Investigating the Impact of Educational Space Design in Fostering Social Distancing: A Case Study of the University of Technology Buildings, Iraq

Ahmed M. Hameed Al-Delfi*, Abdullah S. Salman

University of Technology - Iraq, Department of Architecture, Baghdad, Iraq

*Corresponding author: **90136@uotechnology.edu.iq**

cross**ref** http://dx.doi.org/10.5755/j01.sace.31.2.30746

In the light of the ongoing outbreak of epidemics, the Iraqi government ordered the temporary closure of university buildings and explicit compliance with social distancing, fearing increased infection rates among the large numbers of students. This closure, and the fear of infection, acted as an obstacle for users of educational spaces. To overcome this challenge, the study aimed to investigate the impact of educational space design on the effectiveness of social distancing to reduce the spread of epidemics. The shape, area, and furniture arrangement pattern were determined in the study of educational spaces design as a spatial configuration through the level of wayfinding and permeability. To better understand the relationship between the design of the current educational spaces and the effectiveness of social distancing, this study used a visual survey, field visits, and a quantitative method using a space syntax analysis. And the analysis was carried out on various models of educational spaces design in three elected samples of the buildings of the Technological University Baghdad, Iraq. The analysis values were represented in quantitative tables to illustrate the values of the space syntax attributes and charts showing measures of permeability and wayfinding in all the analysed models. The study results show an impact and a close relationship between the elements of educational space design as a spatial composition and the effectiveness of social distancing. This relationship is formed by the effect of the shape, space, and furniture arrangement pattern in changing the values of spatial space relationships. Furthermore, permeability and wayfinding as spatial characteristics depend on those relationships and control users' circulation within the educational space, which is essential in determining the effectiveness of social distancing.

Keywords: educational space design, university buildings, social distancing, space syntax.

Abstract

Introduction

After the outbreak of (Covid-19) worldwide, Iraq witnessed many waves of epidemics during this period. In response, the Iraqi government took strict measures, including implementing forced social distancing, following WHO's recommendations as preventive measures to reduce the spread of epidemics (WHO, 2020). Social distancing is the most effective strategy for reducing the spread of epidemics, especially in cramped spaces within buildings where many people are present (Prem et al., 2020). The Iraqi government has repeatedly ordered the temporary closure of university buildings and explicit compliance with social distancing, fearing increased infection rates among the large numbers of students. This closure, and the fear of infection, acted as an obstacle for most university building users in educational activities (Ayyildiz and Taskin Gumus, 2021).

Furthermore, to overcome this challenge, many questions have arisen about the problems of designing existing university buildings and how to improve their ability to adapt to new and emerging needs with pandemic outbreaks (Güzelci et al., 2020; Ian Taylor, 2021, p. 188). Accordingly, and with the importance of ensuring continuity of use and at the same time preventing epidemics, the design of architectural spaces must be studied and evaluated from the perspective of epidemic prevention (Megahed and Ghoneim, 2020; Salama, 2020); these include educational spaces in university buildings. The fact that educational space is one of the essential factors in supporting the success of the educational environment that embraces students and faculty (Menon and Suresh, 2020). However, the educational process as an activity practiced in the spaces of university buildings is an essential part of this process based on participation and social interaction between students and faculty, especially in co-working spaces, laboratories, and classrooms (Alnusairat et al., 2020). That is, part of the educational activity is the social aspect.

Thus, educational spaces can increase the spread of potential infections among users. After this saying, the educational spaces must architecturally have spatial characteristics that facilitate compliance with social distancing among users. These spatial solutions are critical because of the approach of conducting educational activities in university buildings, which means more potential risks in increasing the spread of epidemics. University of Technology buildings have a range of facilities, some educational establishments, and others administrative and service buildings. Three samples of educational buildings were elected to study the design of educational spaces in terms of shape, area, and furniture arrangement pattern. Achieving continuity in the use of spaces with effective implementation of social distancing is one aspect of improving the ability of educational buildings to adapt to emerging requirements during pandemic outbreaks (Güzelci et al., 2020). The study aimed to investigate the impact of educational space design on the effectiveness of social distancing to reduce the spread of epidemics. Achieving the aim of this study requires careful evaluation of the spatial configuration of the current educational space and a better understanding of users' internal circulation toward creating an enhanced spatial design that fosters compliance with social distancing within the educational space. More specifically, this study seeks to answer the following research questions:

1. How do elements of educational space design impact the effectiveness of social distancing?
2. What is the appropriate design for an educational space with an excellent social distancing effectiveness level?

The study used the space syntax analysis through the level of permeability and wayfinding, as they are influential factors in facilitating the implementation of social distancing (Abdul Nasir et al., 2021). The space syntax is a method to describe, analyse and measure spatial relationships of spatial configuration within or outside architectural spaces (Jiang and Claramunt, 2002). This analysis provides clear explanations about the potential impact of educational space design as a spatial composition on the level of social distancing effectiveness.

Literature Review

Previous studies that dealt with the architectural design of public buildings from the viewpoint of epidemic prevention emphasized the critical role of the building's layout and architectural spaces in achieving a safe and healthy internal environment that protects humans from the risks of the spread of epidemics (Andrei Fezi, 2021, p. 2; Fezi, 2020; Salman and Hameed, 2021a). In addition, health and epidemic-free educational spaces positively affect students' health and productivity and achieve quality and continuity of use of these spaces (Deshmukh, 2021). However, one of the lessons learned from the outbreak of the (Covid-19) pandemic and subsequent epidemics was the detection of some design problems and challenges, as well as the limited capacity of existing buildings such as homes, commercial buildings, university buildings, and other buildings to face the risk of epidemics (Megahed and Ghoneim, 2020). The effects of this are some of the alerts that motivated architecture professionals to rethink the interior and exterior design of buildings and to develop health standards and approaches that are more effective in preventing current and future epidemics.

Studies dealing with the evaluative issues of indoor spaces towards increasing the effectiveness of social distancing; among these studies is a study conducted by Abdul Nasir et al. (2021). To evaluate the layout of a multi-story recreational building and study spatial organization and management factors that affect the effectiveness of social distancing by focusing on the level of permeability and finding the way as indicators of the building's spatial configuration. The study methodology used the method of space syntax analysis by determining the depth, connectivity, and integration (Abdul Nasir et al., 2021). Either about the relationship between the implementation of social distancing and the layout pattern of common and public indoor spaces in residential buildings, a study conducted by Kareem and Baper (2021). To examine the strength and direction of relationships between common indoor spaces and epidemic control indicators and determine the practical pattern of indoor space planning. The study also adopted an integration, connectivity, and visibility analysis using the space syntax method (Kareem and Baper, 2021). Also, about the existing educational buildings and how to improve their ability to adapt to the emerging needs of the (Covid-19) pandemic, The study of Güzelci et al. (2020) provides a new algorithm for post-occupancy assessment of existing school buildings and provides solutions to improve the adaptability of these buildings. The study used two-dimensional plans of indoor spaces as input to the analysis process using (Rhino/Grasshopper and the add-on Galapagos) (Güzelci et al., 2020). Also, concerning strengthening the design of the indoor environment to meet the current challenge of reconfiguring standard physical settings with social distancing measures, A study conducted by Ugail et al. (2021). to produce appropriate design solutions, the user can choose the most feasible option on the move, addressing the limitations and requirements of specific physical spaces such as space dimensions, door position, windows, corridors, and variables related to the indoor airflow pattern (Ugail et al., 2021). Finally, among studies on the relationship between space resilience and reducing the spread of the epidemic is a study conducted by Salman and Hameed (2021b). This study showed the types and approaches of flexibility in space regulation. It determined the fundamental dimension of architectural composition regarding the degree of connection or isolation to reduce the spread of epidemics. This study theoretically sought to develop internal space assessment and design criteria to increase the building's effectiveness in resisting epidemics from an architectural perspective (Salman and Hameed, 2021b).

Despite the above studies, a range of building design elements adopts diverse analysis approaches toward reducing the spread of epidemics on the one hand and increasing the effectiveness of social distancing on the other. However, no study examined the impact of educational space design (in terms of space shape, area, and furniture arrangement pattern) on the effectiveness of social distancing. Therefore, an accurate evaluation should conduct using space syntax analysis to investigate the impact of the educational space design for university buildings on the effectiveness of social distancing.

Educational Space Design

Space, in general, can be interpreted from the physical side as a three-dimensional field consisting of a set of physical elements that have specific characteristics connected according to relationships to meet users' basic needs and requirements. The design of that space is the set of processes for planning and designing spaces within buildings (Ching and Binggeli, 2018, pp. 2–34). Either for the educational space, it is part of the academic environment. It is the product of design processes that depend on a relationship between space forms and learning practices according to specific objectives to achieve users' educational activities (Gislason, 2010). Space's connection to the educational process is at several functional levels, including; A space for lectures, laboratories, seminars, conferences, and research (research laboratories and faculty offices). In addition, the educational space includes a range of social relationships.

Consequently, it has several determinants of its composition in terms of signature, area, and space suited to the type of educational activities carried out (Ilvitskaya et al., 2019). Therefore, this study's scope will determine the shape, area, and furniture arrangement pattern as physical

variables in the educational space design. Physically, space design is an essential platform for forming and managing occupants' circulation within space (Omer and Goldblatt, 2017). Also, the movement of occupants in architectural spaces is a crucial factor reflected in the effectiveness of social distancing (Usman et al., 2020).

The Social Distancing and Reducing the Spread of (Covid-19)

The outbreak of the epidemics in this era refers to many risks that inevitably affect the future of humanity and a new normal lifestyle that deals with the design aspects that, in turn, affect people's health (Megahed and Ghoneim, 2020). Infection is transmitted either directly through droplets or indirectly after touching the contaminated surfaces (Jang et al., 2020). Especially within narrow spaces, which raises alerts about new space designing guidelines. The practice of social distancing and spatial isolation has proven to be relatively effective in controlling infection in health care facilities (Lewnard and Lo, 2020). Social or physical distancing is a kinetic-spatial mechanism that maintains a distance between persons in public places of at least 2m (6 feet). It prevents people from gathering and staying in crowds and reduces direct contact with people in internal and external spaces (CDC, 2021). The primary purpose of social distancing is to prevent the spread of infectious diseases and viruses, which are transmitted quickly to humans through physical contact between people (Wilder-Smith and Freedman, 2020).

Space Spatial Characteristics

Educational spaces in university buildings are usually designed with different shapes, areas, and patterns to arrange furniture depending on the type of educational function, the design objective of that space, and the changing needs that arise due to unavoidable circumstances. For example, implementing the safe distance of social distancing and fulfilling functional requirements have become an urgent need after the outbreak of epidemics (Güzelci et al., 2020). On the other side, many spatial studies confirm that the occupants' movement, in general, is directly affected by spatial relationships within the space system, where this relativity depends on spatial composition characteristics that create a network of visual and motor relationships that contribute to the understanding and assimilation of the place (Haq, 2003; Zerouati and Bellal, 2020). Accordingly, and what it takes to understand the impact of user circulation on the social distancing effectiveness, the designer must predict the movement paths the users will follow. In addition to identifying the reasons for users' gathering in some zones from the educational space. The spatial characteristics of space that the study will address are:

Permeability

The level of space permeability in architecture indicates the implicit spatial quality of spaces from the point of entry to the farthest point in space (McLane, 2013, p. 6). Furthermore, the space permeability level allows a description of spatial efficiency and analysis of the hierarchy of indoor spaces in the building (Mustafa and Hassan, 2013). Accordingly, the level of permeability provides an understanding of the spatial arrangement priorities in terms of the educational uses position, the hierarchy between public and private, and the depth of distance between parts of the space. Thus, the increasing depth of a specific point within space away from the entry point indicates a decrease in the level of permeability and vice versa (McLane, 2015). In the context of educational spaces that meet multiple educational uses. Zoning and prioritizing places of practice for these educational uses based on permeability can be crucial in increasing the effectiveness of social distancing among occupants (Abdul Nasir et al., 2021). Educational spaces must be designed based on determining the most connected areas between occupants and making them at the lowest depth near the entry point and vice versa to adapt these spaces to social distancing.

In spatial studies, permeability is associated with accessibility and visibility. It indicates the connectivity between spatial points, allowing easy and direct access to the other space points. The contiguity relationship between points describes direct permeability, while the convergence relationship describes the indirect permeability of space (Beck and Turkienicz, 2009). visibility refers to

visual connectivity between spatial space points, as noted by Hanson (1999), permeability (where you can go), and visibility (what you can see). And they are closely related through spatial layers, transparency, intersectional penetration of volume, and the disintegration of boundaries (Hanson, 1999, p. 54). The space syntax tool the research will adopt to study permeability is the visibility map, usually used to study visibility variables (Turner et al., 2001).

Wayfinding

The term "wayfinding" dates back to the middle of the last century when Kevin Lynch first mentioned it in his book The Image of the City. To understand people's cognitive and analytical abilities toward the built environment and classify elements that prevent people from getting lost in urban spaces through experimental processes (Lynch, 1962, p. 5). The wayfinding around explaining the relationship between space and human behavior is trying to clarify decision-making processes on finding the appropriate way from root to destination when they waste people in space (Maghool et al., 2018). Concerning space design and guidance strategies that contribute to raising the level of wayfinding within buildings, many spatial studies have referred to the possibility of using architectural space and indoor processing as a visual guide for people to determine their direction. For example, in architectural spaces such as halls, corridors, stairs, and elevators, an asymmetrical layout pattern is used for indoor spaces, uncomplicated linear paths, and other spatial characteristics that facilitate direction determination and path selection. Either indoor processor includes space shape, structure and boundaries, wall color, changes in floor design, furniture type, use of lighting to maximize focus on a given space, ceiling processors, utilization of function points, markings, and other tools and equipment (Arendholz and Becker, 2015; Chen et al., 2021; Peponis et al., 1990). These design treatments reduce people's chances of getting lost and spatial anxiety, and getting lost results in lower spatial efficiency and greater reliance on help from other people to locate (Lawton, 1996). Thus, people who are unsure where they are and how to get to their destination will intersect with other people within space (Devlin, 2014). These indiscriminate intersections, which can increase physical connectivity and user convergences, are not commensurate with the implementation of social distancing within spaces.

The wayfinding is impacted by the implicit intelligibility of space as spatial configuration through reconnaissance movement and spatial cognition. The reconnaissance movement is directly between the point of origin and the intended destination in spaces with excellent clarity. However, the mysterious spaces tend to be more complex and indirect (Yun and Kim, 2007).

In space syntax methodology, intelligibility is measured by correlating the connectivity with global integration (Hillier, 1996, p. 245). Therefore, the wayfinding depends on intelligibility and accessibility within space, which can be measured by obtaining connectivity and global integration; since the origin of the reconnaissance movement lies in reaching the destination, the more synthetic steps, the more words and the path can be more complex during the movement (Beck and Turkienicz, 2009). As a result, users' mobility within the educational space is complicated, affecting their compliance with social distancing. The space syntax tool the research will adopt to study wayfinding is the axial map, usually used to study people's internal circulation (Omer and Goldblatt, 2017).

Case Study

The elected study case is the buildings of the University of Technology in Baghdad, first Rusafa. It can be accessed through Muhammad Al-Qasim Street, surrounded by it on the east side, opposite Al-Shaab Stadium, and from the other side Al-Sina'a Street. The university has a range of buildings, some scientific engineering departments, and other administrative and service buildings, established in 1975 as one of Iraq's Ministry of Higher Education and Scientific Research universities.

The study selected three samples of the University of Technology buildings, namely the Architectural Engineering Department, the Civil Engineering Department, and the Control and Systems Engineering Department. They are public buildings that provide an essential service to

the community: university education, which has been significantly affected by the conditions of epidemic outbreaks.

The research was limited to studying the design of internal educational spaces for these buildings. These spaces are used for educational functions at multiple levels and stages, such as faculty offices, classrooms for theoretical lectures, laboratories, libraries, and co-working spaces. And are used by large numbers of employees and various categories such as students, faculty, and staff. The last is one of the justifications for electing that is directly influencing the issue of social distancing (a large number of users and the time they stay in educational spaces). These buildings are also architecturally different in the design of educational spaces from the spectrum of shape, area, and furniture arrangement pattern, as shown in **Table 1**.

Table 1

The most crucial information of the case study (Author)

First sample	Building of Architectural Engineering Department		
Description:	It's one of the scientific departments of the university of technology. It was built in the seventies of the last century and used by more than (500) persons, faculty, staff, and students to study architectural engineering. The building consists of four floors; the ground floor includes classrooms for theoretical lessons and architectural design workshops, as shown in **Fig. 1**.		
Building plan:	Fig. 1. The ground floor plan of the Architecture Eng. Dep. building (Authors), based on the projects dep.		
Design of educational spaces:	Shape	Area	Furniture arrangement pattern
	_ Rectangular.	_ (85 - 127) m².	_ Grid. _ Linear. _ External-central.
Second sample	Building of Civil Engineering Department		
Description:	It's one of the oldest scientific departments at the university of technology. It was built in the nineties of the last century. It was used as a department to study civil engineering, comprising three disciplines in civil engineering for more than (850) persons, faculty, staff, and students. The building consists of three floors, with a range of educational spaces, including classrooms and laboratories, as in **Fig. 2**.		

First sample	Building of Architectural Engineering Department
Building plan:	Fig. 2. The ground floor plan of the Civil Eng. Dep. building (Authors), based on the projects dep.

Design of educational spaces:	Shape	Area	Furniture arrangement pattern
	_ Octagonal. _ Rectangle triangle corner.	_ (75 - 250) m².	_ Grid. _ Linear. _ Inner-central.

| Third sample	Building of Control and Systems Engineering Department
Description:	The building was built in 2008, considered one of the university's modern buildings. It was used as a department to study the Control and Systems engineering for more than (400) persons, faculty, staff, and students. The building consists of four floors, with educational spaces on the ground floor, such as laboratories, and one as a multi-purpose classroom, as shown in **Fig. 3**.
Building plan:	Fig. 3. The ground floor plan of the Control and Systems Eng. Dep. building (Authors), based on the projects dep.

Design of educational spaces:	Shape	Area	Furniture arrangement pattern
	_ Square. _ Part of a circle.	_ (88 - 275) m².	_ Grid. _ Linear. _ central.

Research Methodology

The research methodology used in this study is a visual survey, field visits, and quantitative analysis using a space syntax method to investigate the impact of educational spaces design on the effectiveness of social distancing. The research examined the shape, area, and Furniture Arrangement pattern as design variables for space. At the same time, permeability and wayfinding are the spatial characteristics variables of educational spaces design.

Fig. 4 shows the structure of the research methodology used in the study, which began first, reviewing previous studies dealing with keywords on the architectural design of spaces from a social distancing and epidemic prevention perspective to extract the research problem. The

Fig. 4

A diagram of research methodology (Authors)

previous studies, which included keywords on spatial formation factors affecting social distancing and the method of analysing the construction of the space sentence, were then reviewed to determine the essential characteristics of educational space as spatial configuration.

Secondly, determine the case study and elect three samples according to several election justifications that ensure that the profound results of the study are applicable in most educational spaces of Iraqi universities. The study then nailed the collection of data and information through field

visits to the buildings and a visual survey of the plans for educational spaces design. The design of educational spaces has been classified and coded into various models in shape, space, and furniture arrangement patterns to provide the data required in space syntax analysis. It is an objective analysis tool that works to find the best results that can describe the relativity between research variables.

The Visibility Graph Analysis and Axial Map Analysis using (Depthmapx) were adopted to examine visual integration, connectivity, choice, and intelligibility as key indicators in the space syntax methodology for evaluating spatial composition characteristics, namely the permeability and wayfinding. Accordingly, the space syntax analysis of all educational spaces design models in each sample was performed separately. Then the values were represented by tables and charts to facilitate an accurate interpretation of the results.

Third, the results were discussed to explain the impact of educational space design on the effectiveness of social distancing among users. Finally, the study methodology concludes by extracting the conclusions that illustrate the relational characteristic of educational space design as a spatial composition, with specific spatial characteristics that form users' circulation, which controls the level of social distancing effectiveness within the educational space. The study results can provide a theoretical understanding of designing, evaluating, and using educational spaces in university buildings in compliance with social distancing.

Classification and Coding

For analysis and comparison, the design of educational spaces for elected samples of the study case was classified and coded into a set of different models in terms of shape (x.1), space (x.2), and furniture arrangement pattern (x.3) (Güzelci et al., 2020; Hassan and Megahed, 2021; Ugail et al., 2021), As shown in **Table 2**.

Elements	Classification and coding				
Shape x.1	Rectangular (x.1.1)	Square (x.1.2)	Octagonal (x.1.3)	Triangle corner (x.1.4)	Part of a circle (x.1.5)
Area x.2	Large (x.2.1)		Medium (x.2.2)		Small (x.2.3)
	(275 - 200) m2.		(199 - 100) m2.		(99 - 25) m2.
Furniture arrangement pattern x.3	Linear (x.3.1)		Grid (x.3.2)		Mixed (x.3.3)
	External-central (x.3.4)		Inner-central (x.3.5)		Source (s): Authors.
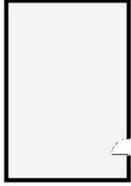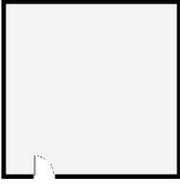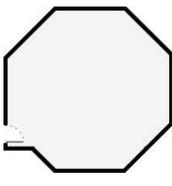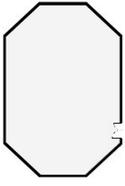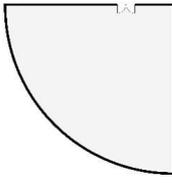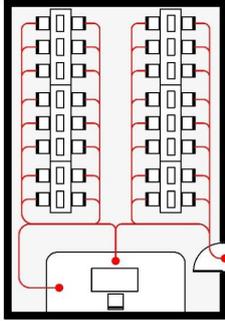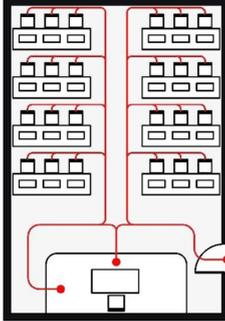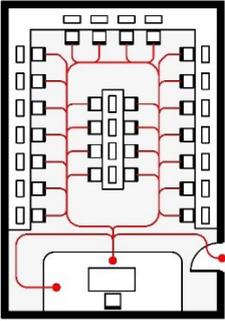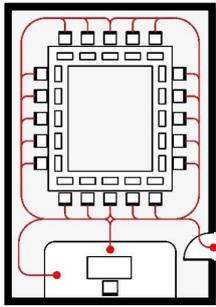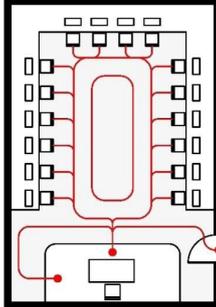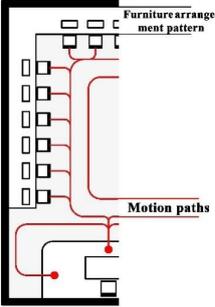
Table 2

Classification and coding of the modules (Authors)

This study attempts to answer research questions about the impact of educational space design elements on the effectiveness of social distancing. Research requires a quantitative analysis tool that works to find the best results that can describe the relationship between educational space design and the social distancing effectiveness.

The study used the space syntax methodology since those most recent spatial studies dealing with the research context above confirmed the role of the space syntax methodology and its ability to explain human behaviors and social activities, including the potential movement of occupants from the perspective of the spatial configuration of architectural and urban spaces (Kishimoto and Taguchi, 2014; Omer and Goldblatt, 2017; Shahbazi et al., 2018). In addition, recent architectural studies conducted after the outbreak of the (Covid-19) epidemic demonstrated the possibility of

Analyses Tool and Search Indicators

using the space syntax methodology in studies dealing with the layout of public buildings from the perspective of reducing the spread of epidemics (Abdul Nasir et al., 2021; Kareem and Baper, 2021).

Space Syntax

Space syntax originated and developed in the 1970s at the Bartlett Unit for Architectural Studies, University College, London. It is a method for quantifying, analysing, and measuring the spatial relationships in buildings and urban structures (Jiang and Claramunt, 2002). It is also an objective method for evaluating and investigating spatial relationships between the morphological struc-ture of architectural spaces and social events (Shahbazi et al., 2018). Technically, the space syntax is defined as a set of techniques to represent and analyse planning and spatial configuration of all types. It means examining the spatial relationship between each unit within the space system, just like examining a word within the text and its relationship to other words (Hillier, 1999; Hillier et al., 1987). Description and measurement of the spatial configuration of spaces using the method of space syntax, based on more than one method of analysis. The analysis will be conducted using the following two methods:

_ **Visibility Graph Analysis (AGA):** The initial idea of this analysis came from areas of visibility that were visible from a particular point. In other words, the basis for this type of analysis is the reflection of light that determines the patterns of people's motor behavior in space (Jiang and Claramunt, 2002; Montello, 2007). by the VGA, visual integration and connectivity values can be obtained as explanatory indicators of space permeability level (McLane, 2015).

_ **Axial Map Analysis (AMA):** Axial lines (axial map) are a graphical diagram that derives from the catalysis of streets and open spaces. This diagram is developed on special software, and it is the basis of the space syntax. The axial map is straight lines of vision and access (Shah-bazi et al., 2018). And it consists of the lowest and longest straight lines covering all parts of space, and this method reflects the space system's comprehensive motor pathways (Omer and Goldblatt, 2017). Also, by the AMA, choice and intelligibility values can be obtained as explanatory indicators of space wayfinding level (Turner et al., 2001).

The study depends on the use of Depthmapx, which Alasdair Turner created at University College London, an application based on computer-assisted mathematical algorithms. The program was first designed in 1998 as a simple processor program (Turner, 2004). And it is possible to analyse the spatial relationships of architectural and urban spaces quantitatively. The program analyses many Measurements that are divided into two parts:

_ **Global Measurements:** reflect the relationship between any point in the space system with all system parts.

_ **Local Measurements:** the relationship between any point in the system, and the points directly associated with it, depends only.

Appropriate indicators for analysis of spatial relationships of educational space, which can be invested in this research, have been determined as follows:

_ **Space syntax indicators in the VGA method:** The Attributes of the space syntax were ex-amined through the VGA method using the following indicators; first, visual integration is a global metric. It represents the number of visual steps to be taken from any point within space to see the points in the complex (Turner, 2004, p. 1). Accordingly, the more excellent the integration value, the closer connecting a point to other points within the space's spatial configuration (Shahbazi et al., 2018). Integration indicates the visibility and accessibility of a point within space according to the connection of accessibility and visibility to space per-meability (Beck and Turkienicz, 2009); this means that the higher the integration value, the more strongly connected and integrated the spatial configuration is, which means the higher the accessibility and visibility. Thus, the level of space permeability is excellent. Secondly, connectivity is a local measure representing the number of points within space that can be

directly seen from a point in the space complex (Turner, 2004, p. 16). A high connectivity value indicates more visual connections between points within the architectural space, which means a more direct correlation between the space parts, that is, more pathways of movement and vision and, therefore, an excellent indicator of space permeability.

_ **Space syntax indicators in the AMA method:** The Attributes of the space syntax were examined through the AMA method using the following indicators; First, the choice is a general measure of the flow rate of occupants' movement in space. Space offers a high probability of choices from many of the shortest connectivity paths that intersect with that space (Shahbazi et al., 2018). If the choice value of the space complex is high, this means easy and smooth movement within space, and thus an excellent indicator of the level of wayfinding within space. Secondly, intelligibility is the correlation factor between connectivity and global integration. And it relates to the arrangement of the relationship of parts to each. Hillier (1996) defines it as a "relationship analysis between how the complex can be seen in its parts and its general pattern" as a distribution of integration (Hillier, 1996, p. 171). And the scattered figure can represent intelligibility analysis. Suppose the scattered points form a straight line that rises at 45 degrees from the bottom left to the top right. In that case, this refers to a strong relationship between local connectivity and global integration. Thus, the system will be apparent (Hillier, 1996, p. 94). by linking clarity to the wayfinding (Yun and Kim, 2007), a high intelligibility value can be an excellent indicator of the wayfinding level in space. As previously addressed, the relationship between research indicators becomes as shown in **Fig. 5**.

_ **Spatial characteristics scales:** The research adopted the Attributes of space syntax, visual integration, connectivity, choice, and intelligibility as indicators to evaluate the spatial characteristics of space. It is necessary to provide measurable scales in determining the level of permeability and wayfinding. The study identified three different scales: excellent, average, and poor, as shown in **Table 3**.

The research indicators identified in this paragraph are essential parameters in determining the users' circulation within the educational space, which can be a reference for the level of effectiveness of social distancing.
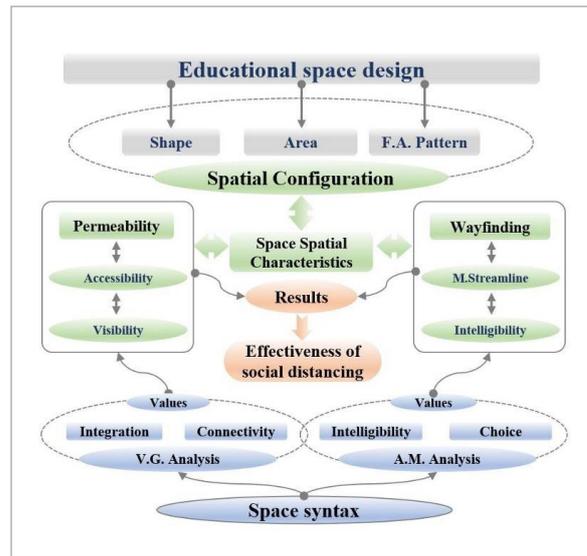
Fig. 5

A diagram to illustrate the relationship between research indicators (Authors)

Table 3

Three scales for the level of permeability and wayfinding (Authors)

Scale	Wayfinding	Permeability
Excellent	The space has a higher average value of choice and intelligibility (900-600).	The space has a higher average value of visual integration and connectivity (300-500).
Normal	The space has a median average value of choice and intelligibility (600-300).	The space has a median average value of visual integration and connectivity (100-300).
Poor	The space has a lower average value of choice and intelligibility (300-0).	The space has a lower average value of visual integration and connectivity (0-300).

Results and Analysis

The space syntax analysis of models for designing educational spaces was carried out using (VGA) and (AMA). First, the analysis began to accurately interpret the results by measuring the visual integration, connectivity, choice, and intelligibility of each sample separately. Then the values are represented by a quantitative table that includes; the design models, their numbers, and the values obtained from the analysis process (higher values are highlighted in red and lower values in blue and median values in orange). Finally, the chart was used to compare the different models for educational spaces design in all samples in terms of permeability and wayfinding scales. This analysis was conducted as follows:

Analysis of first sample models

In The first sample, the design of educational spaces was in six models in terms of shape, rectangular (x.1.1), and in terms of area; medium (x.2.2) and small (x.2.3) with three patterns to arrange furniture; linear (x.3.1), grid (x.3.2) and external-central (x.3.4). The results of this analysis are shown in **Table 4**.

Table 4

The analyses summarize the first sample models (Authors) based on (VGA&AMA)

Design Space Model		x.1.1	x.1.1	x.1.1	x.1.1	x.1.1	x.1.1
		x.2.2	x.2.2	x.2.2	x.2.3	x.2.3	x.2.3
		x.3.1	x.3.2	x.3.4	x.3.1	x.3.2	x.3.4
Model Numbers		1st	2nd	3rd	4th	5th	6th
Method	Space syntax attributes	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.
VGA	Visual Integration	**11.46**	**10.6**	**11.75**	**12.82**	**13.91**	**11.38**
VGA	Connectivity	**286.11**	**234.67**	**340.24**	**297.95**	**289.63**	**222.02**
AMA	Choice	**745.65**	**702.95**	**375.82**	**510.06**	**411.2**	**182.81**
AMA	Intelligibility	R^2	R^2	R^2	R^2	R^2	R^2
		0.88472	**0.975**	**0.964002**	**0.937947**	**0.94815**	**0.954353**

Analysis of second sample models

In The second sample, the design of educational spaces was in six models; in terms of shape, they are octagonal (x.1.3) and rectangular-triangle corners (X.1.4). And in terms of the area, they are large (x.2.1), with three patterns to arrange furniture; Linear (x.3.1), networked (x.3.2), and Inner-central (x.3.5). The results of this analysis are shown in **Table 5**.

Table 5

The analyses summarize the second sample models (Authors) based on (VGA&AMA).

Design Space Model		x.1.3	x.1.3	x.1.3	X.1.4	X.1.4	X.1.4
		x.2.1	x.2.1	x.2.1	x.2.1	x.2.1	x.2.1
		x.3.1	x.3.2	x.3.5	x.3.1	x.3.2	x.3.5
Model Numbers		1st	2nd	3rd	4th	5th	6th
Method	Space syntax attributes	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.
VGA	Visual integration	**11.61**	**11.908**	**12.67**	**14.43**	**11.86**	**57.43**
VGA	Connectivity	**357.11**	**409.91**	**454.14**	**384.91**	**317.82**	**885.06**
AMA	Choice	**895.977**	**1017.85**	**1613.57**	**896.56**	**599.87**	**1203.4**
AMA	Intelligibility	R^2	R^2	R^2	R^2	R^2	R^2
		0.887697	**0.976593**	**0.987974**	**0.890721**	**0.961636**	**0.915676**

Analysis of third sample models

In The third sample, the design of educational spaces was also in six models; in terms of shape, they are square (x.1.2) and part of a circle (x.1.5). And in terms of the area, they are medium (x.2.2), with three patterns to arrange furniture; linear (x.3.1), grid (x.3.2), and external-central (x.3.4). The results of this analysis are shown in **Table 6**.

Design Space Model		x.1.2	x.1.2	x.1.2	x.1.5	x.1.5	x.1.5
		x.2.2	x.2.2	x.2.2	x.2.2	x.2.2	x.2.2
		x.3.1	x.3.2	x.3.4	x.3.1	x.3.2	x.3.4
Model Numbers		1st	2nd	3rd	4th	5th	6th
Method	Space syntax attributes	Avg.	Avg.	Avg.	Avg.	Avg.	Avg.
VGA	Visual integration	**11.73**	**10.83**	**13.29**	**10.94**	**13.09**	**12.34**
VGA	Connectivity	**380.4**	**334.13**	**504.51**	**280.74**	**284.42**	**237.39**
AMA	Choice	**646.42**	**934.27**	**523.99**	**22.81**	**11.11**	**48.02**
AMA	Intelligibility	R^2	R^2	R^2	R^2	R^2	R^2
		0.887732	**0.97588**	**0.962018**	**0.916647**	**0.916051**	**0.959171**

Table 6

The analyses summarize the third sample models (Authors) based on (VGA&AMA)

According to the values obtained using (VAG) in the space syntax analysis, as shown in **Tables 4, 5, 6**. The lowest visual integration value was (10.6) for the second model in the first sample. And the median value of the visual integration was (14.43) for the fourth model in the second sample. In comparison, the highest value was (57.43) for the sixth model in the second sample. Visual connectivity values, the lowest value was (222.02) for the sixth model in the first sample. And the median value of visual connectivity was (357.11) for the first model in the second sample. In comparison, the highest value was (885.06) for the sixth model in the second sample. This means that the sixth model in the second sample with the highest visual integration value is the same as the highest value for connectivity.

This difference in visual integration and connectivity values between the models can be justified. Because the sixth model in the second sample is less in-depth and has many points with direct visual contact within the space than the two models mentioned previously, as shown in **Fig. 6**. Therefore, creating an excellent visual extension and ample space for students' circulation directly connected to the seating results from the space design. Furthermore, this provided a large field of visibility that could increase the level of permeability, thus increasing the effectiveness of social distancing.

As for the values obtained using (AMA) in the space syntax analysis, as shown in **Tables 4, 5, 6**, the lowest value for selection was (11.11) for the fifth model in the third sample. And the median value of choice was (646.42) for the first model in the third sample. In comparison, the highest value was (1613.57) for the third model in the second sample.

The lowest value was (0.88472) for the first model in the first sample in intelligible values. And the median value for intelligibility was (0.93795) for the fourth model in the first sample. In comparison,


(a)   (b)
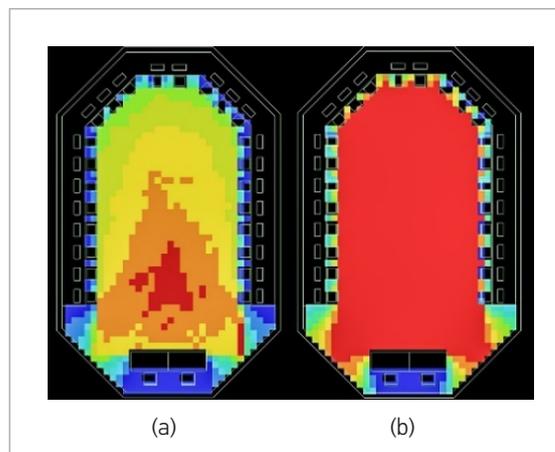
Fig. 6

The second sample - 6th model: (a) visual Integration graph, and (b) Connectivity graph, (Authors) based on (VGA)

Fig. 7

The second sample - 3rd model: (a) Choice graph, and (b) intelligibility graph, (Authors) based on (AMA)


(a) Choice   (b) intelligibility
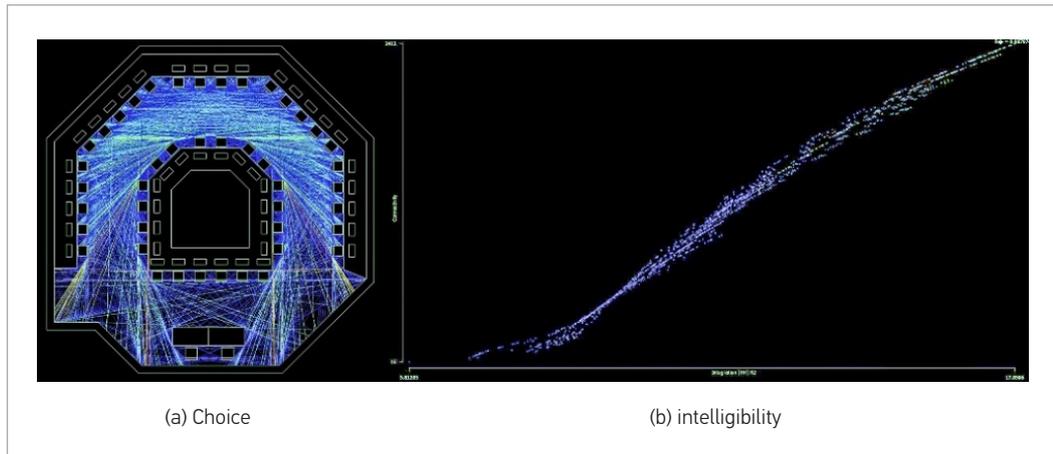
the highest value was (0.98797) for the third model in the second sample. This means that the third model in the second sample with the highest choice value is the same as the highest value for intelligibility because this model has a high value of integration and connectivity.

This case can be justified in the values of choice and clarity; in fact, the third model in the second sample is less deep and has many shortest paths that intersect directly between points within the space than the two models mentioned previously, as shown in **Fig. 7**. Therefore, more intelligible movement paths are provided in the users' circulation area, leading to accessibility from the entry point to the seating and back, resulting from the space design. Furthermore, this has provided an intelligibility flow of movement at a high level that can contribute to increasing the level of wayfinding and thus increasing the effectiveness of social distancing.

Fig. 8

A chart Shows scales of permeability and wayfinding in all models (Authors) depending on (VGA & AMA)
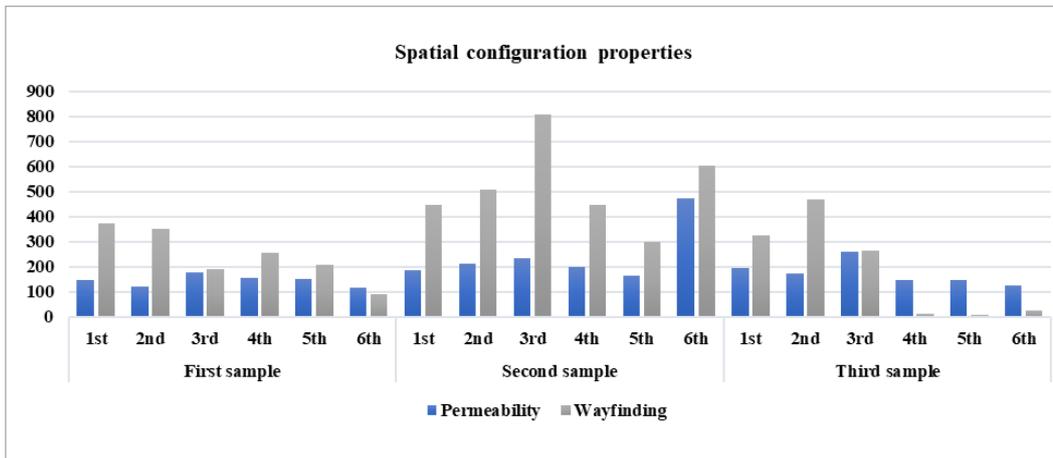
As shown in **Fig. 8**, measurements of the level of permeability and wayfinding can be determined. According to the above values of Visual integration, connectivity, choice, and intelligibility, and the scales previously determined in the search indicators paragraph. So, this showed that the sixth model in the second sample had an excellent level of permeability. In opposite, the poor level of permeability was for the sixth model in the first sample. In comparison, the average level of permeability was in the first model in the second sample. As for the level of wayfinding, it showed that the third model in the second sample had an excellent level. In opposite, the poor level of the wayfinding for the fifth model. In comparison, the poor level of permeability was in the first

model of the third sample. As a result, there are different scales of the level of permeability and wayfinding between the analysed models. This can be attributed to the difference in the values of visual integration, connectivity, and the value of choice and intelligibility for those spaces. Finally, these research results can generally be invested in discussing the study's most important findings to extract significant conclusions.

Discussion

Educational space design:

The educational space is a fixed place for students and staff to perform various educational functions. The design of these spaces was in different shapes and areas, and their differences in the pattern of arranging furniture. The analysis results of those different models showed many weaknesses in the inability of some space design models to facilitate compliance with social distancing, mainly models 4th, 5th, and 6th in the third sample, as shown in **Fig. 8**. The main reason for this is the low level of spatial space characteristics, mainly due to the weak changing spatial relationships in the design of these different spaces in terms of the shape, space, and pattern of arranging furniture. This has led to the inability of a space design to reduce physical convergences between users, thus more gatherings of users simultaneously.

Impact of educational space design:

The shape, area, and furniture arrangement pattern as spatial variables in space design have an essential effect in drawing the motor behavior of users as the circulation within space. For example, the shape of the educational space design features close longitudinal and transverse sides such as rectangular, square, and rectangular with triangular corners. This shape provides intelligible motion paths parallel to the longitudinal sides of space and an appropriate visibility field from the entry to the farthest point directly connected to the seats. This means creating excellent spatial relationships that increase the level of permeability and wayfinding within space, thereby increasing the effectiveness of social distancing.

An area in the educational space design and its impact on the effectiveness of social distancing depends on the proportion of the empty area (space available for students' circulation) to the space area. The larger the proportion of empty area, the better the spatial relationships and the greater the spatial separation between seating seats. This means that increasing empty area in space design increases movement streamlining and accessibility to the intended point, thereby increasing the effectiveness of social distancing achieved by preventing or reducing the most physical contact points between users.

The furniture arrangement pattern in the educational space design has an essential impact on the effectiveness of social distancing. That element defines the paths and direction of movement and the circulation mechanism and significantly affects the space's spatial relationships. The linear and inner-central pattern streamlines intelligible movement and makes selecting the appropriate path to access the intended point. As a result, this achieves an excellent level of permeability, wayfinding, and reducing confusion and random intersections between users, thus increasing the effectiveness of social distancing.

Appropriate design:

Based on the analysis of different models for designing educational spaces, some indicators have emerged about the elements of designing the appropriate educational space from the spectrum of promoting compliance with social distancing. The study determined the appropriate educational space design for physical interaction between users with compliance with social distancing; in terms of space shape, rectangular or square shape, and terms space area, large area (200 m^2), and more. As for the furniture arrangement pattern, linear or Inner-central arrangement of furniture within the educational space, considering the functional performance criteria of the ed-

ucational space. Finally, the study recommends some general guidelines that could enhance the effectiveness of social distancing within the educational space, as follows:

- _ Adopt the flexible pattern of arranging furniture that works on the plains of changing the configuration of the place to suit the increased effectiveness of social distancing.
- _ Space design in a shape and area encourages the implementation of a one-way internal movement path rather than the opposite direction to produce possible intersections between students in the circulation area.
- _ Placing the place that meets temporary educational uses (short stay within the educational space) at a lower depth near the entry point, in contrast to the permanent uses.
- _ Use spatial markers as a mentoring mechanism, especially in first-stage students' educational spaces, to improve wayfinding and reduce indiscriminate movement within space.

Conclusion

The study proved that there is an impact and a close relationship between elements of educational space design and the effectiveness of social distancing. The effect of the space shape is based on the possibility of providing Intelligible movement pathways and an appropriate area of visibility. The impact of the area in space design is also manifested through the proportion of the empty area (space available for students' circulation) to the space area. It controls movement streamlining and accessibility within space. While the furniture arrangement pattern has the most significant impact as it determines the direction of movement, the circulation mechanism, and the user's points of presence within the space.

The close relationship between the educational space design and the effectiveness of social distancing is formed by correlating the shape and area of the space and the furniture arrangement pattern in determining the movement and visual relations of the spatial configuration. These relations, in turn, impact the permeability and wayfinding as spatial characteristics that control the user's circulation. The latter is one of the essential factors in the level of effectiveness of social distancing.

After recent outbreaks of epidemics appear, the importance of conducting spatial analysis to assess the design of existing university buildings to reduce the spread of current and future epidemics. So, this study demonstrates the possibility of the syntax method in investigating the impact of educational space design in fostering social distancing, the space design in terms of the shape and area of the space, and the furniture arrangement pattern using the level of permeability and wayfinding.

The study results support the possibility of usable educational spaces while complying with social distancing. In terms of the architectural design of the educational space, the study found that the space in the shape of a rectangle or square with a large area (200 m^2) and more with a linear or inner-central pattern for arranging furniture, as a design for an educational space appropriate in promoting social distancing compliance.

Adopt the flexible pattern of arranging furniture with the appropriate shape and area for space design, taking into account the streamlining of movement and spatial arranging priorities for uses according to the appropriate depth and using guidance mechanisms to improve wayfinding. Those can be future standards for designing educational spaces to reduce the spread of epidemics. As a recommendation for future studies, it is essential to evaluate data of furniture type, shape, dimensions, and even functions type (dynamic and static) and the potential number of space users. These variables can be addressed from the perspective of fostering social distancing in future research.

References

Abdul Nasir, N.A.B., Hassan, A.S., Khozaei, F. and Abdul Nasir, M.H. Bin. Investigation of spatial configuration management on social distancing of recreational clubhouse for covid-19 in Penang, Malaysia. International Journal of Building Pathology and Adaptation, 2021; 39(5): 782-810. https://doi.org/10.1108/IJBPA-08-2020-0072

Alnusairat, S., Al Maani, D. and Al-Jokhadar, A. Architecture students' satisfaction with and perceptions of online design studios during covid-19 lockdown: the case of Jordan universities. Archnet-IJAR: International Journal of Architectural Research, 2020; 15(1): 219-236. https://doi.org/10.1108/ARCH-09-2020-0195

Andrei Fezi, B. The role of architecture and urbanism in preventing pandemics. SARS-CoV-2 origin and covid-19 pandemic across the globe. Rijeka. IntechOpen, 2021; Ch. 16: 1-20. https://doi.org/10.5772/intechopen.98294

Arendholz, K. and Becker, T. Requirements on building models enabling the guidance in a navigation scenario using cognitive concepts. Breunig. Springer International Publishing, Cham, 2015; Ch.1, 157-173. https://doi.org/10.1007/978-3-319-12181-9_10

Ayyildiz, E. and Taskin Gumus, A. A novel distance learning ergonomics checklist and risk evaluation methodology: a case of covid-19 pandemic. Human Factors and Ergonomics in Manufacturing & Service Industries, 2021; 31(4): 397-411. https://doi.org/10.1002/hfm.20908

Beck, M.P. and Turkienicz, B. Visibility and permeability: complementary syntactical attributes of wayfinding. 7th INternational Space Syntax Symposium. İstanbul, 2009; 009: 1-7.

CDC. Basics of covid-19. Centers for Disease Control and Prevention, 24 May, 2021. available at: https://www.cdc.gov/coronavirus/2019-ncov/your-health/about-covid-19/basics-covid-19.html (accessed 1 November 2021).

Chen, M.S., Ko, Y.T. and Hsieh, W.C. Exploring the planning and configuration of the hospital wayfinding system by space syntax: a case study of Cheng Ching hospital, Chung kang branch in Taiwan. ISPRS International Journal of Geo-Information, 2021; 10(8): 570. https://doi.org/10.3390/ijgi10080570

Ching, F.D.K. and Binggeli, C. Interior design illustrated. 4th ed. Hoboken, New Jersey, Canada; 2018.

Deshmukh, J. Speculations on the post-pandemic university campus - a global inquiry. Archnet-IJAR, 2021; 15(1): 131-147. https://doi.org/10.1108/ARCH-10-2020-0245

Devlin, A. Wayfinding in healthcare facilities: contributions from environmental psychology. Behavioral Sciences, 2014; 4(4): 423-436. https://doi.org/10.3390/bs4040423

Fezi, B.A. Health engaged architecture in the context of covid-19. Journal of Green Building, 2020; 15(2): 185-212. https://doi.org/10.3992/1943-4618.15.2.185

Gislason, N. Architectural design and the learning environment: a framework for school design research. Learning Environments Research, 2010; 13(2): 127-145. https://doi.org/10.1007/s10984-010-9071-x

Güzelci, O.Z., Şen Bayram, A.K., Alaçam, S., Güzelci, H., Akkuyu, E.I. and Şencan, İ. Design tactics for enhancing the adaptability of primary and middle schools to the new needs of postpandemic reuse. Archnet-IJAR: International Journal of Architectural Research, 2020; 15(1): 148-166. https://doi.org/10.1108/ARCH-10-2020-0237

Hanson, J. Decoding homes and houses. 1st ed. Cambridge University Press: Cambridge; 1999. https://doi.org/10.1017/CBO9780511518294

Haq, S. Investigating the syntax line: configurational properties and cognitive correlates. Environment and Planning B: Planning and Design, 2003; 30(6): 841-863. https://doi.org/10.1068/b2960

Hassan, A.M. and Megahed, N.A. Covid-19 and urban spaces: a new integrated CFD approach for public health opportunities. Building and Environment, 2021; 204: 108131. https://doi.org/10.1016/j.buildenv.2021.108131

Hillier, B. Space is the machine, space syntax. 1st ed. the University of Cambridge: London; 1996.

Hillier, B. Centrality as a process: accounting for attraction inequalities in deformed grids. URBAN DESIGN International, 1999; 4(3-4): 107-127. https://doi.org/10.1057/udi.1999.19

Hillier, B., Hanson, J. and Graham, H. Ideas are in things: an application of the space syntax method to discovering house genotypes. Environment and Planning B: Planning and Design, SAGE Publications Ltd STM, 1987; 14(4): 363-385. https://doi.org/10.1068/b140363

Ian Taylor. Universities and colleges, Rethink design guide: architecture for a post-pandemic world. 1st ed. RIBA Publishing, 66 Portland Place: London; 2021; 148, Ch.7: 148-162.

Ilvitskaya, S. V, Perkova, M. V, Petrova, L. V and Shulginova, O.A. Design security adaptation of communication spaces for the modern educational forms, implementation in the educational buildings of universities. IOP Publishing, 2019; 698(3): 033024. https://doi.org/10.1088/1757-899X/698/3/033024

Jang, S., Han, S.H. and Rhee, J.Y. Cluster of coronavirus disease associated with fitness dance classes,

South Korea. Emerging Infectious Diseases,CDC, 2020; 26(8): 1917-1920. https://doi.org/10.3201/eid2608.200633

Jiang, B. and Claramunt, C. Integration of space syntax into GIS: new perspectives for urban morphology. Transactions in GIS, 2002; 6(3): 295-309. https://doi.org/10.1111/1467-9671.00112

Kareem, S. and Baper, S. How to limit the spread of covid-19 in residential buildings: Erbil city as a case study. Design Engineering (Toronto), 2021; 2021(7): 2635-2647.

Kishimoto, T. and Taguchi, M. Spatial configuration of Japanese elementary schools: analyses by the space syntax and evaluation by school teachers. Journal of Asian Architecture and Building Engineering, 2014; 13(2): 373-380. https://doi.org/10.3130/jaabe.13.373

Lawton, Carol A. Strategies for indoor wayfinding: the role of orientation. Journal of Environmental Psychology, 1996; 16(2): 137-145. https://doi.org/10.1006/jevp.1996.0011

Lewnard, J.A. and Lo, N.C. Scientific and ethical basis for social-distancing interventions against covid-19. The Lancet Infectious Diseases, 2020; 20(6): 631-633. https://doi.org/10.1016/S1473-3099(20)30190-0

Lynch, K. The image of the city. 1st ed. MIT Press. Massachusetts Institute of Technology: Cambridge; 1962.

Maghool, S.A.H., Moeini, S.H. (Iradj) and Arefazar, Y. An educational application based on virtual reality technology for learning architectural details: challenges and benefits. International Journal of Architectural Research: ArchNet-IJAR, 2018; 12(3): 246. https://doi.org/10.26687/archnet-ijar.v12i3.1719

McLane, Y. Spatial contexts, permeability and visibility about learning experiences in contemporary academic architecture. PhD thesis. Department of Art Education: Florida State University, 2013.

McLane, Y. Choreographing collaborative academic experiences: the quiet building and the airport lounge. SSS10 Proceedings of the 10th International Space Syntax Symposium. UCL: London, 2015; 27: 1-15.

Megahed, N.A. and Ghoneim, E.M. Antivirus-built environment: lessons learned from covid-19 pandemic. Sustainable Cities and Society, 2020; 61: 102350. https://doi.org/10.1016/j.scs.2020.102350

Menon, S. and Suresh, M. Synergizing education, research, campus operations, and community engagements towards sustainability in higher education: a literature review. International Journal of Sustainability in Higher Education, 2020; 21(5): 1015-1051. https://doi.org/10.1108/IJSHE-03-2020-0089

Montello, D.R. The contribution of space syntax to a comprehensive theory of environmental psychology. Proceedings, 6th International Space Syntax Symposium, İstanbul, 2007; 6(iv):12.

Mustafa, F.A. and Hassan, A.S. Mosque layout design: an analytical study of mosque layouts in the early Ottoman period. Frontiers of Architectural Research, 2013; 2(4): 445-456. https://doi.org/10.1016/j.foar.2013.08.005

Omer, I. and Goldblatt, R. Using space syntax and Q-analysis for investigating movement patterns in buildings: the case of shopping malls. Environment and Planning B: Urban Analytics and City Science, 2017; 44(3): 504-530. https://doi.org/10.1177/0265813516647061

Peponis, J., Zimring, C. and Choi, Y.K. Finding the building in wayfinding. Environment and Behavior, 1990; 22(5): 555-590. https://doi.org/10.1177/0013916590225001

Prem, K., Liu, Y., Russell, T.W., Kucharski, A.J., Eggo, R.M., Davies, N., Flasche, S., et al. The effect of control strategies to reduce social mixing on outcomes of the covid-19 epidemic in Wuhan, China: a modelling study. The Lancet Public Health, 2020; 5(5): e261-e270. https://doi.org/10.1016/S2468-2667(20)30073-6

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

Salman, A.S. and Hameed, T.M. Anti-epidemic architecture strategies: covid-19 an entrance to the design of a preventive architectural product. Journal of Engineering Science and Technology (JESTEC), 2021a; 16 (5): 4109-4120.

Salman, A.S. and Hameed, T.M. Flexibility in sustainable architecture output resistance to epidemics. IOP Conference Series: Earth and Environmental Science, 2021b; 779(1): 012034. https://doi.org/10.1088/1755-1315/779/1/012034

Shahbazi, M., Bemanian, M.R. and Lotfi, A. A comparative analysis of spatial configuration in designing residential houses using space syntax method, case studies: houses of Isfahan and modern architecture styles. International Journal of Applied Arts Studies, 2018; 3(1): 21-40.

Turner, A. Depthmap 4 - A researcher's handbook, London, 2004.

Turner, A., Doxa, M., O'Sullivan, D. and Penn, A. From isovists to visibility graphs: a methodology for the analysis of architectural space. Environment and Planning B: Planning and Design, 2001; 28(1): 103-121. https://doi.org/10.1068/b2684

Ugail, H., Aggarwal, R., Iglesias, A., Howard, N., Campuzano, A., Suárez, P., Maqsood, M., et al.

Social distancing enhanced automated optimal design of physical spaces in the wake of the covid-19 pandemic. Sustainable Cities and Society, 2021; 68: 102791. https://doi.org/10.1016/j.scs.2021.102791

Usman, M., Lee, T.-C., Moghe, R., Zhang, X., Faloutsos, P. and Kapadia, M. A social distancing index: evaluating navigational policies on human proximity using crowd simulations. MIG ,20: Motion, Interaction and Games, New York, 2020; 10: 1-6. https://doi.org/10.1145/3424636.3426905

WHO. Considerations for public health and social measures in the workplace in the context of covid-19. World Health Organisation, 2020; 6.

Wilder-Smith, A. and Freedman, D.O. Isolation, quarantine, social distancing and community containment: pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. Journal of Travel Medicine, 2020; 27(2): 1-4. hhttps://doi.org/10.1093/jtm/taaa020

Yun, Y.W. and Kim, Y.O. The effect of depth and distance in spatial cognition. Proceedings, 6th International Space Syntax Symposium, İstanbul, 2007; 49: 1-13.

Zerouati, W. and Bellal, T. Evaluating the impact of mass housings: in-between spaces, spatial configuration on users, social interaction. Frontiers of Architectural Research, 2020; 9(1): 34-53. https://doi.org/10.1016/j.foar.2019.05.005

About the Authors

AHMED M. HAMEED AL-DELFI

Postgraduate student

University of Technology - Iraq, Architectural Engineering Department, Baghdad, Iraq

Main research area

My research interests focus on Architectural design and Healthy buildings.

Address

Bismayah City, Baghdad, Iraq
Tel. +9647717389377
E-mail: 90136@uotechnology.edu.iq

ABDULLAH S. SALMAN

Professor

Prof, University of Technology - Iraq, Architectural Engineering Department, Baghdad, Iraq

Main research area

Architectural design, Architectural Design Theory, Architectural Ethics Philosophy.

Address

Baghdad, Iraq
Tel. +9647702924472
E-mail: abdullah.s.salman@uotechnology.edu.iq