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Improving the circulation of museum's display halls to adapt with COVID-19 precautionary measures

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Abstract

Museums have an important role in transmitting information and providing scientific and historical experiences to visitors. As published in the 2020 report by the International Council of Museums (ICOM), the COVID-19 pandemic has disrupted the activities of museums around the world, affecting the country economically and culturally. Accordingly, the design of movement paths must be reconsidered to adapt to the precautionary measures for the COVID-19 virus. The research paper is based on a theoretical study followed by an analytical study of a number of international and regional museums that used specific precautionary measures to limit the spread of the COVID-19 virus. The results of these studies helped in an applied study using syntax in space to improve circulation in the National Museum of Egyptian Civilization. The study highlighted the ability of syntax techniques in defining the problem, making decisions to design circulation within the exhibition halls of the museum, and providing recommendations to improve circulation within the National Museum of Egyptian Civilization in times of epidemic crises.

Keywords: circulation of museum's display halls, COVID-19 pandemic, Space syntax.

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1. Introduction

Museums are repositories of scientific knowledge accumulated over centuries and are an essential part of the identity of peoples and nations and a vital element for societies [1]. Where the museum presents the history, culture, customs, and experiences of the community, the museum is an important destination for the city's residents and tourists [2]. And the exhibition center, which is visited by the general public on a regular basis, has a purpose not only for the works of art but also for the architectural space of the museum, which gives visitors one of the most wonderful sensory experiences [1], and thus museums have become an indispensable place for study.

Circulation is one of the most important elements of museum design. In this study, space syntax was used to analyse circulation, as it proved its ability to analyse space planning in buildings [3]. Especially in the analysis of spatial relations of spaces in museums[4], where he was used by the architect Ian Ritchie in developing a master plan for the spaces of the British Museum [5] and the architect Yuan Li in the analysis of the architectural spaces of the Gulangyu Organ Museum[2], and the architect Selma Saraoui in redesigning the circulation in the El Moudjahid Museum of Bejaia [1].

And based on that, the research made field observations for the National Museum of Egyptian Civilization, analysed its internal spaces using the DEPTHMAP, and analysed the precautionary measures used in museums. The research was able to come up with recommendations for how museums can continue to operate during epidemics.

1.1. *Research Problem*

The research problem is summarized in: **First**, the circulation design must adhere to the safety precautions advised by the American Alliance of Museums (AAM), the World Health Organization, and the International Council of Museums (ICOM).

Second, it has been noted that a number of museums place a heavy emphasis on displays while largely ignoring the human experience. However, with the development of society, people gradually realize that the visitor experience has evolved into the core of design and is essential to transforming the museum from a functional space into an experiential space (li et al., 2020).

The research paper aims to highlight the importance of preserving the work of museums and serving the public even in times of epidemic crises, and accordingly, using Space Syntax, it is necessary to design a circulation for visitors that applies the precautionary measures for COVID-19. The research applied this to the National Museum of Civilization, given that it is one of the newly designed museums that opened after the COVID-19 pandemic.

2. Literature Review

2.1. *A study of the effect of the distribution of exhibits on the movement of visitors*

John H. Falk recognized five distinct visitor kinds and self-aspects in his research on modern and contemporary museums: explorers, facilitators, professionals or hobbyists, experience seekers, and rechargers. The level of interest of a visitor in an exhibit varies by institution. It has a lot to do with the museum's exhibits; what interest's one individual may not be intriguing to another. If the designer met the visitors' demands, their evaluation of their experience would simply reinforce their identification with their wishes. [1]

How did the guests behave while they were in front of the exhibit area? Mariani Rousset utilized the results of Robinson et al.'s investigation of European museums in the 1920s and 1930s. According to her, studies have shown that individuals tend to select the correct side when they are in an area without a clear direction. They tend to lean to the right. When the entrance is on the left, they turn to the right. When the entry provides a right or left turn, they halt to weigh their alternatives. [6].

2.2. *Studying the impact of the (Covid-19) virus on museums*

Before the emergence of epidemics such as COVID-19. The focus of the museums was on the development of the museums and the circulation inside them to adapt to the digital age. to be successful in preserving its cultural importance and designed according to the requirements of the modern world [1].

2.2.1. The impact of COVID-19 on the museum sector

Based on an International Council of Museums (ICOM). Report on a survey of 900 museum professionals from five continents, compiled on October 18, 2020, the impact of closing museums can be summarized into three main points:

First, the cultural aspect

Our societies rely heavily on museums. Their role in the education, development and well-being of the population, as well as the importance of information and communication technologies (ICTs). Museums also provide spaces that foster learning, creativity, and conversation [7].

Secondly, the economic situation of the country: The status of museums varies depending on the region of the world being considered. In April, the percentage of closing Regions such as Latin America and the Caribbean, Africa, and the Arab countries have the highest percentage of closed museums as shown in Figure 1.

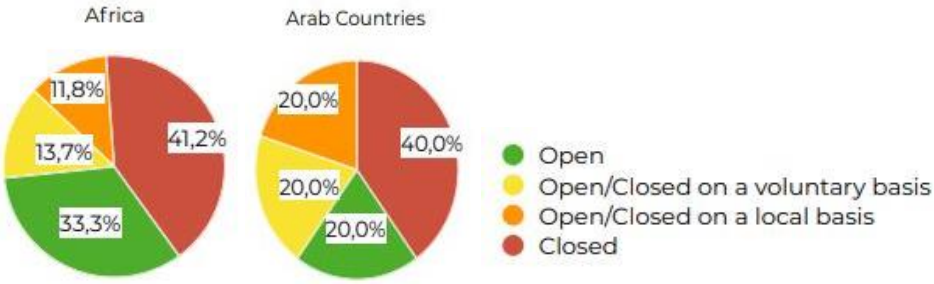

Figure 1. Percentage of closed museums in Africa and the Arab countries[8]

The loss of revenue for 2020 is perceived to be highest in the Arab countries, Asia, Africa, and Latin America and the Caribbean, but the figures are worrying everywhere around the world According to the report of the International Council of Museums (ICOM), as shown in Figure 2.

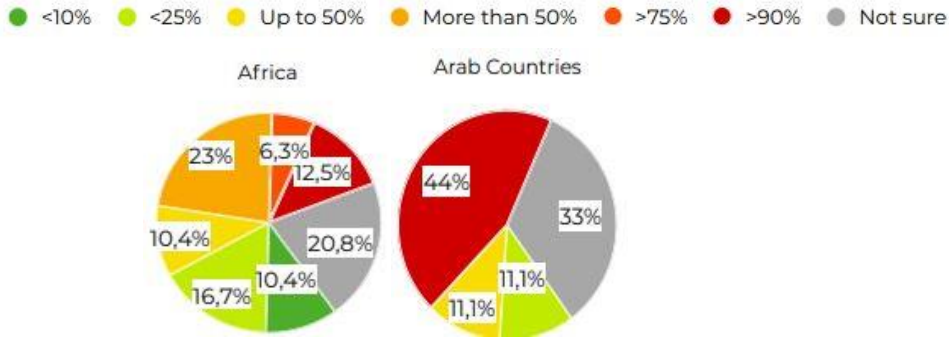

Figure 2. Percentage of revenue losses in Africa and Arab countries[8]

Third, the livelihoods and careers of museum staff and specialists

About 14% of the respondents to the ICOM survey stated that part of the staff had been furloughed or laid off. Furthermore, 16.2% of respondents stated that at least a quarter of museum staff had been laid off or furloughed between February and September 2020 in the wake of the COVID-19 crisis, a number that rises to more than half of the staff for 10.6% of respondents [8].

The research aims to access the technologies available to control the flows, complete the museum itinerary, and assess whether or not they are better suited to the era of the pandemic and therefore the visit, while adhering to the recommendations of COVID-19.

3. Space Syntax as a tool for analyzing circulation in museums

The first architectural structures in which space syntax was used were museums. It helps in understanding different configurations and user behavior. Common behaviors of museum visitors include walking, viewing exhibits, and resting [2]. Using Space syntax, you can test exhibit layouts and visualizations to see if composition and circulation are vital to the success of the visitor experience [1].

3.1. *Examining Art Galleries and Museums Using Space Syntax*

So how has space syntax helped us better comprehend the spatial organization of museums and galleries? Hillier et al.'s (1982) research on the museum or gallery was the first to use space syntax. This article, which examined the plans put out for the London National Gallery's addition, was about design decisions. The study's goal was to demonstrate that by examining important spatial characteristics like axiality, segmentation, and movement choices, the effects of spatial design on the informational potential and social character of the designs could be discussed more explicitly. This would enable a more thoughtful functional assessment to complement the aesthetic considerations [4].

3.1.1. Examples of space syntax application in museums

1- The British Museum: The British Museum's plan includes increasing visitor involvement with the collections as one of its main goals. The British Museum hired Space Syntax Limited to provide a baseline analysis of patron mobility patterns and the physical structure of the museum [5]. The study's main objectives were to identify the features of the museum's spatial organization and determine how those factors affected visitors' experiences. The baseline analysis was done to find areas where visitor flow patterns may be improved[9].

British Museum Methodology: The approach involved tracking visitor movement and evaluating it in terms of building space to create maps that allowed the museum's design to be rethought. Amplify and improve visitor interaction with groups as shown in figure 5.

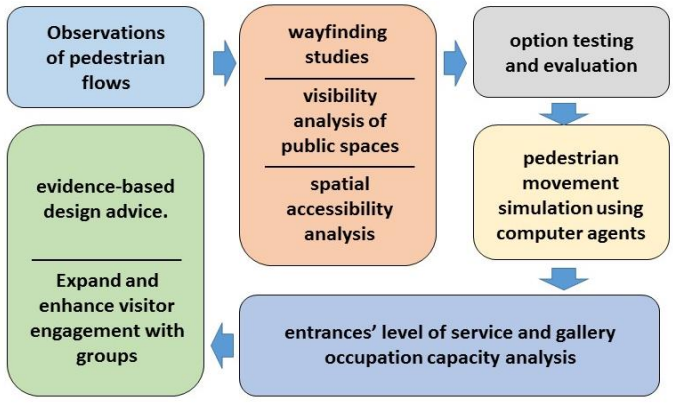

Figure 3 British Museum Methodology_Source: Authors

2- The Gulangyu Organ Museum: The Gulangyu Organ Museum in Xiamen, China, was examined using space syntax, and its space structure was described using topological depth, visual graph analysis, and proxy simulation. As a result, a number of ideas were put forward, such as redesigning the way the museum's operations are organized and turning the museum into an experiential place. Figure 6 displays the approach taken[2].

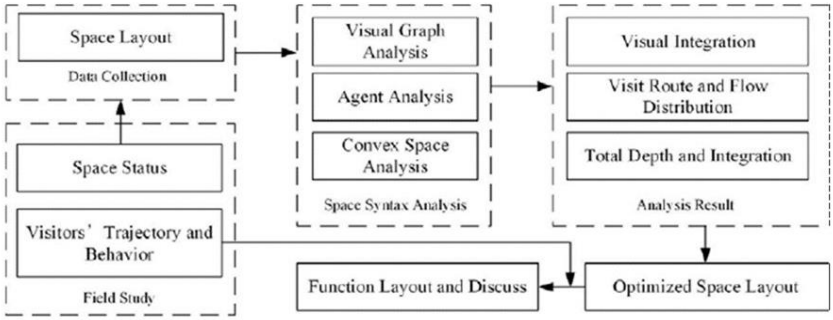

Figure 4 the Gulangyu Organ Museum Methodology[2]

3- El Moudjahid Museum of Bejaia: For a number of reasons, the public does not frequently visit many museums. The history- and mujahideen-focused El Moudjahid Museum of Bejaia has a lot of potential and is now the only museum in the city that provides tourists with this sort of service. It does, however, display some dysfunctions that make going there unpleasant, such as low inclination rates; these caused it to be closed during the COVID19 period due to the difficulty in managing the flow (especially during the event periods); Through the use of Space Syntax, the research were able to carry out a diagnosis and suggest solutions to enhance the exhibition hall during COVID-19[1]. Figure 7 displays the approach taken.

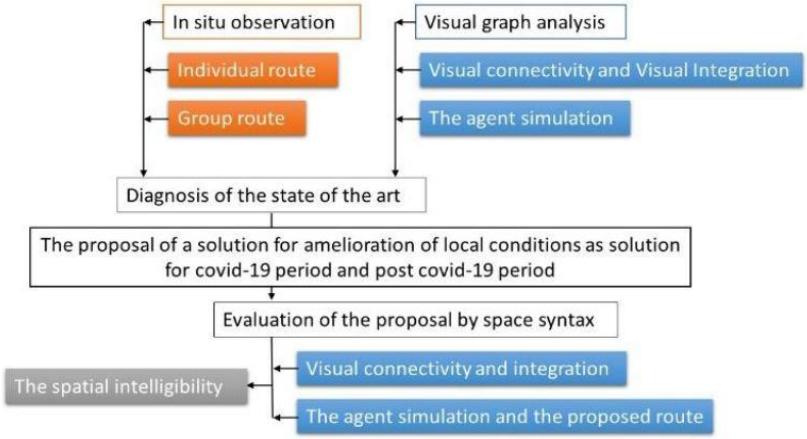

Figure 5 El Moudjahid Museum of Bejaia Methodology[1]

4. Applied Study

4.1. *Methodology*

The research will therefore use the software DEPTHMAP for the spatial reading of the museum. As a result, the research used the Graph Visual Analysis to examine the visibility. It is a method for representing the relationships between the components of a spatial system using colored graphs. The colors are also associated with numerical values that will allow a quantitative and qualitative

analysis of the space in question. It can develop several parameters and concepts, such as i) visual clustering coefficient. ii) Visual integration. iii) Simulation of agents: It is about putting agents representing visitors (a human flow), and thanks to their numbers and the time of the visit, the research can have supposed routes of visit, compare routes, or make changes to a route that already exists [2] iv) The Iovists: correspond to the fields of vision that can be offered to the visitor or user of a space according to the analysis of the spatial configuration of the space in which it is [1].

4.1.1. Research framework

First, field trips were conducted to the Egyptian Museum of Civilization to understand how to effectively divide space into convex spaces and to draw a diagram that reflects spatial divisions and functional patterns. Each of the three showrooms has been divided into a "gate count" as a reference to the numbers of visitors and times of high flow, and to know the distribution of visitors within each showroom. [10]. A map of the activities for users of the space (watching - sitting - filming) was documented by taking a set of pictures over the working hours showing the activities with what is called (static snapshot). Several visitors were randomly selected to do the motion tracking. The behavior used as a reference for studying circulation within the museum. It is distributed with circulation maps and activity maps [10].To analyze the percentages of museum suitability for the COVID-19 virus, a chart depicting the main points of preventive precautions for the virus in museums was created.

Second: The composition of the Egyptian Museum of Civilization was analyzed through the DepthmapX 0.50 program. Third: Based on the results of the field trip and Space syntax analysis and after comparing them with the precautionary measures for the COVID-19 virus that must be available in the museum, the following basic points were proposed to be followed to make the museum an experimental space for visitors and adapt it to epidemics, especially COVID-19. Figure 10 shows the framework used.

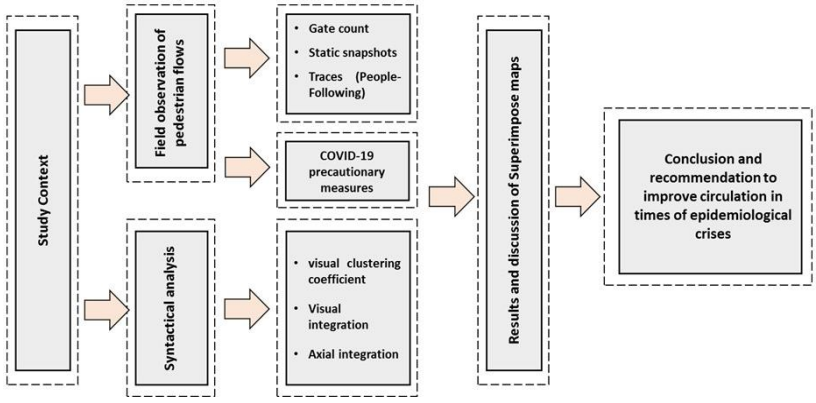

Figure 6 Research frame work_Source: Authors

4.2. *The National Museum of Egyptian Civilization (NMEC)*

The first museum to display Egyptian civilization from the prehistoric era to the modern era, with the aim of establishing a museum that reflects the different cultural aspects of Egypt's rich history UNESCO announced, at the request of the Egyptian government, an international campaign to establish the National Museum of Egyptian Civilization in Cairo in 1982 as shown in figure 8. The joint efforts resulted in choosing the current site in the Fustat area, which was chosen in 1999. The foundation stone for the museum was laid in 2002. In In 2017, as shown in Figure 8.

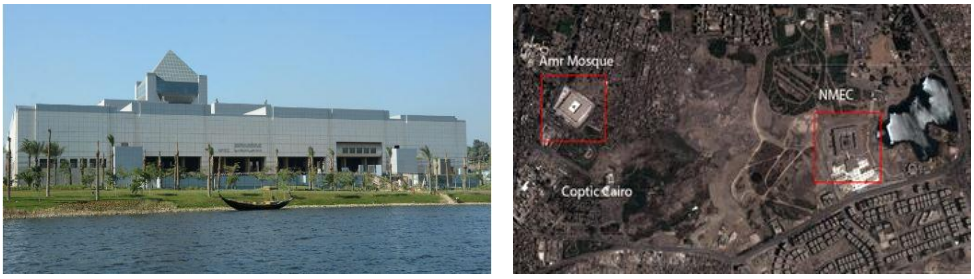

Figure 7 the National Museum of Egyptian Civilization google earth and exterior shot [11]

The museum consists of: first, the main exhibition hall (Figure 9 (a)), which contains a number of artefacts that give an integrated idea of the Egyptian civilization from different eras [12]. Second: The Hall of Mummies (Figure 9 (b)), the hall includes 20 royal mummies. Third: The Egyptian Textile Hall (Figure 9 (c)), which consists of a ground floor and an upper floor. The hall is displayed on the ground floor. Some of the textile belongings of Al-Moez Street On the upper floor, the belongings of the "Mohamed Ali" family are displayed.

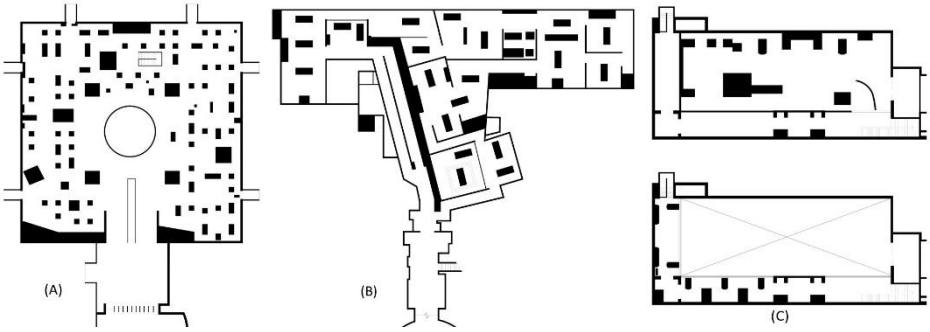

Figure 8 plan of the National Museum of Egyptian Civilization (A) The main exhibition hall, (B) The Hall of Mummies, (C) The Egyptian Textile Hall_Source: Authors

In this study, the research will analyse the current situation of designing a circulation in the three museum exhibition halls according to the data collected from field monitoring.

4.3. *Observation*

4.3.1. Gate counts

Gate count is used to establish the flows of people at sampled locations within the city over the course of a day[13]. In order to make observations, the research divided the exhibition hall into several spaces (gates), observing each gate for a period of 2.5 to 5 minutes, as shown in Figure 11, during working days and weekends. Figure 12 show the average number of counts in gates bar hours.

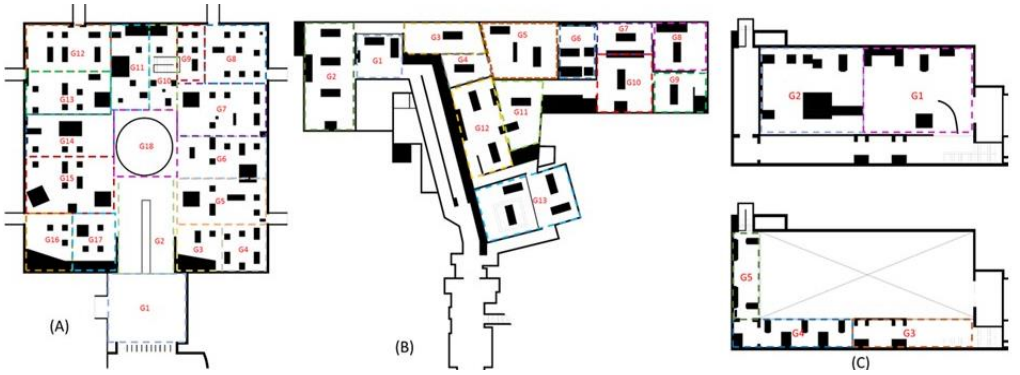

Figure 9 Divided the exhibition hall into several spaces (gates)_Source: Authors

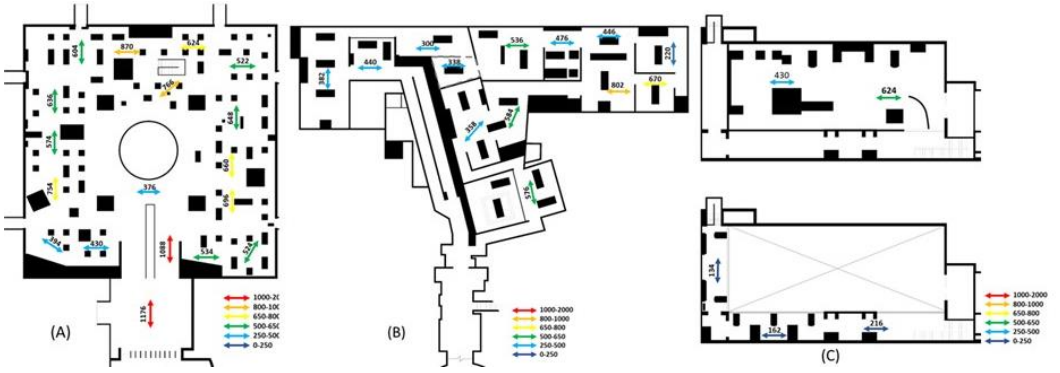

Figure 10 average number of Gate counts bar hours_Source: Authors

4.3.2. Static snapshots

Static images are frequently taken in urban settings to record how public spaces or spaces inside buildings are utilized. The method is useful for differentiating between jobs that require movement and others that do not (such as standing and sitting). By tracking and mapping these actions over time, collected at regular intervals throughout the day to provide an unbiased assessment of both recurring patterns of activity and unique or abnormal behavior [10].

The research pinpoint fixed locations that are simple to observe. The research selected the gates' placements as our observation spots. At regular times throughout the day, activities are recorded for a five-minute period. A sample of

the monitoring technique is shown in Figure 14. Map of the activity inside the museum galleries, Figure 15.

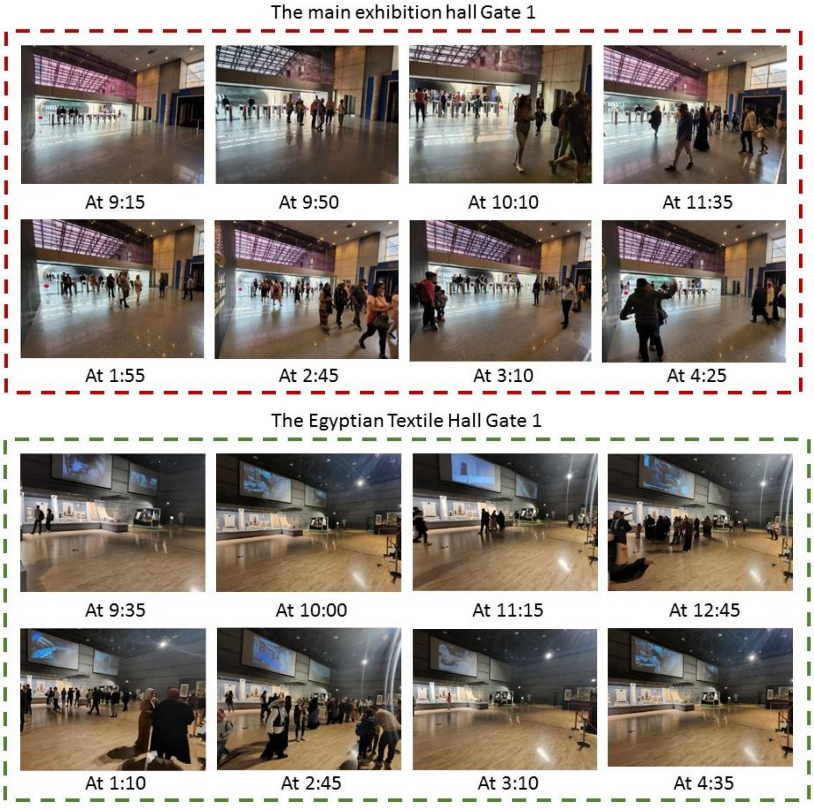

Figure 11 Static snapshots for the main exhibition hall and The Egyptian Textile Hall

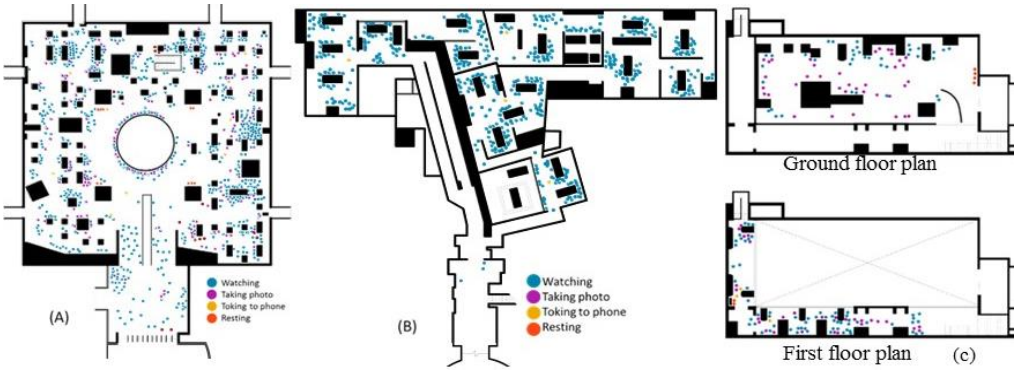

Figure 12 collective Static Snapshots of the museum display_Source: Authors

Through monitoring, it was found that the basic activities inside the museum are divided into:

- Watch - taking photos - Talking on the phone - Resting - Move over

4.3.3. Traces (People-Following)

People tracking is an important technology for tracking flows. The research randomly pick people from the starting point of the trip (entrance), follow them, track their movement, and draw them on a clear map of the site. Tracking ends when the person leaves the study area. It is crucial to ensure that the person is not aware that they are being followed so that their behavior is not affected. This map helps ensure effective circulation design[10]. Figure 16 represents the tracking a group of people who were randomly selected to study the tracking of visitors inside the gallery's hall of the National Museum of the Egyptian Quarter.

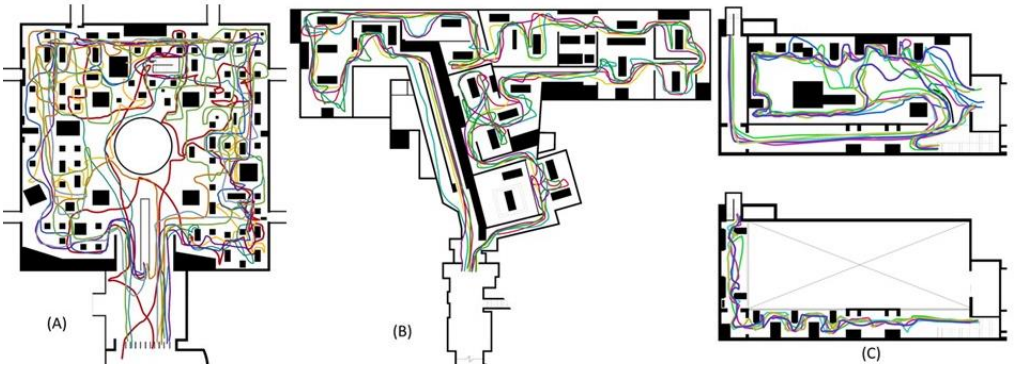

Figure 13 tracking People Map of the museum display-Source: Authors

During the visit, it was noticed that, although the main showroom displays exhibits from different Egyptian eras and these eras were arranged in a historical order, the visitor could not tell when and where the exhibits of each era ended, so the research saw a great dispersion in the movement of visitors in the hall (Figure 16 (a)). Unlike the hall of mummies, in which visitors walk in one clear direction (Figure 16 (b)), in the textile hall, there is a circulation on the ground floor, which is evident due to the small hall, and it appears strongly on the first floor since it is a clear one-way circulation, (Figure 16 (c)).

4.4. *COVID-19 precautionary measures*

To reopen museums again in the era of epidemics, museums and cultural institutions must comply with government directives and meet the safety measures specified by the responsible authorities. In this part, the research will compile the precautionary measures that must be provided in museums, as indicated by the International Council of Museums (ICOM), the American Alliance of Museums (AAM), and the World Health Organization, to see if the Egyptian Museum of Civilization achieves them and the percentage of points achieved. And Through observation, the research determined which of these points were achieved in the museum.

Table 1 the precautionary measures that must be provided in museums [14]–[17]

	The precautionary measures	Detective	Partially detective	Not detective
Preparing for the Arrival of the Public	Define a maximum number of visitors allowed into the museum and inform the public about it			√
	Define a maximum number of visitors per exhibition room and inform the public (allow a safety distance of 1.5 m between each visitor)		√	
	Determine average visit time to establish time slots			√
	As far as possible, set up a booking system (online, by phone and/or by e-mail). Set up an online ticketing system	√		
	Consider opening hours dedicated to certain groups of publics (e.g. > 65 years of age)			√
	Deny access to persons showing symptoms of the disease			√
	Notify the public of context-related restrictions on the institution's website (if applicable) and before entering the museum		√	
Adopting the flow of visitors	Avoid or manage lines at entrances and counters		√	
	Consider ground markings for lines to ensure that the recommended distance of 1.5 m is maintained		√	
	Ensuring distance between visitors and reception counters, possibly installing glass to protect staff and visitors	√		
	Ensure that separate flows of entrances and exits are maintained and provide a one-way tour of the rooms (if possible)		√	
	Guided tours and educational presentations can be offered if a safe distance between participants is respected. Set specific time slots for group visits and limit their size			√
	The openings of common commercial areas (cafeteria, bookshop, shops) are subject to specific national regulations			√
Strengthening Health	Install hand sanitizer dispensers at the entrance of the museum and provide warning signs to encourage visitors to respect the health measures in force			√
	Ensure that visitors have access to toilets (allowing them to wash their hands with soap) and adapt this access to the rules of social distancing in force (safe distances).		√	

	Ensure that devices such as audio guides, headphones and other similar equipment are systematically disinfected after each use		√	
	Disability-assisted facilities and exposed devices with control buttons for educational purposes should be cleaned frequently with disinfectants		√	
	Interior doors will remain open (if possible). Otherwise, they must be disinfected each time they are used	√		
Restricting Some Access If Necessary	Restricting access to rooms and facilities that cannot be fully cleaned or disinfected		√	
	Lifts must be reserved for persons with reduced mobility, ensuring that the distance of 1.5 m is respected between each user. The control buttons must be disinfected after each use			√
	If the common areas do not allow the application of the rules of social distancing, an adjustment of timetables and traffic could be considered			√
Reception and Security Staff	Security personnel must be present at the reception desk and in the museum rooms to ensure that there is sufficient distance between the visitor and the works on display, and between the visitors themselves.		√	
	Provide staff with adequate protective devices (masks, disinfectants), mandatory condition for opening to the public		√	
In work and storage areas	Ensure that all staff has easy access to hand wash facilities with hot water and soap, disinfection gel, and disposable gloves.		√	
	Museums should have a quarantine area for things. This area should contain empty shelves, cabinets, and boxes.		√	
	Meetings, takeover committees, group activities, arenas, rallies, or any other activity should be postponed.			√
	Wash and disinfect hard surfaces, handles, door knobs, light switches, coffee-machines, and the like with great frequency.	√		
	Masks, even homemade cloth masks, should be worn.		√	
	Ensure that only a limited number of people work in the same room, 1.5 – 2 m is recommended as the distance between individuals.	√		
	Consider changing filters in HVAC systems. Another type of regular, controlled ventilation for collection and storage areas.	√		

Out of 30 points, there are only 6 detective points, 14 partially Detective points, and 10 not detective points.

4.5. *Syntactical analysis*

In this part of the study, the research will review the results of the field observation analysis of the National Museum of Civilization and the maps that will help us in the spatial analysis.

4.5.1. Visual clustering coefficient

The visual clustering coefficient is an indicator for both convex and axial maps if you aggregate them together[10]. The red sections are, means more convex and may be work spaces. The blue areas are more extended and might end up being quite mobile (figure 16).

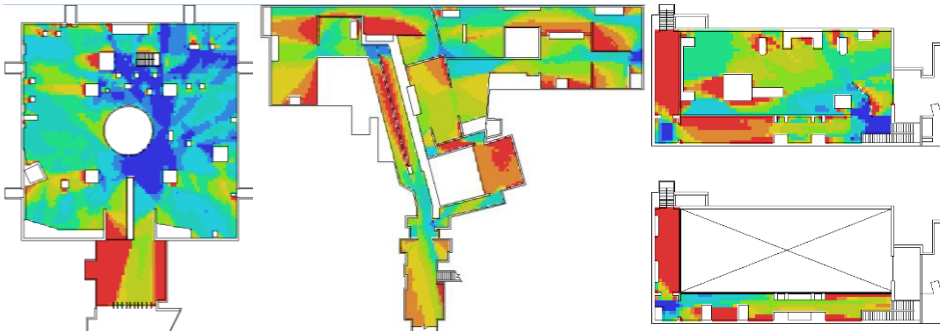

Figure 14 visual clustering coefficient graph of the museum display_Source: Authors

4.5.2. Visual integration

Visual integration may be a crucial component of layout, given that there is a lot of layout that can be seen and understood. if individuals wanted to see a lot of preparation and collaboration with others, they would want to be in red portions [10]. While the blue portions of the chart are the least apparent, the red areas of the plot are the most prominent (figure 17).

Figure 15 Visual integration graph of the museum display_Source: Authors

4.5.3. Axial integration

The flattest areas of the graph appear highlighted in red. Discrete spaces are in the blue colour range. Both integration and separation imply a social meaning. In many cases, the integral areas become active centers, while the discrete areas are associated with stillness and calmness (Kinda Al-Sayed et al., 2014), (figure 2 0) .

Figure 16 Axial integration graph of the museum display_Source: Authors

5. Results and discussion

5.1. *Gate counts Results*

The main exhibition hall by observation, the entrance space represented in G1 and G2 is the most popular gathering place for visitors. The presence of the elevator and the exit staircase from The Hall of Mummies raises the numbers of visitors in G10 and G11, (Figures 11(a) and 12(a)). It was noticed that the number of visitors increases on the right side of the hall (Figure 16(a)), and this can be considered based on the results of Robinson and Milton's research as the research mentioned earlier.

The Hall of Mummies There is a relative convergence in the numbers of individuals because there is control over the numbers of visitors entering the hall. The number of visitors to G10 (Figures 11(b) and 12(b)) is increasing because it houses King Ramses II's mummy, many visitors come specifically for it.

The Egyptian Textile Hall The number of visitors to the hall is generally lower than that of the main exhibition hall and the hall of mummies. The number of visitors increases in G1, (Figures 11(c) and 12(c)), as it is the starting point, the transition point to the first floor, the end point, and the exit point.

5.2. *Superimpose the Static Snapshots and visual clustering coefficient*

Figure 17 The Static Snapshots and visual clustering coefficient of the museum display_Source: Authors

The main exhibition hall Through analysis, it was discovered that there is a strong correlation between the program's results and the observation's findings, where the red part appears to indicate the quietest spots in the movement to practice an activity in the entrance space, where visitors stand to take pictures and read what is contained in the gallery. The bigger blue portion, which is positioned in the center of the hall, indicates the areas of mobility. And it was noticed in the map that the blue colour increases in the right half of the hall, depending on and emphasizing the increase in movement there, as the research mentioned previously. (Figure 21(a)).

The Hall of Mummies Through the analysis, it was noticed that the results of the observation and the results of the program are identical to a large extent, as with a clear and stable circulation and in one direction, individuals walk in a medium-speed movement, so the spaces inside the hall are dominated by the colors (green, yellow, and orange). The research believe that the designer placed the exhibits in this way to ensure continuous movement and to allow the largest number of visitors to pass through and view the exhibits, (Figure 21(b).

The Egyptian Textile Hall Through the analysis, the research found that the hall on the ground floor is similar to the observation, except for the red-colored part of the staircase to the exit point, as it is a corridor for the movement of visitors to the exit point. on the first floor Visitors stand before descending the stairs to view the exhibits on the ground floor from above, (Figure 21(c)).

5.3. *Superimpose the Static Snapshots map and Traces (People-Following) map with Visual integration graph*

Figure 18 Superimpose the Static Snapshots map and Visual integration graph_Source: Authors

Figure 19 Superimpose tracking People Map and Visual integration graph_Source: Authors

The main exhibition hall, The Visual integration graph shows that the red colour represented on the left side of the showroom is more visible because it contains exhibits with low heights, causing them to go there. However, as shown in the map, The Static Snapshots and Traces (People-Following), the majority of visitors' head to the right side of the hall. The research believe that the reason is due to the presence of the separator (the entrance to the hall of mummies), which obscures the clear view of visitors. The visitor starts turning right before he reaches an area that allows him to see which places are clearer, so he turns to them as shown in (Figures 22(a) and Figures 23(a)).

The Hall of Mummies, the Visual Integration Graph shows that the parts in red, which indicate the clearest vision, are located in the places where visitors move between one space and another inside the showroom, which indicates that the circulation inside the hall is very clear to visitors. Also, the places of the exhibits are of medium visibility, which makes seeing and accessing them easy and clear,

while the areas in blue and green are the least visible, so they do not contain exhibits. The map traces (people following) show that the circulation of the visitors is close in shape and is almost unified and integrated with the Visual Integration Graph. (Figures 22(b) and Figures 23(b)).

The Egyptian Textile Hall, the Visual Integration Graph shows that the textile hall is not visible to visitors. On the ground floor, the entrance void seems to be the most obvious area, unlike the rest of the hall. This is due to the height of the exhibits, particularly those in the center of the hall, which obscures visitors' views. Looking at the map traces (people following), this did not constitute an obstacle in the circulation, perhaps due to the fact that the distance between the exhibits in the middle of the hall and those on the outskirts is large. On the first floor, the research see that the circulation is clear to the visitors, as it is in a straight line and the movement is in one direction, as shown in (Figures 22(c)) and (Figures 23(c)).

5.4. *Superimpose tracking People Map and Axial integration graph*

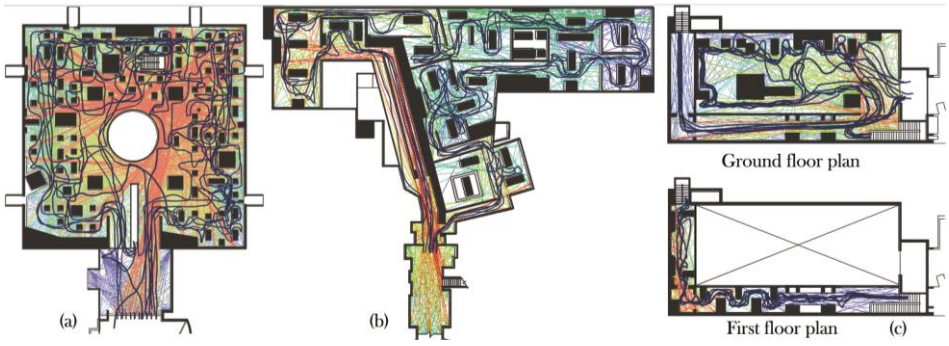

Figure 20 tracking People Map with Axial integration graph_Source: Authors

The main exhibition hall, through analysis, the research found that there is a significant relationship between the tracking People Map and the axial integration, where the red color represents the circulation of visitors, and the research see the red color increasing in the right half of the hall over the left text. Also, the research sees that there should be movement lines distributed throughout most of the showroom, and perhaps the arrangement of the exhibited elements is what affected the concentration of movement in one part without the other as shown in figure 24 (a).

The Hall of Mummies, through analysis, the research found that there is a weak relationship between the results of the axial integration and tracking people, as the program shows that the lines of movement are concentrated at the entrance only, while weak in the rest of the hall. This is not identical, as there is a clear circulation between the branches of the hall, the cause can be that people move in a one-way circulation direction (Figure 24 (b).

The Egyptian Textile Hall, the research found that on the ground floor, it was not inferred that there is a clear circulation that shows the main movement in the void, and the research see that the reason for this is the weak of vision in the hall, as the research mentioned previously. In contrast to the first floor, which shows a clear longitudinal line showing the existence of a clear and specific circulation in one direction, Figure 24 (c).

6. Conclusion

It is known that museums contribute to a great cultural impact and that their closure due to the spread of epidemics (Covid 19) led to many problems, which the research reviewed in this study. The research used space syntax to quantitatively analyze the graphic structure of the National Museum of Egyptian Civilization and discussed the relationship between visitor behavior and space.

The results showed us that there is a relationship between human behavior and syntactic properties. Visual integration maps and other syntactical maps were analyzed, and it was found that the maps closely matched the observation maps. As a result, space syntax and observation techniques were used to identify the problems of the National Museum of the Egyptian Quarter.

There is a weakness of clarity in the circulation in the main exhibition hall, and it does not show the historical development of Egyptian civilization. The Hall of Mummies is the most reliant on vision maps, as they are identical to field notes. However, in the case of one-way rotation, the accessibility map was not used because the circulation was predetermined. There is a weakness of vision in the Egyptian Textile Hall because it contains high-rise exhibits on the ground floor.

The Hall of Mummies It is the hall that most effectively achieves precautionary precautions for COVID-19 by limiting the number of visitors and the regularity of their movement, which makes it easier to control them and leave safe distances between individuals. On the first floor of the Egyptian Textile Hall, the research sees that the distance between the exhibits is small and may cause risks in times of large flow.

7. Recommendation

In The main exhibition hall the research recommend rearranging the exhibit locations to be more effective with visitors, less distracting in their circulation, and clearer, which leads to the ability to control the number of visitors and achieve social divergence to avoid the risk of infection from epidemics.in the hall of Mummies the research recommend making sure that the hall is well ventilated.

For the ground floor of the Egyptian Textile Hall, the research recommends redistributing the exhibits so that the vision is clearer and more accessible. The

research also recommends reducing the number of exhibits on the first floor and redistributing them along the movement corridor from the staircase to the exit to make it a more active corridor.

This study showed that the space syntax is a very useful tool to verify the performance and use of the National Museum of Egyptian Civilization. And by using it in the analysis, museums can be reconfigured to improve their performance and avoid their closure in times of pandemic crisis. The study also showed the museum's shortcomings in the precautionary measures that must be available in the museum, and the research recommend that they be taken into consideration.

8. References

[1] S. Saraoui, A. Attar, and A. Belakehal, "Redesigning the Museum Route for Effective Flow Management During and after the Pandemic," *New Design Ideas*, vol. Special Issue, no. ICCAUA2022, pp. 1–26, Sep. 2022.

[2] Y. li, J. Huang, and L. Yang, "From functional space to experience space: Applying space syntax analysis to a museum in China," *International Review for Spatial Planning and Sustainable Development*, vol. 8, pp. 86–99, Apr. 2020, doi: 10.14246/irspsda.8.2_86.

[3] B. Hillier and J. Hanson, *the Social Logic of Space*. London, 1984. Accessed: Dec. 04, 2022. [Online]. Available: https://kupdf.net/download/bill-hillier-julienne-hanson-the-social-logic-of-space_59139a1bdc0d604439959eb7_pdf#

[4] B. Hillier and K. Tzortzi, "Space Syntax," in *A Companion to Museum Studies*, John Wiley & Sons, Ltd, 2006, pp. 282–301. doi: 10.1002/9780470996836.ch17.

[5] Space Syntax, "British Museum." https://spacesyntax.com/project/british-museum/ (accessed Nov. 28, 2022).

[6] M. Rousset, *Espace public ET publics d'expositions. Les parcours: une affaire à suivre. Espace urbain en méthodes*. France, 2001.

[7] American Alliance of Museums, "COVID-19 and Museum Volunteers," May 28, 2020. https://www.aam-us.org/2020/05/28/covid-19-and-museum-volunteers/ (accessed Dec. 27, 2022).

[8] International Council of Museums, "Follow-up survey: the impact of COVID-19 on the museum sector." https://icom.museum/en/covid-19/surveys-and-data/follow-up-survey-the-impact-of-covid-19-on-the-museum-sector/ (accessed Dec. 11, 2022).

[9] "Case studies Space Syntax – Online Training Platform." https://www.spacesyntax.online/applying-space-syntax/building-methods/application/ (accessed Dec. 04, 2022).

[10] Kinda Al_Sayed, A. Turner, B. Hillier, S. Iida, and A. Penn, *Space Syntax Methodology*, 4th ed. UCL,London, 2014. Accessed: Jul. 20, 2022. [Online]. Available: https://www.scribd.com/document/321130270/Al-Sayed-Turner-Et-Al-2014-Space-Syntax-Methodology

[11] NMEC, "Museum History." https://nmec.gov.eg/museum-history/ (accessed Dec. 16, 2022).

[12] NMEC, “Historical Timeline.” https://nmec.gov.eg/historical-timeline/ (accessed Dec. 16, 2022).
[13] T. Grajewski and L. Vaughan, “Space Syntax Observation Manual,” UCL, 2001, p. 3. Accessed: Dec. 04, 2022. [Online]. Available: https://dokumen.tips/documents/space-syntax-observation-manual.html
[14] UNESCO, “Museums around the world in the face of COVID-19,” 2020. https://unesdoc.unesco.org/ark:/48223/pf0000373530 (accessed Dec. 21, 2022).
[15] International Council of Museums, “Conservation of museum collections.” https://icom.museum/en/covid-19/resources/conservation-of-musem-collections/ (accessed Dec. 12, 2022).
[16] American Alliance of Museums, “Curatorial Dreaming in the Age of COVID-19,” May 04, 2020. https://www.aam-us.org/2020/05/04/curatorial-dreaming-in-the-age-of-covid-19/ (accessed Dec. 27, 2022).
[17] International Council of Museums, “Museums and end of lockdown: Ensuring the safety of the public and staff.” https://icom.museum/en/covid-19/resources/museums-and-end-of-lockdown-ensuring-the-safety-of-the-public-and-staff-2/ (accessed Dec. 12, 2022).