philadelphia: W.B. Saunders Company.

Crawford, C., Vanoli, E., Decorde, B., Lancelot, M., Duprat, C., Josserand, C., Jilesen, J., Bouadma, L., & Timsit, J.-F. (2021). Modeling of aerosol transmission of airborne pathogens in ICU rooms of COVID-19 patients with acute respiratory failure. *Scientific Reports*, *11*(1), 11778. https://doi.org/10.1038/s41598-021-91265-5

Dbouk, T., & Drikakis, D. (2021). On airborne virus transmission in elevators and confined spaces. *Physics of Fluids*, *33*(1), 011905. https://doi.org/10.1063/5.0038180

Duill, F. F., Schulz, F., Jain, A., Krieger, L., van Wachem, B., & Beyrau, F. (2021). The Impact of Large Mobile Air Purifiers on Aerosol Concentration in Classrooms and the Reduction of Airborne Transmission of SARS-CoV-2. *International Journal of Environmental Research and Public Health*, *18*(21). https://doi.org/10.3390/ijerph182111523

Fezi, B. A. (2021). The Role of Architecture and Urbanism in Preventing Pandemics. In V. Kumar (Ed.), *SARS-CoV-2 Origin and COVID-19 Pandemic Across the Globe*. https://doi.org/10.5772/intechopen.98294

Foster, A., & Kinzel, M. (2021). Estimating COVID-19 exposure in a classroom setting: A comparison between mathematical and numerical models. *Physics of Fluids (Woodbury, N.Y. : 1994)*, *33*(2). https://doi.org/10.1063/5.0040755

Frumkin, H. (2021). COVID-19, the Built Environment, and Health. *Environmental Health Perspectives*, *129*(7), 075001. https://doi.org/10.1289/EHP8888

Gao, X., Wei, J., Lei, H., Xu, P., Cowling, B. J., & Li, Y. (2016). Building Ventilation as an Effective Disease Intervention Strategy in a Dense Indoor Contact Network in an Ideal City. *PLOS ONE*, *11*(9), e0162481. https://doi.org/10.1371/journal.pone.0162481

Gbadamosi, A. Q., Oyedele, L., Olawale, O., & Abioye, S. (2020). Offsite Construction for Emergencies: A focus on Isolation Space Creation (ISC) measures for the COVID-19 pandemic. *Progress in Disaster Science*, *8*. https://doi.org/10.1016/j.pdisas.2020.100130

Grydaki, N., Colbeck, I., Mendes, L., Eleftheriadis, K., & Whitby, C. (2020). Bioaerosols in the Athens Metro: Metagenetic insights into the PM10 microbiome in a naturally ventilated subway station. *Environment International*, *146*. https://doi.org/10.1016/j.envint.2020.106186

Haigh, R., & Amaratunga, D. (2010). An integrative review of the built environment discipline's role

in the development of society's resilience to disasters. *International Journal of Disaster Resilience in the Built Environment*, *1*(1), 11–24. https://doi.org/10.1108/17595901011026454

He, R., Liu, W., Elson, J., Vogt, R., Maranville, C., & Hong, J. (2021). Airborne transmission of COVID-19 and mitigation using box fan air cleaners in a poorly ventilated classroom. *Physics of Fluids (Woodbury, N.Y. : 1994)*, *33*(5). https://doi.org/10.1063/5.0050058

Huang, J., Jones, P., Zhang, A., Hou, S. S., Hang, J., & Spengler, J. D. (2021). Outdoor Airborne Transmission of Coronavirus Among Apartments in High-Density Cities. *Frontiers in Built Environment*, *7*. https://doi.org/10.3389/fbuil.2021.666923

Jarvis, M. C. (2020). Aerosol Transmission of SARS-CoV-2: Physical Principles and Implications. *Frontiers in Public Health*, *8*. https://doi.org/10.3389/fpubh.2020.590041

Knibbs, L. D., Morawska, L., Bell, S. C., & Grzybowski, P. (2011). Room ventilation and the risk of airborne infection transmission in 3 health care settings within a large teaching hospital. *American Journal of Infection Control*, *39*(10), 866–872. https://doi.org/10.1016/j.ajic.2011.02.014

Kumar, P., & Morawska, L. (2019). Could fighting airborne transmission be the next line of defence against COVID-19 spread? *City and Environment Interactions*, *4*. https://doi.org/10.1016/j.cacint.2020.100033

Kummitha, R. K. R. (2020). Smart technologies for fighting pandemics: The techno- and human- driven approaches in controlling the virus transmission. *Government Information Quarterly*, *37*(3). https://doi.org/10.1016/j.giq.2020.101481

Laddu, D., Paluch, A. E., & LaMonte, M. J. (2021). The role of the built environment in promoting movement and physical activity across the lifespan: Implications for public health. In *Progress in Cardiovascular Diseases* (Vol. 64, pp. 33–40). W.B. Saunders. https://doi.org/10.1016/j.pcad.2020.12.009

Lockton, D., & Stanton, N. a. (2010). *Design with Intent - 101 patterns for influencing behaviour through design*. Bekshire: Equifine Windsor

Maturana, B., Salama, A. M., & McInneny, A. (2021). Architecture, urbanism and health in a post-pandemic virtual world. *Archnet-IJAR: International Journal of Architectural Research*, *15*(1), 1–9. https://doi.org/10.1108/ARCH-02-2021-0024

McClure, W. R., & Bartuska, T. J. (2007). *The Built Environment: A Collaborative Inquiry into Design and Planning* (Wendy R. McClure & Tom J. Bartuska, Eds.; 2nd Edition). John Wiley & Sons, Inc.

Mecenas, P., da Rosa Moreira Bastos, R. T., Rosário Vallinoto, A. C., & Normando, D. (2020). Effects of temperature and humidity on the spread of COVID-19: A systematic review. *PLoS ONE*, *15*(9 September). https://doi.org/10.1371/journal.pone.0238339

Megahed, N. A., & Ghoneim, E. (2020). Antivirus-built environment: Lessons learned from Covid-19 pandemic. *Sustainable Cities and Society*, *61*, 102350–102350. https://doi.org/10.1016/j.scs.2020.102350

Mittal, R., Ni, R., & Seo, J. H. (2020). The flow physics of COVID-19. *Journal of Fluid Mechanics*, *894*(894). https://doi.org/10.1017/jfm.2020.330

Mueller, J. T., McConnell, K., Burow, P. B., Pofahl, K., Merdjanoff, A. A., & Farrell, J. (2020). Impacts of the COVID-19 pandemic on rural America. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(1). https://doi.org/10.1073/PNAS.2019378118

Murphy, M. (2020). *The role of architecture in fighting a pandemic*. The Boston Globe. Retrived from: https://www.boston-globe.com/2020/04/06/opinion/role-ar-chitecture-fighting-pandemic

Nasir, Z. A., Campos, L. C., Christie, N., & Colbeck, I. (2016). Airborne biological hazards and urban transport infrastructure: current challenges and future directions. *Environmental Science and Pollution Research International*, *23*(15), 15757–15766. https://doi.org/10.1007/s11356-016-7064-8

O'Shea, L. (2009). *Design and Security in the Built Environment*. Fairchild Books.

Papadaki, K., Karma, S., Siountri, K., Siti, M., Vassi, A., & Bakogiannis, E. (2020). Re-designing the Built Environment as a Strategic Tool for

Anticipating Emergency Situations: The Greek Strategy for Dealing with COVID-19 Crisis. *INTREST – International Journal of Real Estate Studies*, *14*(S1), 62–72. Retrieved from https://intrest.utm.my/index.php/intrest/article/view/64

Pinter-Wollman, N., Jelić, A., & Wells, N. M. (2018). The impact of the built environment on health behaviours and disease transmission in social systems. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1753), 20170245. https://doi.org/10.1098/rstb.2017.0245

Ronchi, E., Scozzari, R., & Fronterrè, M. (2020). *A risk analysis methodology for the use of crowd models during the Covid-19 pandemic*. Retrived from https://www.lunduniversity.lu.se/lup/publication/73f845d2-1a9d-432f-a8a8-63969c5b78ad

Sadrizadeh, S., & Holmberg, S. (2014). Surgical clothing systems in laminar airflow operating room: a numerical assessment. *Journal of Infection and Public Health*, *7*(6), 508–516. https://doi.org/10.1016/j.jiph.2014.07.011

Salama, A. M. (2020). Coronavirus questions that will not go away: interrogating urban and socio-spatial implications of COVID-19 measures. *Emerald Open Research*, *2*, 14. https://doi.org/10.35241/emeraldopenres.13561.1

Sharghi, A., & Asadi, S. (2020). Effect of Built Environment on Health Dimensions during the Quarantine: A Cross-Sectional Study Following the Covid-19 Pandemic in Iran. *Journal of Rescue and Relief*, *12*(4), 242–253. https://doi.org/10.32592/jorar.2020.12.4.2

Shenton, F. C., Addissie, A., Alabaster, G., Baziwe, D., Carrasco Tenezaca, M., Chinula, D., Jatta, E., Jawara, M., Jones, R., Knudsen, J., Krystosik, A. R., McCann, R., Murima, N., Mutuku, F., Nguela, R. L., Nieto Sanchez, C., Nix, E., Okumu, F., Ruel-Bergeron, S., … Lindsay, S. W. (2019). Research agenda for preventing mosquito-transmitted diseases through improving the built environment in sub-Saharan Africa. *Cities & Health*, 1–9. https://doi.org/10.1080/23748834.2019.1684771

Singh, V., & Verma, S. (2021). Unearthing the response pattern of COVID-19 research in social sciences. *International Journal of Sociology and Social Policy*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/IJSSP-04-2021-0094

Smieszek, T., Lazzari, G., & Salathé, M. (2019). Assessing the Dynamics and Control of Droplet- and Aerosol-Transmitted Influenza Using an Indoor Positioning System. *Scientific Reports*, *9*(1), 2185. https://doi.org/10.1038/s41598-019-38825-y

Sopeyin, A., Hornsey, E., Okwor, T., Alimi, Y., Raji, T., Mohammed, A., Moges, H., Onwuekwe, E. V. C., Minja, F. J., Gon, G., Ogbuagu, O., Ogunsola, F., & Paintsil, E. (2020). Transmission risk of respiratory viruses in natural and mechanical ventilation environments: implications for SARS-CoV-2 transmission in Africa. *BMJ Global Health*, *5*(8). https://doi.org/10.1136/bmjgh-2020-003522

Srivastava, S., Zhao, X., Manay, A., & Chen, Q. (2021). Effective ventilation and air disinfection system for reducing coronavirus disease 2019 (COVID-19) infection risk in office buildings. *Sustainable Cities and Society*, *75*. https://doi.org/10.1016/j.scs.2021.103408

Tang, L., Liu, M., Ren, B., Chen, J., Liu, X., Wu, X., Huang, W., & Tian, J. (2021). Transmission in home environment associated with the second wave of COVID-19 pandemic in India. *Environmental Research*, *204*(Pt A). https://doi.org/10.1016/j.envres.2021.111910

Tang, V., Acedo, A., & Painho, M. (2021). Sense of place and the city: the case of foreign residents in Lisbon. *JOURNAL OF SPATIAL INFORMATION SCIENCE Number N*, xx-yy. https://doi.org/10.5311/JOSIS.YYYY.II.NNN

The American Institute of Architects. (2004). *Security planning and design : a guide for architects and building design professionals.* In Joseph A. Demkin (Ed.), New Jersey: John Wiley & Sons.

Torraco, R. J. (2005). Writing Integrative Literature Reviews: Guidelines and Examples. *Human Resource Development Review*, *4*(3), 356–367. https://doi.org/10.1177/1534484305278283

Yağcı Ergün, S. F., & Nebioğlu, A. (2022). Reanalyzing the features of the traditional Turkish houses in view

of the Covid-19. *A|Z ITU JOURNAL OF THE FACULTY OF ARCHITECTURE*, *19*(3), 487–500. https://doi.org/10.5505/ITUJFA.2022.33497

Yang, W., & Marr, L. C. (2011). Dynamics of Airborne Influenza A Viruses Indoors and Dependence on Humidity. *PloS One*, *6*(6). https://doi.org/10.1371/journal.pone.0021481

Yang, Y., Li, Y., Kral, K., Hupert, N., & Dogan, T. (2021). Urban design attributes and resilience: COVID-19 evidence from New York City. *Buildings and Cities*, *2*(1), 618. https://doi.org/10.5334/bc.130

Zamani, Z. (2019). Effects of Emergency Department Physical Design Elements on Security, Wayfinding, Visibility, Privacy, and Efficiency and Its Implications on Staff Satisfaction and Performance. *Health Environments Research and Design Journal*, *12*(3), 72–88. https://doi.org/10.1177/1937586718800482

Zhang, F., & Ryu, Y. (2021). Simulation Study on Indoor Air Distribution and Indoor Humidity Distribution of Three Ventilation Patterns Using Computational Fluid Dynamics. *Sustainability*, *13*(7), 3630. https://doi.org/10.3390/su13073630

Zhang, Y., Tzortzopoulos, P., & Kagioglou, M. (2019). Healing built-environment effects on health outcomes: environment–occupant–health framework. *Building Research and Information*, *47*(6), 747–766. https://doi.org/10.1080/09613218.2017.1411130

Zordan, M., & Tsou, J. Y. (2020). Urban Transitions in Pandemic Scenarios: Insights from Hong Kong. *Journal of ASIAN Behavioural Studies*, *5*(17), 55–70. https://doi.org/10.21834/jabs.v5i17.376