The role of waiting area typology in limiting the spread of COVID-19: Outpatient clinics of Erbil hospitals as a case study

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Abstract
In the post-healthcare context, protecting patients against pandemic diseases like COVID-19 has become designers’ responsibility; the amount and effectiveness of change are unknown, particularly in terms of future design. This study explores the potential significance of waiting area typology within outpatient clinics in generating a healthy and therapeutic environment for patients and users in terms of social distancing, as well as whether there is a relationship between outpatient and the provision of social distancing. This study employed a quantitative approach based on space syntax theory, through four different syntactic maps (Isovist, Axial, Convex and Visibility Graph Analysis), to depict hospitals in Erbil city by adopting five outpatient layout typologies such as centralized and decentralized (linear, lobby, sectoral and mixed), through measuring wayfinding, accessibility, privacy, density and circulation as outpatient layout typology factors. Results identified that there is a clear effect of outpatient layout typology factors on providing social distancing especially in waiting areas, the decentralized outpatient layout represented by both sectoral and linear typologies is the most useful typology based on social distancing compared to others. Given the influential role of outpatient layout in providing a healthy and safe healing atmosphere with more social distancing for patients, research findings provide a useful resource for healthcare designers, particularly for waiting areas within outpatient clinics.

Keywords
Outpatient clinics, waiting areas, healthcare, social distancing, outpatient layout typology, space syntax, COVID-19

Introduction
Healthcare aims to keep people healthy. People may think that medicine is the only factor that affects the speed of a patient’s recovery, but besides medicine, other factors must be taken into account, and these factors relate to the physical environment for hospital layout, especially its role in limiting the spread of epidemic diseases such as COVID-19. However, Coronavirus disease (COVID-19) is an infectious disease caused by the novel coronavirus SARS-CoV-2 which has been declared as a pandemic by World Health Organization. This is considered a transmitted disease so social distancing has been one of the solutions to decrease the number of infected cases, and the safe distance has been set to be between 2 and 3 m. The World Health Organization (WHO) and United Nations partners support social distancing, which emphasizes maintaining a physical space of at least 2 m from the person nearby, as an important factor in slowing the spread of the Coronavirus. However, the term social distancing has formed some misinterpretations as some people incorrectly believe that the word social distancing means, altering our relationship position with people or that we must be parted from family and friends. Due to this misunderstanding, the WHO has introduced the term ‘physical distancing’. The vocabulary has been changed to emphasize that by maintaining physical...
distance, people can continue to be socially and emotionally connected to their precious ones and family.\textsuperscript{2}

The challenge for the designers is how they can include social distancing in their designs, and how they can improve the future design of hospitals in a way that will stand against epidemics like COVID-19. Unlike the other sectors quarantine cannot be applied for hospitals because there are always emergencies. Avoidance and control of healthcare-related infection and the management of spaces require a multi-factorial method. This includes suitable space and conveniences in all areas to support simple infection prevention and control repetition, including correct patient placement. The simple infection control performs that should apply in all healthcare at all times are mentioned as Standard Defences. Significantly, hospital designs allow flexibility of use over time and design for future service requirements. Hospital buildings would probably require a life span of several decades, through which time, there are possible considerable developments in healthcare technology and variations in the system in which healthcare is delivered.\textsuperscript{3}

Each hospital consists of several departments, including an inpatient department, emergency department, outpatient department, computed tomography, operating room unit and X-ray. Outpatient care, also known as ambulatory care, is given in hospital-based outpatient or stand-alone clinics, physician offices, ambulatory surgery centres and a variety of other specialized settings where patients receive treatment but do not stay overnight.\textsuperscript{4} This paper focused on the typology of outpatient clinics inside hospitals based on the location of waiting areas. In other words, the outpatient department is the department where patients are treated without an overnight stay. There are many requirements for the outpatient department and they are as follows: sixty percent of the space shall be provided for the corridor and waiting, and there shall be seating for one-third of the daily visitors. The space specified for the examination and consultation room should not be less than 7,432.2 m\(^2\) and 13,935.5 m\(^2\), respectively. Moreover, the location of outpatient clinics should be close to vital adjuncts, easily accessible, smooth flow of traffic, preferably on the ground floor. Furthermore, when considering the design of an outpatient department, it should meet some of the basic requirements such as:

1. Accessibility of patients
2. Standard signage that is both effective and intelligible should be planned.
3. Patients’ dignity and privacy must be respected.
4. Plan for future growth.
5. Areas with educational resources
6. The waiting room and public areas should be sufficiently large.
7. Day-care centres could be used as a support service.
8. Natural light and excellent ventilation should be allowed.\textsuperscript{5}

The outpatient department has several components and one of these components is the waiting area, which is the focus of this study. When designing waiting areas, it is important to consider the following aspects:

- The privacy of the waiting area is very important and it should be considered and provided.
- Personal space should be considered; there should be space provided for patients and their families. In addition, the arrangement of the waiting area is also important. It should be arranged in a way that patient and their companions should be near each other but not close to other patients.
- Visible and accessible from other parts of outpatient clinics.
- Have visual signs for wayfinding.
- Variety of comfortable seating and arrangement.
- Containing physical elements such as lighting, plants and finishing.
- Easy circulation between waiting areas and other areas of outpatient clinics especially service parts.\textsuperscript{6}

The term typology refers to a classification based on a fundamental type.\textsuperscript{7} In architecture, the term represents a set of characteristics that help classify and categorize buildings into various categories of types, a typology is distinct from the idea of a model.\textsuperscript{8} In healthcare buildings, there are various classifications of typology, as in outpatient layout, which means arranging outpatient units in such a way as to give the best result, less walking distance and associated handling cost between units. However, outpatient clinics in hospitals can be classified into two groups of typologies, which are centralized and decentralized. Centralized outpatient typology means the waiting area surrounded by examination rooms and service areas, while in the decentralized typology the waiting area is not located in the centre of the department, as it is characterized by its different design and location, which are classified into four types: lobby, sectoral (grouped), linear and mixed.\textsuperscript{9}

In this paper, the relevant studies were classified into two groups, the first group of studies dealt with healthcare and the classification of outpatient layout typology and the second dealt with the importance of providing social distancing in the built environment in general and healthcare buildings in particular. Based on studies on outpatient layout typology, Vahdatzad and Griffin\textsuperscript{10} in their research have studied the relationship between function and form, to show how patients’ care efficiency is affected by the layout of outpatient. They emphasized that incorporating the design of the outpatient department with the physician room assignment is a tactical decision. Jiang et al.\textsuperscript{11} aimed to
study people’s preference for the waiting area, which is the integration of nature with the design of the waiting area. In a context not far away, Sharareh\textsuperscript{12} studied the problems in the waiting area represented in aspects related to space planning, finishing of the waiting area, furniture design and materials. Similarly, Andrade et al.\textsuperscript{13} studied the effects of physical environments on patients’ health. The physical environment includes the surrounding environment, interior design and architectural design. On the other hand, outpatient clinics depend on the quality of the physical environment, and surprisingly, the social environment does not affect outpatient satisfaction. The results indicated that patients’ satisfaction is affected by environmental quality according to their perceptions of it and that patients’ condition moderates this relationship. As for the design of the internal environment of hospitals, Sadek\textsuperscript{14} revealed that wayfinding, accessibility and circulation are critical factors in the design of hospitals that require careful handling.

As for studies on social distancing, Megahed and Ghoneimb\textsuperscript{15} described the need for a physical environment to limit the effects of a pandemic before considering a way to improve medicine. They explained that after COVID-19, architecture will not be the same because people have learnt how the physical environment can cause problems in thinking about transmitted diseases like COVID-19. The result of this study, which was conducted based on literature and document reviews, demonstrated the importance of an ‘antivirus-built environment’ and confirmed that this type of built environment is important for stopping and isolating viruses or other transmitted diseases. Abdul Nasir et al.\textsuperscript{16} have discussed the effects of ‘spatial configuration management’ on social distancing in hospitals. This includes the importance of space management and planning in providing social distancing focussing on wayfinding as a vital factor; they identified that the level of wayfinding indicated the level of management. In another related context, Nguyen et al.\textsuperscript{17} showed that by providing social distancing in hospitals, the number of active cases of COVID-19 was decreased. Moreover, Sun and Zhai\textsuperscript{18} discussed the importance of ventilation and social distancing in combating COVID-19. It is known that social distancing helps prevent direct contact between patients and this will help reduce the rapid spread of the disease. As for ventilation, too, it should be considered because ‘indoor ventilation is strongly associated with the risk of infectious respiratory disease’.\textsuperscript{18} Likewise, Ghosh et al.\textsuperscript{4} studied the effects of social distancing on COVID-19 cases in India. The data in this research were obtained over 100 days of patient observation; the study found that social distancing delays outbreaks of transmitted disease.

Previous studies related to outpatient-clinics layout typologies and social distancing were highlighted, analysed and discussed to discover the most influential factors in spatial layout typologies. These studies did not provide a systematic framework to link these two aspects, nor did they provide a clear and comprehensive understanding of the potential impact of providing social distancing and its effects on the spread of infectious diseases within waiting areas in outpatient clinics. The relationship between social distancing and hospital layouts in general and outpatient clinics and waiting areas within them, in particular, is an important design issue, where good outpatient clinics layout may limit the spread of infectious diseases among outpatients, specifically in waiting areas. Among the factors associated with the type of outpatient clinics and waiting areas, which are expected to have an effective role in reducing these diseases, are privacy, wayfinding, accessibility, circulation and space density. Thus, these factors may create a positive environment in achieving social distancing, at least within the waiting areas in outpatient clinics, to prevent the spread of diseases in general and the COVID-19 pandemic in particular.

Architects, planners and built environment professionals are keen to examine many social and spatial implications to generate new patterns and configurations of use.\textsuperscript{19,20} The built environment in hospitals is critical as it is associated with infectious epidemics. COVID-19 has shown us this problem with hospitals. To deal with this pandemic, professionals in the architecture, urban design, planning and design agencies sectors have already shifted their focus to visualizing the post-pandemic era. However, the research and studies that have already been done are not enough to imagine what an antivirus-built environment would look like. To bridge this gap, this study examines the impact and potential role of outpatient layout typology including the waiting area in creating social distancing and thus limiting the spread of the coronavirus. Accordingly, this study seeks to shed light on questions related to the nature of this relationship to find out whether the difference in typologies of outpatient clinics, including the location of waiting areas, has a role in providing social distancing or not.

This research aims to study the possible relationship between architectural designs or the built environment represented by different layout typologies of waiting areas within outpatient clinics in Erbil hospitals. The social distancing achieved through these plans may reduce or limit the spread of the Coronavirus caused by the gathering of patients within these spaces. Additionally, to discover how configurations of waiting areas within outpatient clinics have a role in generating accurate social distancing. This is to determine which spatial models are most effective in creating an optimally social distancing environment. Therefore, this study pursues to achieve the following specific objectives:

1. To discover the impact of outpatient layout typology on the spread of the Coronavirus, which may be caused by the gathering of patients in waiting areas.
2. To detect the best distribution and layout typology of waiting areas within outpatient clinics that promote social distancing.

**Methodology**

This study adopted the space syntax approach as a quantitative method to achieve the research objectives and solve the research problem. Space syntax provides data collection in numerical form from samples and case studies for analysis and comparison. Although space syntax is a theory, it may also be used based on its tools and techniques to analyse spatial configurations. Methodologically, it tries to graphically and mathematically describe the topological relationship between spaces at various levels of urban design and architectural interior designs. This is accomplished by measuring space syntax parameters both locally and globally. DepthmapX software with version X10, Tasos Varoudis, has been applied for calculating space syntax indicators and parameters. Five cases of outpatient clinics representing five hospitals in Erbil city have been selected. The AutoCAD plans of these cases are modified and rescaled to be suitable with the same scale, then exported to the DXF format, to be used in DepthmapX software for analysing their spatial structures and configurations. In this study, four different types of space syntax maps were used as measurement tools. All these types of maps can be transformed into graphs for purpose of analysis. These syntactic maps are (Isovist Map for calculating Isovist area, Axial Map for calculating integration, Convex Map for calculation both mean depth and integration and VGA for calculating connectivity) to quantify the variables and factors of the study which are (wayfinding, accessibility, privacy, circulation and space density). Figure 1 is a flowchart that shows the methodology used in this study.

**Syntactic maps and measurement indicators**

Four different syntactic maps and indicators were used for measuring the study variables, the following are their definitions and what their lower and upper values mean.

**Isovist map.** Isovist map depicts the areas that are visible from convex spaces or axial lines. It is a set of points visible from a specific point inside the space concerning the size and shape, and is also known as ‘the field of view’ in which the area of view can be calculated. For this study, Isovist area was used to provide a clear form for the five selected layouts, the high value of the Isovist area provides easy wayfinding inside outpatient clinics.

**Axial map.** This type of syntactic map depicts the least number of axial lines covering all convex spaces of a layout and their connections. It can be defined as the smallest number of axial lines that are associated and crossed to cover the entire designated area, and the measure of how fine axial lines are crossed can be measured by the connectivity and integration. Hillier and Hanson, Al-Sayed, Tuner and Dettlaff sustained that the longer the line, the more possible to be crossed by other lines. The colour range indicates the high and low readings; the most integrated and connected parts are shown in red, orange and yellow colours, while the blue and dark blue specify the less connected and segregated spaces. For this study, integration measurement was used to measure the integrated spaces inside outpatient clinics, the high value of integration means the more accessible area in outpatient clinics.

**Convex map.** The convex map was used to consider the configuration relationships among spaces. It was chosen and used to analyse defined spaces such as buildings or part of...
buildings more than urban spaces. Moreover, it is an indication of the minimum number of interconnected convex polygons that cover the entire system to denote fewer or more voids in a given space. Colour range specifies the high and low readings; red, orange and yellow indicate the most combined and connected parts, while blue and dark blue indicates the less connected and segregated spaces. At the same time, a convex map offers the study of the mean depth of spaces where the colours red, orange and yellow indicate the deep spaces in the plan. In this study, mean depth and integration were used; mean depth measures the number of spaces to reach the desired area, a higher value of mean depth indicates more privacy within the desired area. As for integration which measures the most common area between spaces, a low value of the integration is an indicator of a low-density area.

**Visibility Graph Analysis (VGA).** Visibility graphs analyse the range of any point in the spatial layout that is visible from other points. A graph also measures and calculates the points that are not directly visible by testing how many intervening points are needed for a point to see others. The VGA can be applied to two levels; eye level (for what a standing person can see) and knee level (for how people can move). As it is important to understand the spatial layout and how people can move within it. The graph shows a different range of colours from red to dark blue; red, orange, yellow and light green identify high visibility, while blue and dark blue identify low or no visibility. For this study, connectivity was used as a syntactic measurement indicator to show the links and movement between spaces in outpatient clinics where the high value of connectivity provides better circulation. Table 1 presents overall space syntax maps and indicators used for measuring study variables.

**Table 1.** Syntactic maps and indicators for measuring variables of the study.

| Maps     | Measurement indicators | Study variables |
|----------|------------------------|-----------------|
| Isovist  | Isovist area           | Wayfinding      |
| Axial    | Integration            | Accessibility   |
| Convex   | Mean depth             | Privacy         |
|          | Integration            | Space density   |
| VGA      | Connectivity           | Circulation     |

**Study variables**

Nowadays, the hospital faces new challenges that include protecting all its users from infectious diseases, and in parallel with the healthcare provided by hospital facilities, there is another essential factor that must be taken into consideration to prevent the spread of infection, which is social distancing. Thus, and based on previous studies, the right to privacy has been acknowledged as a fundamental human right that must be respected in all parts of life, including patient care, medical and nursing environments. Maintaining patient privacy is critical since it is the healthcare provider’s first legal and ethical obligation to the patient. Privacy is another important factor as an ethical and legal obligation of healthcare providers to the patient. Thus, this study identified some of the basic factors related to the design of the outpatient layout, through which the difference in its various and different typologies can be evaluated. This difference may lead to a difference in the levels of providing social distancing between patients themselves and between them and the medical staff within the outpatient clinics in general and waiting areas in particular. The following are the most important of these factors and variables adopted by the study:

**Wayfinding.** Reaching a destination is one of the initial steps that a patient seeks to solve in a hospital. Difficulties surrounding this process may cause inefficiency in the accessibility and circulation. Wayfinding is the process of solving spatial problems while navigating from one point to another. It encompasses three mental operations: information processing, decision-making and decision execution. Moreover, it perceives the relationships between zones, with the physical and visual access between them, and makes it possible to discover qualities required in circulation paths that connect the spaces.

**Accessibility.** According to Turner, the spatial configuration of hospital departments should provide for quick access to staff equipment and supplies. To ensure the safety of patients, healthcare departments should have an obvious architectural layout that allows staff to readily access patient rooms and promote a clear vision for continuous observation.

**Privacy.** The right to privacy has been acknowledged as a fundamental human right that must be respected in all parts of life, including patient care, medical and nursing environments. Maintaining patient privacy is critical since it is the healthcare provider’s first legal and ethical obligation to the patient. According to Chaudhury et al., patients benefit from privacy since it gives them peace of mind and reduces their stress levels. If the patient has his private location, he feels more at ease and is more willing to share personal information with the staff or throughout the medication process.

**Space density.** The definition of human population density is the number of people residing within a given area. However, for realistic representations of population density to be useful, appropriate Spatio-temporal scales must be used. In healthcare buildings, short distances or travel times enhance the use of some services; however, travel times are affected by a variety of factors,
including how the population spreads in the space. Given the same healthcare resources, denser populations would be expected to have shorter travel times than dispersed ones.\(^{40}\)

**Circulation.** Building circulation is one of the most important design factors associated with spatial planning, particularly in the early stages of building design, and has a considerable impact on the overall design quality.\(^{41}\) However, one of the central themes in architectural theory, design and practice is moving through space. Le Corbusier\(^{42}\) proposed that to truly experience architectural space, one must walk through and around it. In architecture, circulation is an architectural planning process. In particular, circulation routes are pathways people take through and around buildings or urban places. Circulation is often thought of as the ‘space between spaces’, having a connective function, but it can be much more than that.\(^{43}\) It is the communication among differentiated spaces and between the exterior and the interior. It may be achieved by openings alone in the simplest plan, but most buildings require distinct spaces allotted to horizontal and vertical circulation (corridors, lobbies, stairs, ramps, elevators, etc). These are designed by the procedure of analysis employed for differentiating uses.\(^{44}\) However, circulation is much more than the mere allocation of common space. Its importance lies in the correct integration of the many departments of the hospital so that different types of traffic that cross the length and width of the hospital are separated as much as possible, traffic routes are kept short, and patients and others are protected from intrusion and the risk of hospital-acquired infection.\(^{45}\)

**Case studies**

A field survey was conducted on hospitals in the city of Erbil to collect data about their layout typologies. There are a distinct number of hospitals with different typologies that contain outpatient clinics with various patterns of both centralized and decentralized types (linear, lobby, sectoral and mixed). Five different types of outpatient clinics representing Erbil city hospitals were selected for both types (centralized and decentralized).

**Centralized outpatient typology – centralized waiting area (CMC hospital).** CMC is one of the privately funded hospitals in the east of Erbil city, located on Koya Street. It consists of 134 beds. The outpatient clinics are located in a separate building next to the main hospital building and are connected by a corridor on the second floor. The outpatient layout is of a centralized type which means that the waiting area is located at the centre of its spatial configuration and is surrounded by doctors’ rooms and other service areas. Figure 2 shows the architectural plan of the outpatient clinics of CMC Hospital with the typology of its waiting area.

**Decentralized outpatient typology – linear waiting area (Paky hospital).** Paky is also one of the privately funded hospitals in Erbil city located on Nowruz Street. It has a capacity of 70 beds. The outpatient clinics are located behind the main entrance of the building. The layout design of the outpatient clinics is linear, the main corridor located within its spatial configuration is designed as a waiting area, which means that the corridor serves as a circulation area and a waiting area at the same time, and the doctors’ room and other services are located on both sides of the waiting area. Figure 3 shows the architectural plan of the outpatient clinics in Paky Hospital in addition to its waiting area scheme.

**Decentralized outpatient typology – lobby waiting area (Valia hospital).** Valia is a newly built, privately funded hospital located in the southeast of Erbil city on the 120 m ring road. It consists of 28 beds as an inpatient unit with emergency and outpatient clinics. The outpatient clinics are located directly at the main entrance to the hospital, meaning that the waiting area is located in the main lobby of the hospital. Thus, the design of the outpatient clinics is decentralized and called the lobby typology. Figure 4 shows the architectural layout of the Valia’s Hospital outpatient clinics with a diagram of the waiting area.

**Decentralized outpatient typology – sectoral waiting area (Rizgari hospital).** Rizgari is a public sector hospital considered the largest hospital in Erbil, located on the 40-m ring road at the intersection of Gulan and Koya Streets. It has 400 beds; outpatient clinics are located on both sides at the rear of the building. Outpatient clinics layout of the sectoral or grouped typology consisting of eight sub-waiting areas, that is, there are eight groups of doctors’ rooms with their waiting area, Figure 5 shows the architectural plan of the Rizgari Hospital’s outpatient clinics as well as the schematic diagram showing the location of waiting area within its spatial configuration.

**Decentralized outpatient typology – mixed waiting area (Swedish hospital).** The Swedish hospital is one of the privately funded and managed hospitals located in the northwest of Erbil city on the 100-m ring road. The outpatient clinics of the hospital are located at the backside of the hospital, and it has two types of waiting areas which are the lobby and the linear waiting area, so it can be classified as a mixed outpatient layout typology. Figure 6 shows the architectural plan of the Swedish hospital’s outpatient clinics with its waiting area scheme.
Figure 2. CMC outpatient clinics layout and waiting area scheme.

Figure 3. Paky outpatient clinics layout and waiting area scheme.

Figure 4. Valia outpatient clinics layout and waiting area scheme.

Figure 5. Rizgare outpatient clinics layout and waiting area scheme.
Analysis, interpretation and discussion of results

The data was processed using four different types of syntactic maps such as (Isovist Map, Axial Map, Convex Map and VGA) provided by the space syntax methodology. These analytical maps provide measurement indicators (Isovist area, integration, mean depth and connectivity) that were used to evaluate variables and factors related to spatial layouts and configurations of outpatient clinics, including waiting areas such as (wayfinding, accessibility, privacy, space density and circulation). The following are analysis, discussion and interpretation for each factor to discover the most influential factor in providing social distancing between patients, especially in waiting areas within outpatient clinics, and thus determine which spatial typology of outpatient clinics, including waiting areas, have a critical role in reducing or spreading infectious diseases among outpatients.

Wayfinding. Wayfinding is one of the important factors related to the spatial configuration that, if carefully designed, has a role in providing social distancing and thus limiting the spread of infectious epidemic diseases among patients. Based on the Isovist map, the Isovist area represented in 360 degrees of view, was used as a measurement indicator, a higher value indicates easier wayfinding. The results showed that the Isovist area had the highest average value in the decentralized-linear layout typology of outpatient clinics with (706), followed by the centralized typology (263.8), while the lowest average values of the Isovist area were in the decentralized typologies of (mixed, lobby and sectoral) with (235, 125.5 and 44), respectively. Both results of the numerical and colour Isovist map showed that the outpatient clinics with decentralized-linear typology have a larger Isovist area compared to other types, and accordingly it can be said that the design of the linear outpatient clinics achieves easier wayfinding, which avoids crowding within the waiting area and thus higher social distancing (Table 2, Figure 7).

Accessibility. Accessibility is the most independent factor influencing the provision of social distancing. To measure the accessibility factor, the integration was used as a measurement indicator based on the Axial Map, where the higher value is the most integrated space, that is, the most accessible in the required area. In this regard, warm colours such as red, orange and yellow indicate high accessibility of spaces, while cold colours such as blue and dark blue indicate low accessibility, and this negatively affects the result as it leads to low values as shown in Figure 8. The results of integration extracted from the Axial Map significantly indicate that the outpatient clinics of CMC Hospital with centralized layout typology represent the highest average

Table 2. Average values of Isovist area of all case studies.

| Case studies | Outpatient layout typologies | Isovist area value |
|--------------|-----------------------------|-------------------|
|              |                             | Minimum | Average | Maximum |
| CMC          | Centralized                 | 253     | 263.8   | 274.4   |
| Paky         | Decentralized Linear        | 560     | 706     | 716     |
| Valia        | Lobby                       | 121     | 125.5   | 130     |
| Rizgari      | Sector                      | 37      | 44      | 56.7    |
| Swedish      | Mixed                       | 174     | 235     | 266.6   |
value of (14) compared to other cases, that is, it is the most accessible, while the integration averages were equal in three cases of decentralized typology of (linear, lobby and mixed) with a value of (10). Among all five cases, the sectoral decentralized typology for outpatient clinics in Rizgari Hospital achieved the lowest average with a value of (6), which indicates an advantage in terms of spatial isolation and thus more social distancing. Accordingly, it can be said in general that decentralized typology for outpatient clinics, including waiting areas, is better compared to centralized typology in terms of avoiding overcrowding and achieving more social distancing (Table 3), (Figure 8).

*Privacy.* To measure the privacy factor, the mean depth was used as a measurement indicator provided by the Convex Map. The high value of the mean depth means a large number of spaces needed to reach the required space, and thus more privacy in that space. In a colour map, warm colours represent most areas of depth, while cool colours show less depth. The results related to the mean depth extracted from the convex map show that the decentralized – sectoral typology represented by outpatient clinics in Rizgari Hospital is the deepest with a mean depth of (4), while three cases (centralized and decentralized (linear and mixed) were equal with a value of (3), while the lowest average depth was found in the decentralized – lobby typology with a value of (2.5), (Table 4). Accordingly, decentralized typology, especially the sectoral type, is the deepest spatially among the five cases, meaning that it achieves the highest level of privacy and thus greater social distancing (Figure 9).

*Density.* Spatial density has been used as an important factor for determining the level of social distancing in a particular place. Based on the Convex Map analysis, integration was used as an indicator to measure the space density coefficient for all case studies. A higher integration rate is an indicator of greater density or more crowded area, while lower values mean spaces of lower density, which helps provide more social distancing and thus reduce the spread of infectious diseases, especially COVID-19. The results show that the lowest average of integration was

![Figure 7. Coloured Isovist map shows Isovist areas in all case studies.](image)

![Figure 8. Integration graph based on Convex Map analysis for all case studies.](image)

| Case studies | Outpatient layout typologies | Axial map integration |
|--------------|-------------------------------|-----------------------|
| CMC          | Centralized                   | 2.72                  |
| Paky         | Decentralized                 | 3                     |
| Valia        | Lobby                         | 2.3                   |
| Rizgari      | Sectoral                      | 3                     |
| Swedish      | Mixed                         | 3                     |

Table 3. Summary of integration results obtained from the Axial Map for all case studies.
achieved by the decentralized – sectoral and lobby typology with values ranging from (1.12 to 1.17), respectively while the integration averages were higher in the decentralized – linear, centralized and mixed typologies with values of 1.45, 1.37 and 1.29, respectively (Table 5). The results obtained from the colour map confirm what has been achieved through the integration indicator based on the Convex Map, where the warm colours indicate the most integrated spaces, in contrast, the cold colours indicate the least integrated and more isolated spaces as shown in Figure 10. Accordingly, it can be said that the design of outpatient clinics, including waiting areas in the decentralized – sectoral layout typology, achieved an integration average that is the lowest compared to the rest of the cases, indicating that the spatial configuration of this typology is more segregated and less spatially dense and thus has an advantage in providing social distancing.

### Table 4. Summary of mean depth results obtained from the Axial Map for all case studies.

| Case studies | Outpatient layout typologies | Convex map – Mean depth |
|--------------|------------------------------|-------------------------|
|              |                              | Minimum | Average | Maximum |
| CMC          | Centralized                  | 2       | 3       | 5       |
| Paky         | Decentralized Linear         | 2       | 3       | 4       |
| Valia        | Lobby                        | 2       | 2.5     | 3       |
| Rizgari      | Sectoral                     | 2.5     | 4       | 5.5     |
| Swedish      | Mixed                        | 2       | 3       | 4       |

### Table 5. Summary of integration results obtained from Convex Map for all case studies.

| Case studies | Outpatient layout typologies | Convex map – Integration |
|--------------|------------------------------|---------------------------|
|              |                              | Minimum | Average | Maximum |
| CMC          | Centralized                  | 0.7     | 1.37    | 5       |
| Paky         | Decentralized Linear         | 0.78    | 1.45    | 4.2     |
| Valia        | Lobby                        | 0.76    | 1.17    | 3.22    |
| Rizgari      | Sectoral                     | 0.79    | 1.12    | 2.27    |
| Swedish      | Mixed                        | 0.82    | 1.29    | 3       |
Circulation. Easy circulation inside outpatient clinics provides more social distancing and prevents overcrowding. To measure the circulation factor, a connectivity indicator provided by VGA was used. A high degree of connectivity means easy movement or circulation of patients between outpatient spaces. The results revealed that the highest connectivity value was found in the decentralized – linear typology with a value of (7177) followed by the centralized and decentralized – mixed typologies with values of (1.45, 1.37 and 1.29), respectively, while both decentralized – sectoral (grouped) and lobby typologies came with close connectivity values of (716, 68 6), respectively, as shown in Table 6. On the other hand, the warm colours shown by VGA colour map analysis represent high connectivity values, that is, ease of circulation inside outpatient clinics, while cool colours represent low connectivity values meaning difficulty in movement and circulation as shown in Figure 11. Accordingly, and based on the result of the VGA connectivity, the best movement within the outpatient spaces of the case studies was achieved in the decentralized – linear typology, superior to the centralized typology, while the decentralized – lobby typology appeared as the weakest spatial configuration in terms of circulation and thus a low level of social distancing among patients.

Based on the results obtained, five outpatient layout typology factors (wayfinding, accessibility, privacy, density and circulation) play a significant role in creating social distancing in outpatient waiting areas. Optimal solutions to minimize the spread of COVID-19 were discovered by examining and studying outpatient layout typology factors utilizing space syntax tools.

Summary of findings

This study addressed the relationship between the impact of the spatial configuration typology of outpatient clinics in Erbil hospitals and their role in limiting the spread of infectious diseases among patients, especially within waiting areas, which ultimately leads to encouraging social distancing and thus creating a more comfortable and healthy environment. In short, based on analysis, measurement tools and indicators, interpretation and discussion of results, the current research effort has revealed this relationship. Here is a summary of the most important results:

- The comparison of the syntactic measurements indicated that the decentralized – sectoral (grouped) layout typology has the highest Convex Map mean depth and less Convex Map integration, which proved that it has good privacy, fewer density areas and thus greater social distancing.
- The decentralized – linear typology has the highest degree of Isovist area and VGA connectivity, which means that wayfinding and circulation factors are at a high level. A preference in these two factors may create an atmosphere of overcrowding and more friction between people and thus a lower level of social distancing.
- As for the accessibility factor, the centralized layout typology is the most integrated, that is, the easiest to reach, and this may result in a kind of overcrowding and contact between people and thus less social distancing. On the contrary, we see that decentralized –

| Case studies | Outpatient layout typologies | VGA – Connectivity |
|--------------|------------------------------|-------------------|
|              |                              | Minimum | Average | Maximum   |
| CMC          | Centralized                  | 40      | 3221    | 8132      |
| Paky         | Decentralized                | 5       | 7177    | 15,794    |
| Valia        | Lobby                        | 23      | 684     | 1740      |
| Rizgari      | Sector                       | 38      | 716     | 2941      |
| Swedish      | Mixed                        | 34      | 1736    | 4763      |

Figure 11. VGA connectivity graph of all case studies.
sectoral typology is the least integrated, that is, the least accessible among all cases, and this is what gives it the advantage in providing the highest level of social distancing and consequently limiting the spread of infectious diseases particularly COVID-19 (Figure 12).

- Data extracted from the syntactical maps (Isovist, Axial, Convex and VGA), has an effective role in measuring factors and variables related to spatial configurations of the layout typologies of outpatient clinics, such as (wayfinding, accessibility, privacy, space density and circulation). The results showed the preference of decentralized typology (linear, sectoral, lobby and mixed) in general over centralized typology in most of the mentioned factors in terms of providing social distancing and thus reducing the spread of infectious pandemics, especially COVID-19, among patients in outpatient clinics in general and waiting areas in particular. For instance, decentralized – linear typology achieved a high level of wayfinding and circulation with values of Isovist area (706) and VGA connectivity of (7177), unlike the decentralized – sectoral typology which achieved a high level of the rest of the variables which are accessibility, privacy and density with values of axial integration, convex mean depth and integration (6, 4 and 1.12), respectively.

- Regarding the negative side of the results, from syntactical maps of outpatient layout typology factors, centralized typology is considered as the worst typology based on providing social distancing to limit the spread of COVID-19. For example, centralized typology achieved less value of wayfinding and circulation compared to the decentralized-linear typology, and less value of privacy, density and accessibility compared to the decentralized – sectoral typology. Table 7 shows the overall collected results regarding all adopted factors of outpatient layout typologies including waiting areas based on different syntactic measurement tools and indicators

Table 7. Overall data and results were extracted from syntactic maps and indicators.

| Space syntax maps | Layout typology | Centralized | Linear | Lobby | Sectoral | Mixed |
|-------------------|----------------|-------------|--------|-------|----------|-------|
| Isovist           | Isovist area   | 263.8       | 706    | 125.5 | 44       | 535   |
| Axial             | Integration    | 14          | 10     | 10    | 6        | 10    |
| Convex            | Mean depth     | 3           | 3      | 2.5   | 4        | 3     |
| Convex            | Integration    | 1.37        | 1.45   | 1.17  | 1.12     | 2.29  |
| VGA               | Connectivity   | 3221        | 7177   | 684   | 716      | 1736  |

Red value: high rating, Blue value: low rating, Black value: average rating

Conclusions

Waiting areas in outpatient clinics in hospitals are considered a potential source for the spread of epidemics and infectious diseases due to the gathering of large numbers of people within a specific space. Outpatient clinics layout typology has undergone many changes due to the wishes and requirements of patients as well as other factors related to its spatial and functional nature. These changes were
reflected in the presence of different typologies and spatial configurations for waiting areas in particular and outpatient clinics in general. This study aimed to examine the impact and potential role of outpatient layout typology including the waiting area in creating social distancing and thus limiting the spread of the coronavirus. The study shed light on questions related to the nature of this relationship to find out if the difference in the typologies of the outpatient clinics, including the location of waiting areas, may have a role in providing social distancing between outpatients. Five different outpatient layout typologies (centralized and decentralized: linear, lobby, sectoral and mixed) representing Erbil city hospitals based on the location of their waiting areas were selected.

Among the main factors associated with the layout typology of outpatient clinics and waiting areas, which are expected to have an effective role in understanding and evaluating the differences in the structure and configuration of these typologies, five factors were selected, including wayfinding, accessibility, circulation, privacy and space density. To measure these factors, the methodology of space syntax was applied by adopting four different syntactic maps (Isovist map, axial map, convex map and VGA). These analytical maps contributed to providing indicators such as (Isovist area, integration, mean depth and connectivity). The results showed a preference for decentralized typology (linear, sectoral, lobby and mixed) in general over centralized typology in most of the mentioned factors in terms of providing social distancing and thus limiting the spread of infectious epidemics, especially COVID-19, among patients in outpatient clinics in general and waiting areas in particular.

In conclusion, based on the study factors, the research finding revealed that there is a direct relationship between the layout typology of outpatient clinics, including waiting areas and the level of social distancing, as it showed that the difference in the structure of these configurations generates a difference in the levels of social distancing achieved in each of them. Given the influential role of outpatient typology in providing a safe, comfortable and healthy indoor environment with the greater social distancing between patients and avoiding spatial overcrowding, the research findings provide a useful resource for healthcare designers in their future designs, particularly in outpatient waiting areas.

Study limitations

Researchers in this research faced many difficulties and limitations, for example, but not limited to:

- Data collection in hospitals during COVID-19 has been a challenge.
- Many hospitals in the study area (Erbil city) have turned into hospitals for COVID-19 patients, forcing researchers to limit the investigation to only five cases.

Opportunity for future studies

This research paper provided social distancing data and opened an opportunity to conduct more relevant studies such as:

- Selecting and testing other healthcare factors to provide social distancing to improve and achieve more useful data.
- The application of different research methodologies besides Space Syntax such as simulation creates an opportunity to conduct correlational analyzes among the findings.
- Choosing other parts and sections within the hospital’s planning to provide social distancing and reduce the spread of transmitted diseases.
- Studying the concept of social distancing in other hospital departments.

Authors’ contribution

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