

REDESIGNING THE MUSEUM ROUTE FOR EFFECTIVE FLOW MANAGEMENT DURING AND AFTER THE PANDEMIC, EL MOUDJAHID MUSEUM OF BEJAIA

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Abstract. Given the considerable sums of money wasted on their creation, many museums are not well attended by the general public for a variety of reasons. The city of Bejaia museum, which is dedicated to the history and the Moudjahid (ancient Algerian soldiers of the liberation fight), has a lot of potential and it is now the only museum of city that provides this sort of service to visitors. However, it shows some dysfunctions that make the visited unpleasant, such as low attendance rates; causing its closure during the Covid19 period due to difficult flow management (Especially during event periods); we propose a syntactic analysis with a state of the museum through this study, which will allow us to make a diagnosis and propose solutions to improve the exhibition for the covid-19 and the post covid 19 periods.

Keywords: museum, management of flow, museum route, ambiance, spatial configuration, space syntax.

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1. Introduction

Since their inception, museums have continued to be the types of exhibition centers that the general public visits most regularly (Peressut, 1999). The combination of scenography and museography allows us to showcase not only the artworks but also the architectural space of the museum, giving visitors one of the most exquisite sensory experiences that will have a profound mental influence.

Algeria, like all nations of the world, has several museums located in various areas of the territory, mostly national museums of history, contemporary arts, fine arts, water, archaeology, ... most museums date from the French colonial era, or were designed after architectural competitions initiated by the government in the post-independence period.

In 1998, cultural heritage awareness came into existence and officially granted due protection. Museums in Algeria do not welcome swarms of visitors due to the cultural unawareness of revisiting history landmarks. The majority of the museums receive important flows during special events, for example, the national museum of water, on the day we celebrate the World Day of Water.

With the current health situation related to Covid-19, museums, like all public buildings, work with restrictions, which tend to work when the attendance is low, just mark stickers on the floor, the distance is also managed in this way and the number of

visitors through filters. But if the flow is important, what are we going to do, the time allocated to the visit cannot in this case be controlled.

1.1. Conceptualization

1.1.1. The museum route as a tool for pleasure and learning

Since the creation of the museum building, a free route for visitors to take while they consider the works on exhibition has been suggested as the museum visit route.

As early as the emergence of the museum white cube with modernism, the route became an element built by the architects (Fernández, 1999). It is thought from the design phase to be key element from which other spaces emerge.

The challenge of successful museum design is to find a link between the design itself and the museum architecture of the exhibition. To do so, we will need to focus on the following: i) the exhibition space, ii) the exhibition audience, iii) the mode of the exhibition and the use of technology, iv) thinking container-content together (Mattern, 2014).

The research of visitor behavior is compelled by the examination of the route (Gras *et al.*, 2017). The discussion with the visitor to understand his decision was a first step in comprehending his behavior and choices in the museum space; it was later discovered (Martella *et al.*, 2016). Recently, visitors' behavior has been influenced by how their senses are built up while they are there, which has become a crucial component. The in-situ analysis is a new type of analysis that was inspired by in-person interviews. Then, we find various methods like surveys, observations, interviews, or the usage of research technologies like Bluetooth (Najbrt & Kapounová, 2014; Yoshimura, *et al.*, 2014).

All of these methods served to clarify the potential connection between displacement and the exhibition's conceptual spatial language (Eidelman *et al.*, 2018). In modern museums, museography has significantly altered how visitors perceive and interpret their experiences (Bollo & Dal Pozzolo, 2005). The quality of the exhibit therefore becomes a crucial factor in the designer's decision of the museum, the visitor, and the route to be designed (Ferilli *et al.*, 2016). Time is equally important for researchers to assess the visitor's behavior. Comparing the visit's timeframe and the span of time each visitor indulges in contemplating the works (Rashed *et al.*, 2016). Time being analysed in clusters for the visit and the course would help us predict the typical behaviour of visitors in the coming exhibitions (Martella, 2017).

The typology of museum routes is vast (Saraoui *et al.*, 2018). We cite among the varied palette the classification of Mariani-Rousset which corresponds to our research: i) The thought route: The idea of the designer, ii) the proposed route: the exhibition or the actual path, iii) the lived route: the path of the visitor (Mariani-Rousset, 2012).

The museum route was conceived with the aim of highlighting works of art. We pay visits to appreciate the works exposed but also to appreciate the ambiance all around (Patterson & Bitgood, 1988). The visitor's attention is an element not very simple and which must be taken into account. The visitor's attention had been defined by the psychological literature; we can switch from a process initiated as a psychological reaction to a process of mechanical behaviour (Bitgood, 2010). The visitor's attention is influenced by the exhibition object's, their size, positions, and proximity to other objects (Turgay Zıraman & Imamoğlu, 2018; Langlois, 2010).

The opening of the visual fields and the visual comprehension of the sequences to be investigated will contribute to capturing the visitor's attention. Scenography and light,

whether natural or artificial, play a very essential part in the creation of pleasant ambiances for the visitors (Rohloff *et al.*, 2009).

1.1.2. *The appropriation of the museum space by the typical visitor*

The nobility, who were frequently wealthy people or rulers, had been the first people to visit museums in human history. There are numerous visitors to the museum today, and they come from all social groups (Melton, 1972; Hooper-Greenhill, 2013). Two categories of visitors can be distinguished based on attendance, according to Hood Marylyn in an analysis of her research on American museums: i) the assiduous: individuals with a certain intellectual level who fall into a particular socio-professional category of high income, they are frequently engaged in their communities on a cultural level, and they can understand museum codes; and ii) the occasional: Rarely do members of the middle class in society hold a baccalaureate degree, make a modest living, and engage in pastimes that revolve around their families or communities. They participate in cultural activities less frequently and are frequently spectators on their travels (Hood, 1994).

In his research on modern and contemporary museums, John H. Falk identified five different visitor types and self-aspects: explorers, facilitators, professionals/ hobbyists, experience seekers, and rechargers. From one museum to the next, a visitor's interest in the display varies. It has a lot to do with the museum's content; if something is interesting to one person, it could not be to another. The visitor's assessment of their experience would only strengthen the identity perception of their wants if the designer satisfied the visitors' needs (Falk, 2014).

How did the visitors act while they were in front of the display space? The findings of Robinson et Melton's research on European museums in the 1920s and 1930s were used by Mariani-Rousset. According to her, research has demonstrated that when people are in an area without a clear direction, they tend to choose the right side. They gravitate toward the right while facing the back of a room. They turn to the right when the entrance is on the left. They pause to consider their options if the entry offers a right or left turn (Mariani-Rousset, 2012).

There are various ways to describe a visitor's behavior in a museum, and they all reveal a lot about the number of people who visit (Gottesdiener *et al.*, 2014). We give two examples here: the first one by observing his visit and politely asking him to explain each time there is a response (choice of direction, short or long stop, hesitation, etc.); researchers have used a wide range of investigational tools, starting with straightforward in-person observation (Coavoux, 2015). The interview, even down to using a camera that follows the visitor (Schmitt, 2012). The report that continues returning back (Falk, 2013) presented (as an obvious element and offered to be eyed) is exposed to a process of cognitive and sophisticated interpretation with regard to the diversity of the approaches. This interpretation is frequently connected to either singular (behavior related to the group of visits) or plural (cognitive, physiological, historical, etc.) qualities (Schmitt, 2013).

These researches are often applied to various cases of the museum. What about history museums? History museums are museums of a particular value, other than the symbolic side, most of the exposed objects require an explanation. The presence of the proposed visit guide on the spot is often more than necessary to understand the historical chronology and the exposed objects. However, the tour guide remains a traditional tool that can be replaced by multimedia technological tools more adapted to the museum today (Hommet *et al.*, 2018).

This theoretical conceptualization serves as a solid theoretical foundation for our research since, regardless of the type of exhibition or the culture of the nation to which it belongs, museum components will always be the same. Additionally, the museum on which we will be working is a history museum created in accordance with modern museum design principles.

1.1.3. Studying the spatial configuration and how it affects the display space (the syntactic structure of the museum space)

Our study will take into account how the spatial arrangement of the museum space, and the layout of the exhibits may affect the control of flows and the effectiveness of the museum experience.

We will use as an example Hillier's research, who was interested in the spatial life in architectural and urban environments. Although many works have been developed in this field, those that consider the spatial language and configuration will be the ones that will interest us the most. This life is frequently connected to spatial arrangement and movement, and Hillier had justified the use and revelation that the space syntax may provide if it is used to assess the intelligibility of the space regardless of its typology on the basis of this idea (Hillier *et al.*, 1987; Hillier & Penn, 2004). The observations made by this researcher and his team in their study on the Tate gallery (Hillier *et al.*, 1996) clearly demonstrate that a critical reading of the visitor movements and the spatial configuration will be able to lead us to suggest, using the space syntax, a museum course that resolves quite a few issues with the depth of the spaces, of integration, and also of connectivity; thus offering a good assumption of responsibility (Hillier & Tzortzi, 2006; Tzortzi, 2015; 2016).

1.2. Which museum and which museum route for tomorrow

Before to the Covid 19, the majority of study focused on prolonging the urge to move in the museum. The primary goal was to research how museums will function in the digital era. It will be successful in maintaining the museum's cultural relevance through its accessibility, open fields, and suggestion of an ideal model tailored to the demands of the modern world.

It is also to remedy the problem of the existing museums as the proposal of privatization of some exhibition space for the good management of the museum, or the reconsideration of the failures of museography (Le Guen, 2019).

In these pandemic times, the aspect treated in museums is the museum route, which is confronted with a diversity of museum space typologies. Due to the epidemic, museums have advised tourists to take a detour that still functions largely routinely and efficiently. New visitors appear to feel at ease using this kind of route, whereas regulars feel uneasy and wait for the suggested route to vanish.

A highly fascinating study is the museum of El Moudjahid in the Algerian city of Bejaia. Before the epidemic, we noted problems with the spatial organization, and this insight is still pertinent now. The museum shutters during the pandemic, and even when it is open for events, Covid 19's constraints make the observed dysfunctionalities worse. What techniques are available to control the flows, complete the museum route, and therefore the visit, while adhering to the Covid-19 recommendations? The purpose of this study is to offer alternatives for the display before evaluating whether or not they are better suitable for the pandemic era.

2. Material and Methods

2.1. The El Moudjahid Museum of Bejaia

The Algerian revolution is chronicled in the El Moudjahid Museum in the city of Bejaia. It was constructed, like all Algerian museums, as a result of a competition organized by the Ministry of Moudjahidines, which was won in 1998 by the POLYEC study office for architecture, urbanism, and design. The museum is designed in a contemporary style, and in addition to being white and having large windows, we can say that the architect tried to use a wonderful metaphor to symbolize Algeria and its revolution, which is represented by the crescent and star at the level of the external volumetry.



Figure 1. Location map (Google earth) and photos of exterior and model of the museum EL MOUDJAHID of Bejaia

The museum is composed of two levels under the ground floor (which are not interiors because of the integration with the slope), a ground floor level, and two upper levels. In our research, we will be interested in the permanent exhibition spaces that occupy two levels of the museum, the ground floor (+0,00m), and the level below dedicated to the permanent exhibition (-4,08m).

The main entrance and reception space are located on the ground floor level, and they are joined by a lengthy hallway known as the exhibition corridor. As soon as you enter, a large exhibition hall awaits you, where you can find a section of the exhibition route, a staircase leading to the upper floors, where administration and a library are located, and another leading down to the level housing the permanent exhibition, which is the area that receives the most visitors.

A sizable display room where the exhibition cabinets generate arrangements in accordance with the exhibition can be found on the level designated to the permanent exhibition. Additionally, there are restrooms, a balcony for temporary art displays, and a section of the closed archive that is never used.

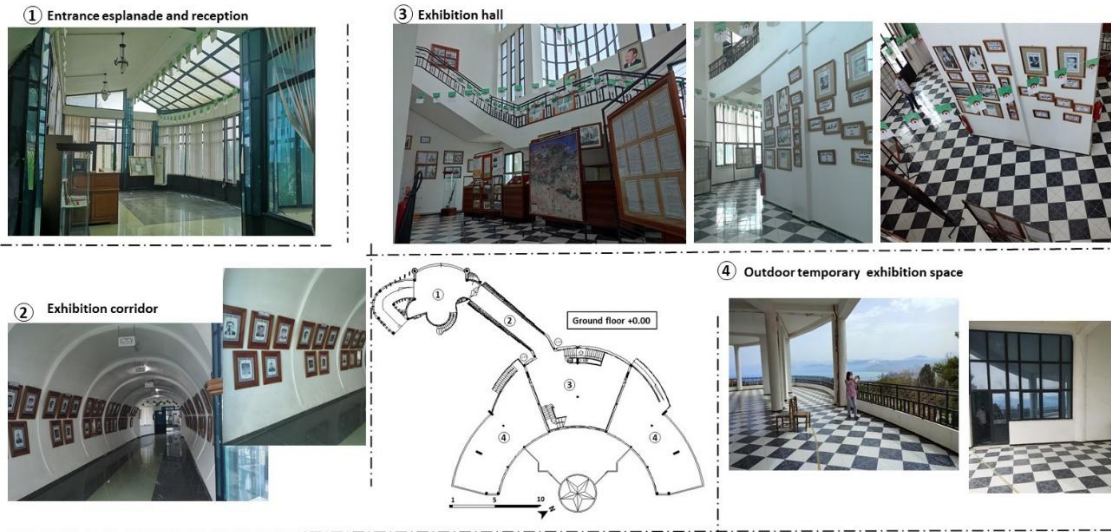


Figure 2. Plan of the ground floor dedicated to the exhibition

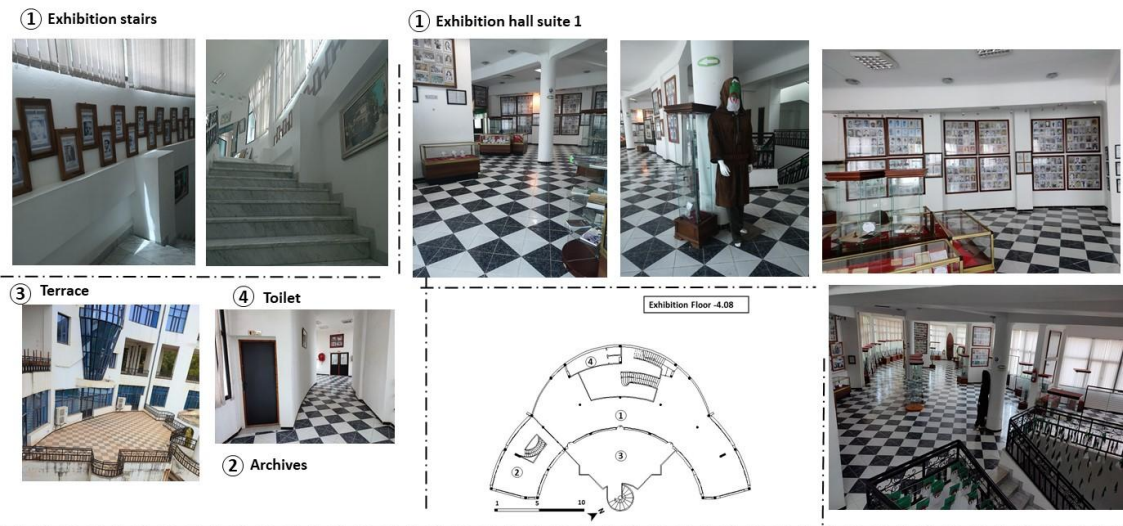


Figure 3. Plan of the level dedicated to the exhibition

The museum of El Moudjahid, which we shall investigate, has a significantly lower attendance rate due to factors related to its remote location than other museums, which often have very high attendance rates due to their intended audience. due to the paucity of transportation in the area and the fact that it is a historical museum. Aside from the capital city, we estimate a maximum of 20 visitors per day during regular events, and 150 for special occasions scattered throughout 5 to 4 daily visits. And due to its closure during the Covid-19, the visitor rate reduced, and for the times of activities the general public is targeted (invitation of the political personalities or persons in charge of the city, more some former soldiers known in the area).

In this study, we will analyze the existing state and according to the data, we will propose a more suitable layout to the spatial structure and conditions of visit according to Covid- 19, which we also intend to evaluate by space syntax.

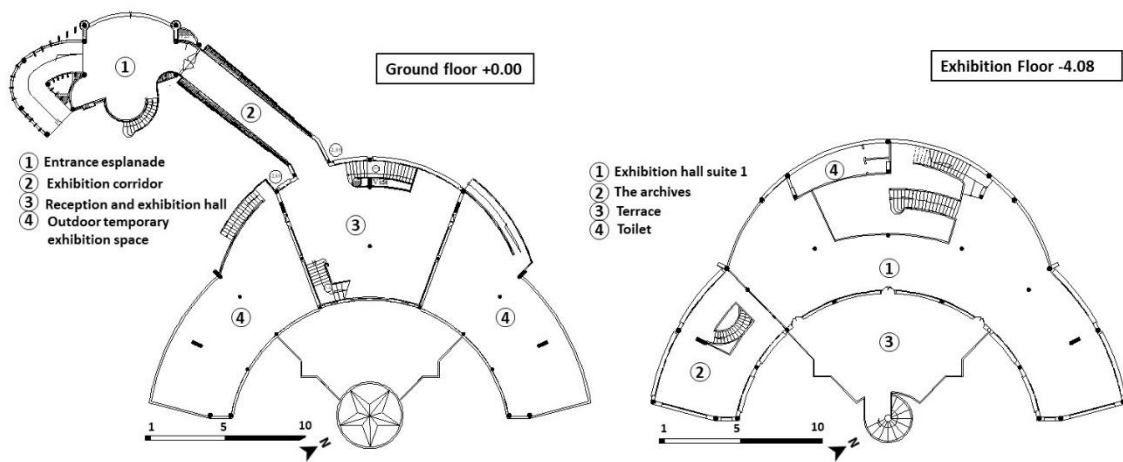


Figure 4. The levels of exhibition and evaluation of the museum EL MOUDJAHID of Bejaia

It should be noted that the museum route has three display components. The wall frames are the most prominent part on all walls, followed by the vertical and horizontal cabinets, which are typically employed as design components for spaces.

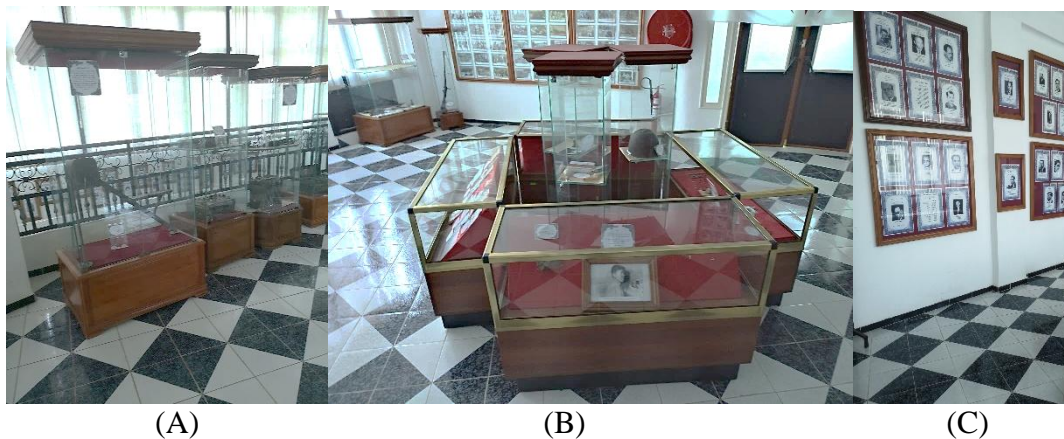


Figure 5. The typology of the exhibition in the museum (A) Vertical cabinets (B) Horizontal cabinets, (C) Wall frames

2.2. Methodology

2.2.1. In situ observation and collection of visitors' opinions

Since the museum is not frequently visited, the analysis of visitor routes alone was done at various times of the year. We have elaborated our observation in situ in the form of a commented route (Lenel, 2014). In times of events or when we have group visits to the museum planned by various organizations, the behavior of visitors in groups was examined.

It is noticed that the notion of the commented route is often accompanied by the notion of sequence (Viry & Gauthier, 2019; Petr, 2004; Thibaud & Grosjean, 2001). This notion which creates a hierarchy within the museum space will allow us to better understand the behaviour of the visitors (Klein, 1993; Falk & Dierking, 2000). The sequences in our case study will be just the permanent exhibition spaces. For the ground

floor we have two, according to Figure 4, it is space 1 and 2, for the exhibition level, it will be space 1.

According to the attendance rate, we have chosen four samples of individual visitors, about thirty people whose average age is 37.3 of both sexes in a balanced manner.

For the group visitors we have targeted the period of the event, 03 subgroups: 30 young students, 30 elderly people, and finally 30 young civil servants constituting families. The sample taken is a varied sample of balanced sex and different age categories of various intellectual level. We have conducted questions to which they answer as soon as they are in the exhibition space (in question) and the complete answers, we have made a statistical treatment of the results. The objective is to understand the behaviour of visitors in the museum space, their attention, and finally their opinions on the route.

2.2.2. *The spatial composition: diagnosis*

The investigation of the museum's spatial organization is a topic of our study. From a functional perspective, exhibition is the primary activity, but other areas also incorporate the overall architectural design. In order to suggest remedies for the circumstances in which we currently live, we plan to make a diagnosis of the composition as it already exists.

Bill Hillier and his colleagues at Bartlett, University College of London, developed space syntax in the late 1970s (Hillier, 1998; Hillier & Hanson, 1984). Whether urban or architectural, it is a field that employs a number of methods that produce outcomes at the academic and professional levels (Yamu *et al.*, 2021). Space syntax, which derives from topology and mathematical graph theory, enables the visualization of various architectural compositional parameters through maps and graphs (Laouar & Mazouz, 2017; Hillier, 1996).

The first architectural structures to be employed in space syntactic analysis were museums. Understanding the differences between different configurations and user behavior were additional goals of the project (Hillier & Tzortzi, 2006; Mazouz & Benhsain, 2009). The analysis of architectural space, and more specifically the museum, uses a variety of methodologies. Some characteristics of the morphology can encourage the visitor to investigate the layouts and the visualization of exhibitions if the spatial configuration is vital to the success of the visitor experience (Rohloff *et al.*, 2009).

We will therefore use the software DEPTHMAP© for the spatial reading of the museum (Tzortzi, 2011). Thus we analyzed the visibility by the Graph Visual Analysis. It is a method that allows representing through colored graph the relationships that exist between the components of a spatial system. 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 connectivity which is defined as the representation of the most visible area from any point, or the reverse, if the visual connectivity is great, the spatial relationships are strong, we can also judge this point as the one that allows the most accessibility (Hillier & Tzortzi, 2006). ii) Visual integration: It is the visual association between a node and the others, this feature allows us to judge our movements in a space if to get to the desired space we have to pass through another or not (Hillier & Tzortzi, 2006). 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 we can have supposed routes of visit, compare routes, or makes changes to a route that already exists (Li *et al.*, 2020). 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.

2.2.3. Condition of the sanitary situation and proposal

We will provide suggestions for improvements to the current museum route based on this first reading. To comprehend the new functionality and the new proposal's contribution, the verification of this proposal is more than important. In this essay, we'll discuss the two levels of the permanent exhibition's visitor-friendly display space.

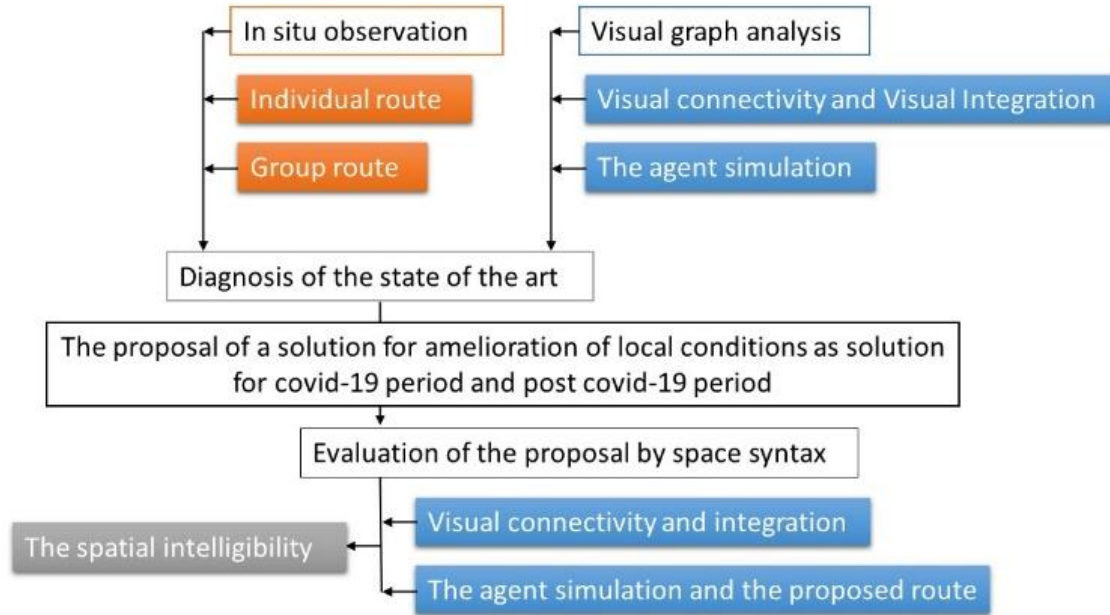


Figure 6. A methodological framework

3. Results and discussion

3.1. The existing situation

3.1.1. Observation in situ of the state of the route

In order to determine whether the route provides good spatial orientation to the visitors, we first examined the conditions of the visit for several persons strolling alone without the public, followed by the three groups of about thirty people visiting together without the guide. This observation was made before to Covid-19 during our in-person research with architecture students, and at Covid-19, we provide the following observations:

- This reading allowed us to note that the visitors alone had spent a lot of time in the museum on average 90 Minutes and that they missed on average 20% of the exposed works which are often (Figure 8). i) exposed in the same way, ii) exposed in the same route, iii) existence of a dominant object which attracts the attention compared to other objects, the route followed is the one we have drawn in figure 07. 70% of single visitors complain of discomfort in their visits for reasons related to the way the works are displayed. The visitor sometimes stays at the same point and turns to see the

exhibits, which distracts him from the direction of the route, this situation worsens with the large flow.

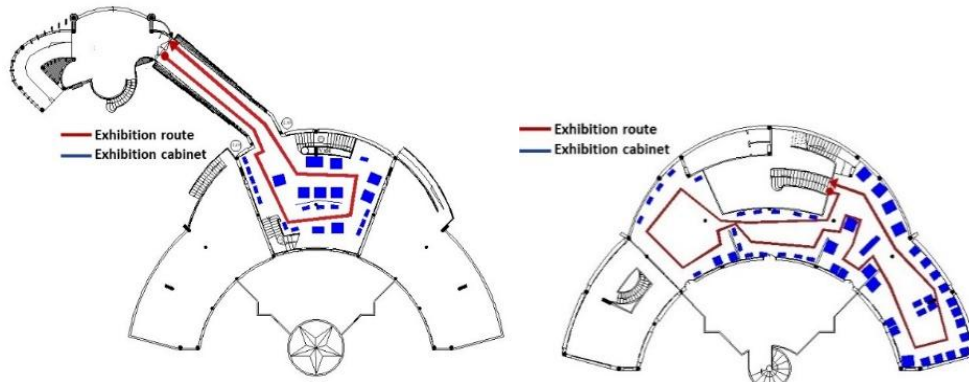


Figure 7. Diagram of the movements of a single visitor observed in situ during different durations (from T1 to T4)

- As for the group we noted that 25% of the route was not visited, the average time spent at the exhibition is 75 minutes; however, most visitors in the absence of the tour guide pass through the same points more than once, and never pass through another point. We have represented the flow of the visit in Figure 10. We see that for the ground floor during T2 the visitors divide into two groups, and in T4 the groups exchange the exhibition spaces. For the case of the exhibition level as soon as the visitor leaves the stairs, he will have the choice between two directions, most of them during T2 choose the right side, during T3 the exhibition takes place in two groups, which will exchange the spaces afterward (Figure 9). They will find themselves afterward in front of the staircase in T4, or during the last sequence of the time of the exhibition, we find out exactly the same image of the ground floor during T1.
- The existence of two exhibition elements disturbs the group of visitors who sometimes admit to being attracted by the closest element at 40%, and in 68% of the answers the wall frames in the exhibition level most of them consider it as a treatment of the wall and not an element of the exhibition (Figure 9).
- For both specimens, the route does not offer a good spatial orientation as it is now. The field of vision is quite open, but the works are not organized in such a way that we take advantage of their arrangements. So early in cabinets, sometimes on tables, adding to that all that is exposed and not deposited at a human height, such as the frames of the martyrs. The presence of the guide is necessary not only to explain the works on display but to make the route clear.



Figure 8. Visitor sample, individual or without group



Figure 9. Group visit sample variability of attentions (Photos 2-3©direction of museum FB page)

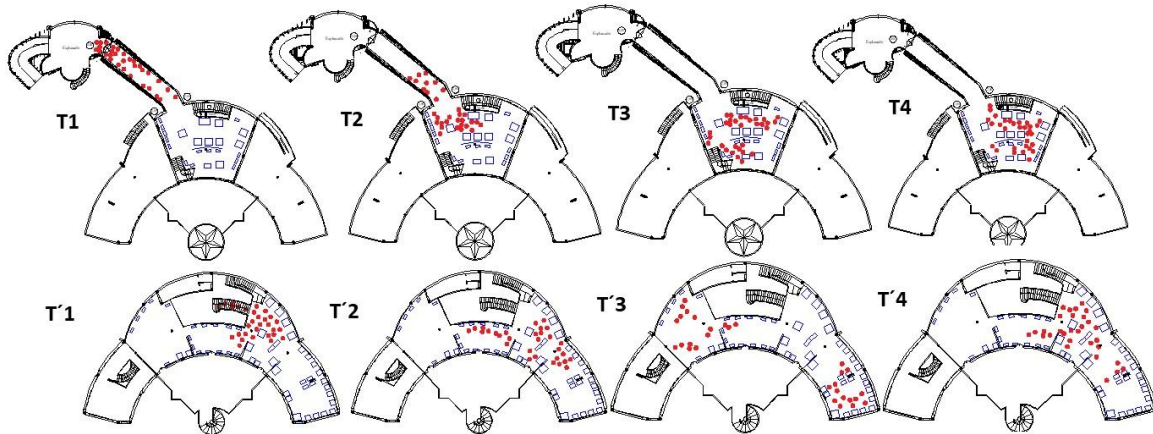


Figure 10. Movement pattern of visitor groups observed in situ during different periods (T1 to T4)

We gave each visitor a paper in which they put the element that attracted their attention in the route according to the time of the visit, and analyzing the graphs we find that:

- On the ground floor and at the beginning of the visit, for a visitor who walks alone in the route, the element that captures the attention of most are the frames exposed on the wall in 70% of the answers, while for the rest of the corpus visitors look with their eyes for the rest of the museum route (Figure 11, a). During T2, between the exhibition corridor and the first exhibition space, only the visitors show a particular interest in the route, and this is up to 50%, most of them do not notice the frames hanging on the walls and unconsciously go towards the exhibition cabinets whatever their type. During the third time of the visit, the visitor's attention is maximal for the vertical and horizontal cabinets; however, it is decreased for the museum route and the wall frames. During the final time of the visit, the visitor's attention goes to the wall frames at values of 40% (to which They has shown no interest since the beginning of the tour). In the case of the level dedicated to the continuation of the exhibition, we found that the attention of the visitor to the route diminishes as the museum space is discovered; it begins in 60% of the answers and ends in 15%, the interest in the frames hanging on the wall increases as the time of the exhibition passes, going from 10% in the responses of visitors to 30% towards the end of the visit.
- For the behavior of the group on the ground floor (Figure 11, a), we notice that half of the visitors in the group are visually searching for the museum route while the other half are attracted by the frames exposed on the walls. As we move to the second

exhibition space, the attention of the group changes, with the largest number of visitors being attracted to the route and the museum space at 40%, while other visitors are attracted to either the vertical or horizontal cabinets at 25%. During the T3 period of the exhibition, the attention to the museum route decreases and is replaced by an exploration of the exhibition. Towards the end of the exhibition, visitors continue to appreciate the vertical type of display cabinets that characterize the end of the floor's route at 50%, while 25% of visitors show particular attention to the frame exposed on the wall.



Figure 11. The elements that attracted the visitor's attention during the visit (from T1 to T4)

For the level dedicated to the exhibition (Figure 11, b), the attention of the visitors' increase as time passes towards the frames at the wall level. At the end of the tour, 40% of the visitors are interested in the frames. For the exhibition cabinets the attention decreases and increases according to the position of the visitor in the tour, otherwise for the attention that the visitor gives to the museum route it varies from 40% to 30% towards the end.

3.1.2. The syntactic language of the museum

Visual connectivity and visual integration

According to the analysis of the vision graph, the two levels of the exhibition present very high values of visual connectivity (Figure 12), the most connected part presents two-thirds of the ground floor (Max=18600, Min=6800) while for the floor it is at the level of the southeast of the spatial composition (Max=26617, Min=8555).

For the visual integration, we have raised very low rates at the level of the ground floor. The most integrated part is in the center of the spatial composition, which means that if we are there we can visually dominate all the parts composing the ground floor (Max=378,19, Min=31,41). For the case of the floor, the point where the integration is the highest is located in the southeast of the plan. The configuration of all the parts composing the plan is symmetrically corresponding from this angle of vision. The further away we go, the more the values will decrease (Max=94.3, Min=13.74).

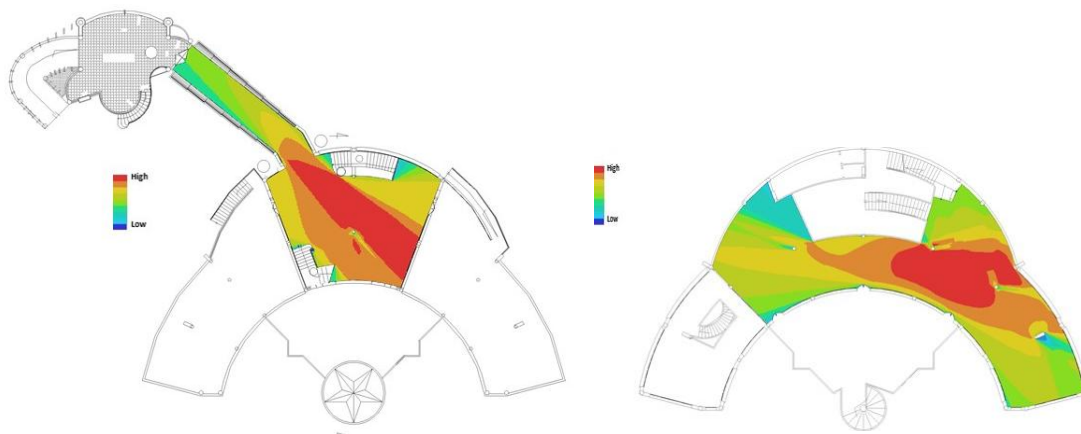


Figure 12. Result of the visual graph analysis showing the visual connectivity

The comparison of the visit path and the agent simulation

In order to see the options provided to museum visitors as a solution, we conducted a study using space syntax and an agent simulation, and we compared the results to the observation in situ. For the purposes of this simulation, we used the highest possible visiting rate settings, which correspond to 150 visitors per typical visit.

The agent simulation offered us for both levels a more or less closed path, which starts and ends at the same point, we noticed that the parts where the integration is high can host the most interesting works in the exhibition (Figure 13).

Our on-site observation allowed us to see that the exhibit cabinets are arranged in a multidirectional manner that deviates from a visit-encouraging exhibition path. There are several museum sequences where one must pass twice to see different artifacts, such as the exhibition corridor located on the bottom floor, and several spots on the floor. Visitors struggle to choose their route and run the risk of going through a point multiple time.

The ground floor is more or less compatible with the spatial design when we compare the agent simulation and the observed route, but the options on the display floor are entirely different.

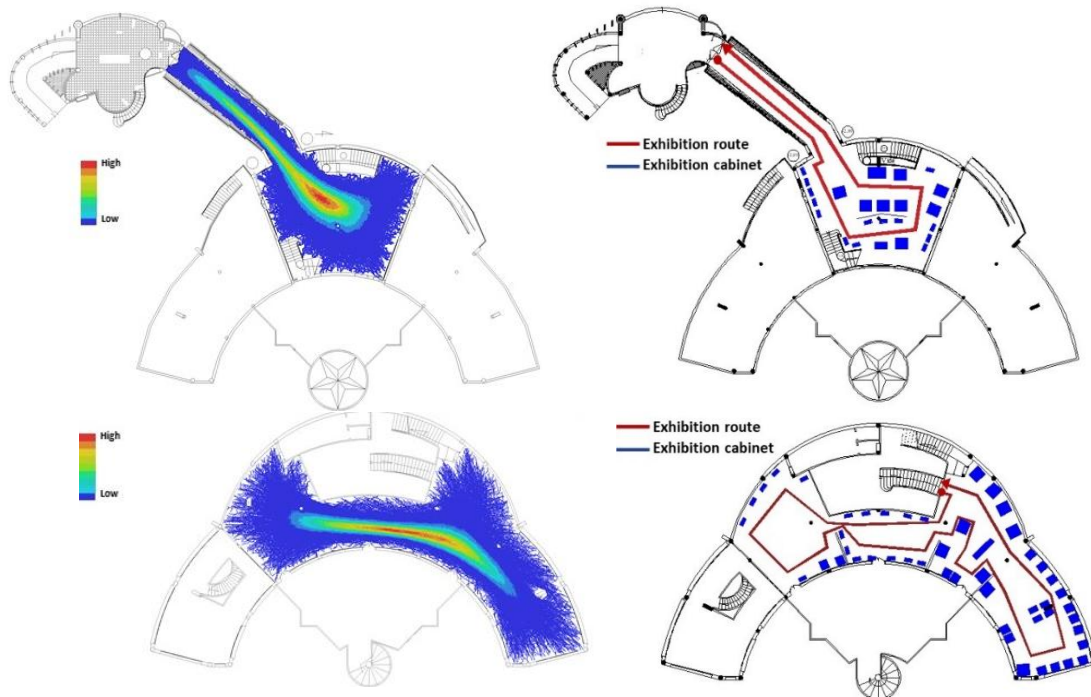


Figure 13: Comparison between the observed route and the one suggested by the agent simulation

3.1.3. From the ambience to the ambiances

In a project completed before to the sanitary crisis, we attempted to assess the atmosphere of the museum in order to integrate analysis of the spatial layout and ambience in the museum.

We present in this point the whole of the noted remarks:

Luminous ambience: The luminous ambience should be studied in order to respond to the needs of the exhibition and to make the functioning of the museum more suitable, we have noticed that despite the existence of bay windows that could be exploited for good museology, these bay windows are totally covered by Venetian blinds (Figure 14), which are never opened, and the use of artificial light is quite frequent whatever the period of the year.

For the most unfavorable period of the year and for overcast weather, the space is characterized by uniform illumination.

The sound ambience: The sound ambience should also be studied, we found that the sound levels are approximately around 40 db in all spaces which let us say that the composition of the wall is not well adapted, these rates are explained by the poor insulation, and they correspond to the noise of the mechanical track next door.

We tried to measure the noise with a sound level meter on the spot with a tour guide at two points (in which the guide stops to explain to the groups). According to our observations (Figure 15), the visitors do not complain about the noise. They are at ease and can listen to the guide in a normal way. It is noticed that the highest values are located at the guide's position and vary between 65 and 62 db, the more one moves away from this position the values tend to decrease.

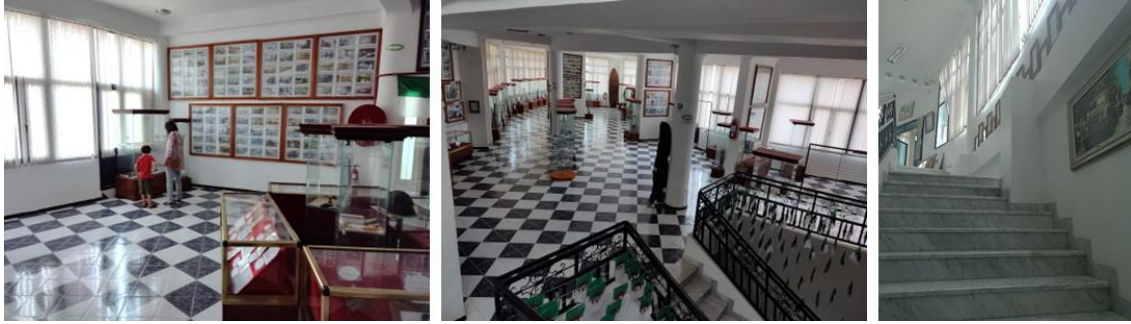


Figure 14. The existence of solar protection (Venetian blinds)

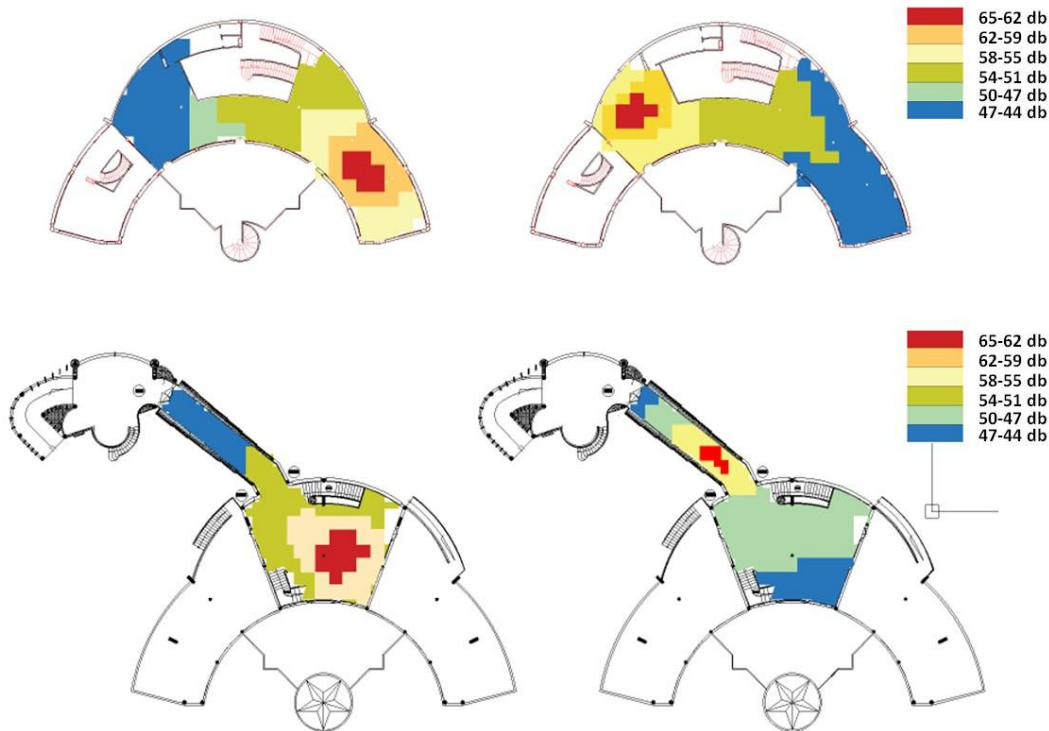


Figure 15. Values of the in-situ measurements of the sound levels in two points of the exhibition, in the existence of a guide

3.2. Diagnosis and proposal

According to this first reading, we will propose solutions of the spatial composition, respecting all the aspects already analyzed, including the ambience aspects but in a superficial way. The ambiances will be the object of another research work which will be developed soon. We will try to improve the integration and then to solve the problem of the route so that the exhibition is more adapted to the current situation:

- Increase the values of visual integration in the museum by organizing the exhibition spatially, and proposed a directed route in which the fields of vision will be more directed to the exhibition than the space itself (Seeing that what is important is the works exposed and not the museum space).
- Avoid the visitor passing through the same point twice.

- Use spaces to filter the flow such as the exhibition corridor or the space just after the stairs on the lower level of the exhibition.

We considered all of these points, and we proposed to reorganize the exhibition with removable walls that are 1.6 human height maximum, and that will allow the support of all the points mentioned above. We also noticed that the space dedicated to the archive also exists in the library, and on the first level of the basement, therefore the space following the archive is not exploited. Thus, we proposed to integrate it into the exhibition space to solve the problem of the inadequate route and the multi-directional implantation of the exhibition. The route will therefore be divided into three parts: for the ground floor from the access to the exhibition corridor until the staircase of the exhibition level, a linear route directed, a linear route centered on the level dedicated to the exhibition which will also be directed, and finally, the last section going from the exit of the staircase of the ground floor to the exit of the exhibition corridor.

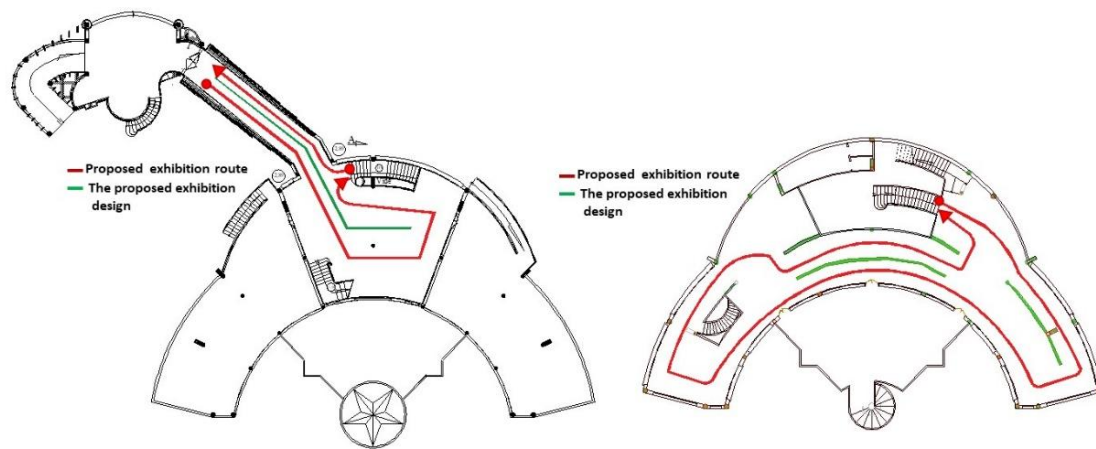


Figure 16. Proposed new spatial configuration for improved Covid 19 period flow management

3.3. Evaluation of the proposal

In what follows, we intend to carry out an evaluation of the proposal and compare it with the current state.

3.3.1. Connectivity and visual integration

Museal space without displays:

Regarding the visual connectivity, we note for the ground floor (Max=2851, Min=669), for the floor (Max=16528, Min=4837).

We compare here the visual integration of the two levels of exposure to the current state (Figure 15), and the proposed. We note that for the ground floor level the values of overall visual integration tend to be low, we notice that in the dominance of the color blue and its shades, the area of highest visual integration is located in the center of the plan, the remaining spaces are not integrated. For the proposal, the low values are non-existent, the high values of visual integration seem to occupy half of the total area of the ground floor (Max=20.50, Min=7.15), and they are located in the southeast part of the plan.

For the case of the floor in the current state (Figure 15), only one area is characterized by high values of visual integration, for the remaining surface integration tends to be low. For the new proposal with the elimination of the archive space, we have created a second pole of visual integration, and with the arrangements of the proposed

new route, the values tend to increase. The colors of the blue shades that represent the low values are reduced in the proposal (Max=21.53, Min=9.82).

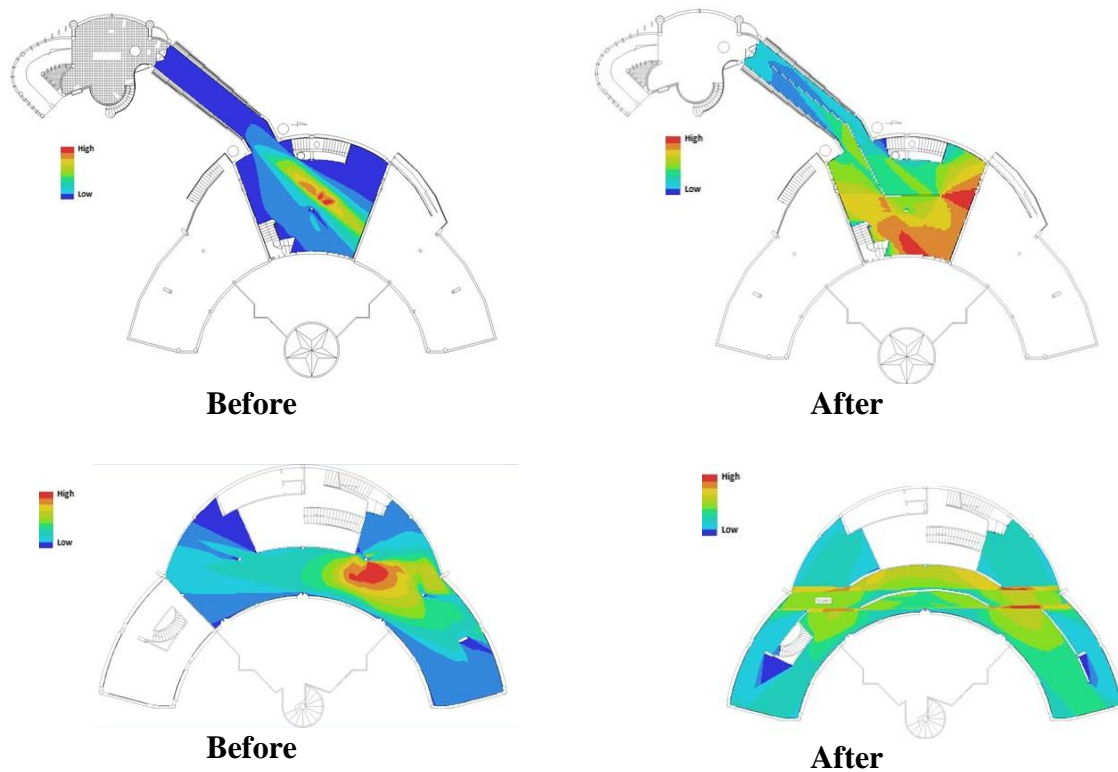


Figure 17. Comparison of visual integration values in the existing and new proposal (without displays)

Museal space with displays

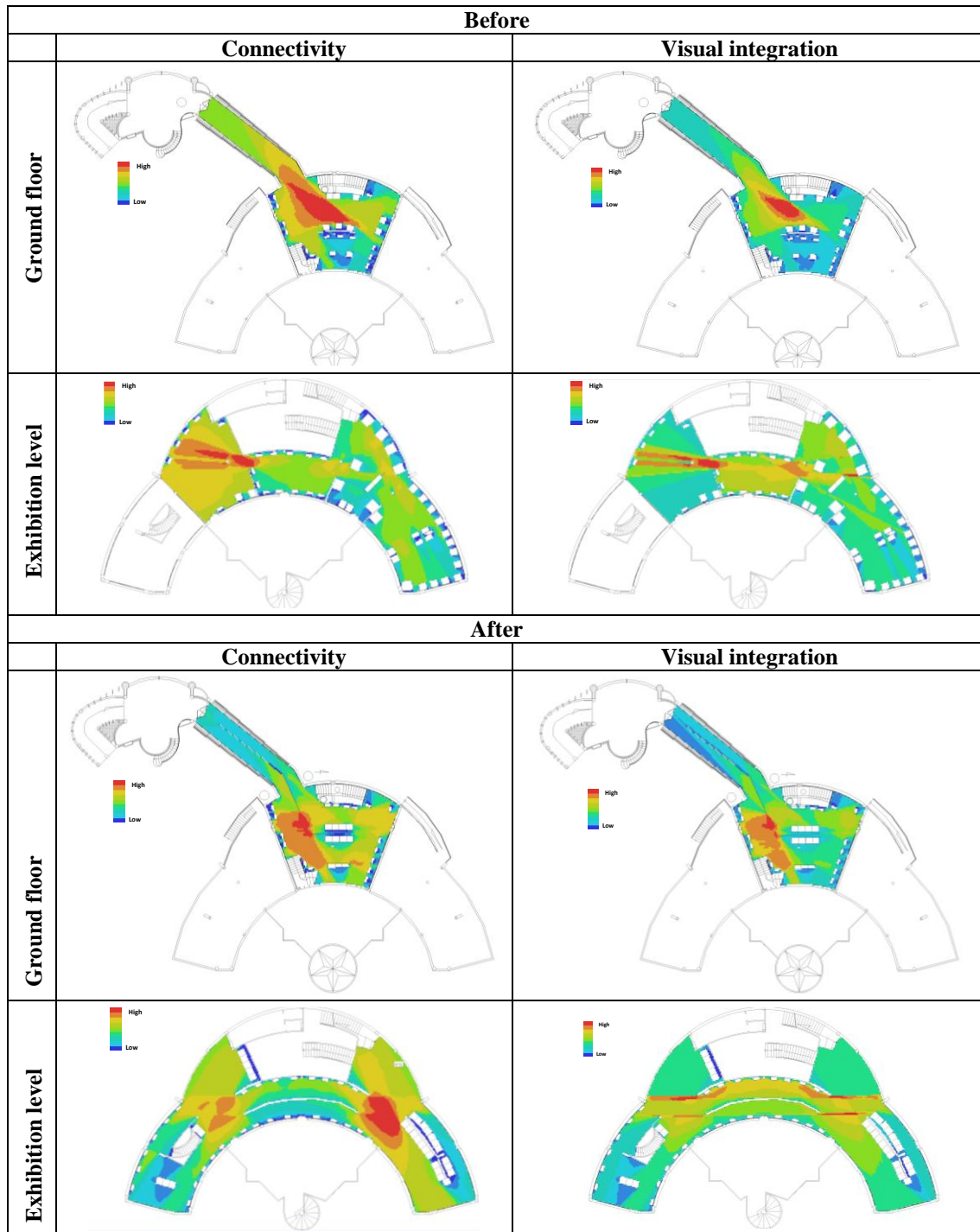
As we explained in (2.1), the museum space is distinguished by the presence of three different types of exhibition items, all of which can be moved around and arranged in various ways. We shall examine the syntactic space and its components in this section (as they are, then proposed).

Regarding the visual connectivity, we observe that for the first floor, we obtained values that were very similar to the results of the analysis using the displays (Max=2457, Min=434), while for the floor, the values of the maximum connectivity tend to decline and the average connectivity predominates (Max=12525, Min=3725).

Here, we contrast the proposed level with the two display levels' visual integration in their current states (Table 1). (With exhibition elements). We can see that on the first floor, the total visual integration values have a tendency to be high in the reception area, low in the show area, and high in the exhibition corridor. Visual integration scores in the proposal tend to be lower in the entrance hall but rise to an average level in the exhibition space. The highest visual integration values are found in the exhibition space, where they are also found for the state of the premises.

In the floor case (Table 01), we can see that the floor plan results that correspond to those of connectivity show that the highest visual integration values are concentrated in two symmetrical areas on the floor (after the archive space has been removed), but that overall, the integration values are typical of the average floor.

Table 1. Comparison of visual integration values in the existing and the new proposal (with displays)



3.3.2. Comparison of justified graphs

We were able to develop the justified graphs of our museum using the Agraph© software by realizing convex spaces, first for the proposal and subsequently for the state of the art.

Table 2. Comparative analysis of the justified graphs of the two levels analysed before and after the proposal

The ground floor (Before)						The ground floor (After)					
	TDn	MDn	RA	i	CV		TDn	MDn	RA	I	CV
Min	7,00	1,40	0,20	1,25	0,50	Min	10,00	1,42	0,14	1,90	0,75
Mean	9,66	1,93	0,46	2,56	1,00	Mean	14,25	2,03	0,34	3,32	1,00
Max	13,00	2,60	0,80	5,00	1,50	Max	18,00	2,57	0,52	7,00	2,00
The exhibition floor (Before)						The exhibition floor (After)					
	TDn	MDn	RA	i	CV		TDn	MDn	RA	i	CV
Min	19,00	1,90	0,20	1,50	0,50	Min	31,00	2,38	0,23	1,85	0,33
Mean	28,90	2,89	0,42	2,67	1,00	Mean	43,28	3,32	0,38	2,77	1,00
Max	40,00	4,00	0,66	5,00	1,50	Max	55,00	4,23	0,53	4,33	2,00

According to the initial graph observations for the ground floor, the present museum space starts with a non-distributive asymmetry; nevertheless, as one approaches space (2), which is the reception, the graph starts to become complex. When it comes to the exhibition level, the graph begins with non-distributive asymmetry and transitions to distributive symmetry at the first exhibition space (3). At this point, we will either have

two exhibition spaces in the complex graph or all of the exhibition spaces will be connected by one or more spaces.

In terms of the proposal, we have suggested a symmetrical distributive graph for the first level from the entrance that shuts in the reception area while starting the second graph. The latter graph's apparent complexity enables a good reading of the exhibition space.

For the exhibition floor, we see that despite its complexity after the third level of depth, the distributor space's graph and type ringy system will present the visitor with two options in this scenario. In comparison to the present, the proposed space has less depth steps.

These findings are supported by the Agraph© figures, which show that the values in the proposed structure for the case of relative asymmetry (RA) are less than those of the existing structure for the ground level and 0.38 instead of 0.42 for the floor, respectively.

The integration example follows the same pattern; as the value of the integration rises in the proposals, we go up to the floor level of 2.56 to 3.32. Even though the shift in the floor of the exhibition went from values of 2,62 to 2,77, it nevertheless had a significant impact on how the flows within the museum space were managed.

3.3.3. *The agent simulation for the proposal*

The exhibits and the route are the most crucial components of a history museum. To compare the planned route with the ideal route suggested by the new spatial layout, we conducted an agent simulation (Figure 16). The results of the connection and visual integration implemented in the points are more coherent thanks to the simulation agent (3.3.1). We have noticed that for the ground floor the routes overlap. For the case of the level dedicated to the exhibition, the routes correspond. However, in the places where integration is important, we can put the objects in front of which the visitors spend a lot of time so that they can be seen.

We have taken in each level the largest isovist in terms of perimeter and surface, we have compared it to the same point, we could thanks to our proposal reduce the field of vision to half the size. The goal of this reduction is to make the visitor more focused and draw his attention to the exhibitions rather than the museum area (Figure 17). Given that we are at a historical museum, this decrease will restore the value and purpose of the museum route.

3.4. *The intelligibility*

As a synthesis, thanks to the values of connectivity and visual integration we have been able to visualize the graphs of the global intelligibility. The degree to which a line's number of direct connections is a reliable indicator of its importance within the system as a whole is measured by axial intelligibility (namely, it is a correlation between axial connectivity and axial global integration). Strong correlation or high levels of intelligibility imply that the whole may be understood from the parts (Hillier *et al.*, 1987).

It should be noted that according to the standards beyond the value 0.5, the museum is readable to visitors. For the ground floor, the R^2 was 0.54 and after our intervention became 0.91, for the exhibition level the R^2 was 0.53, slightly increased to 0.84 when we added the space dedicated to the archives to the total exhibition space (Figure 18). This means that the museum space, especially the ground floor, has become more legible to

the visitor than it was before, and this proves the correspondence between visual connectivity and visual integration.

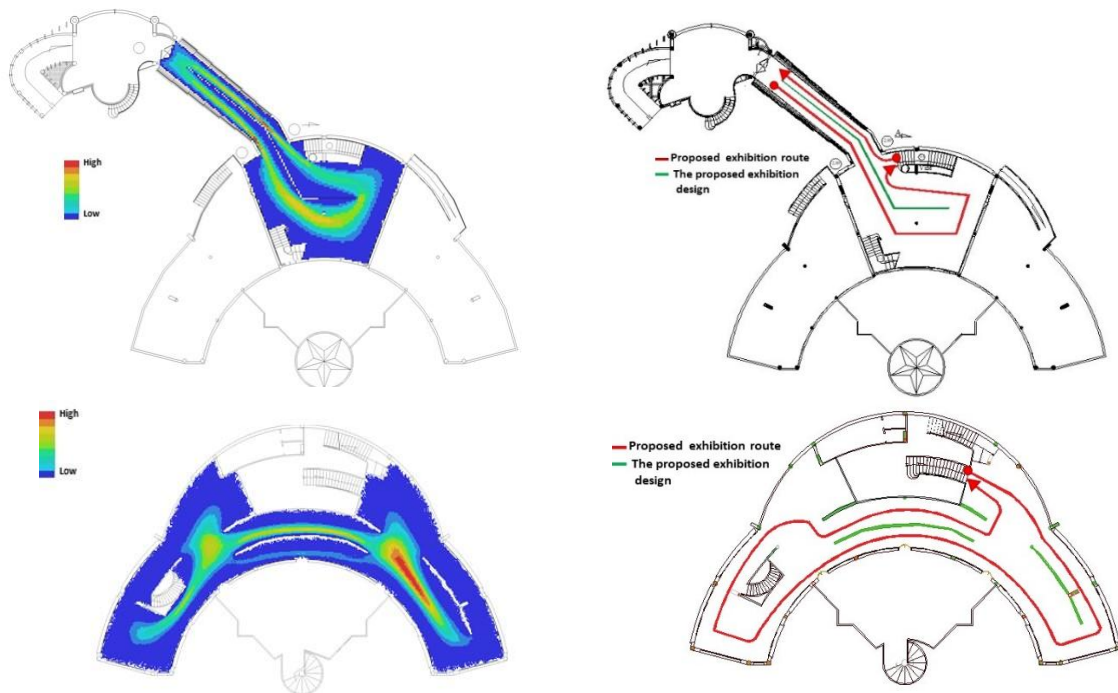
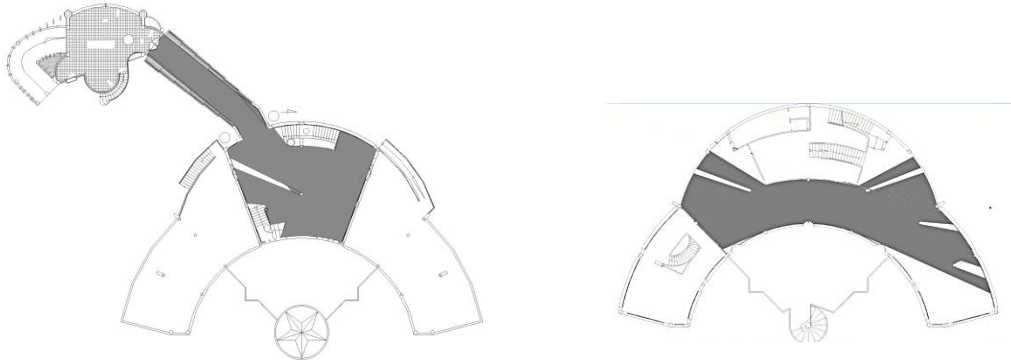


Figure 18. Comparison between the proposed route and the agent simulation

Simulation isovists existing space (Visual fields)



Simulation isovists proposed space (Visual field)

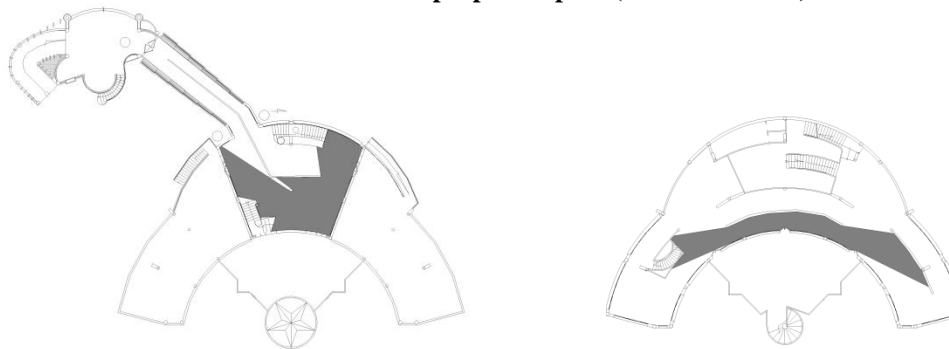


Figure 19. Comparison between the largest isovists in the existing state and the same in the proposed model

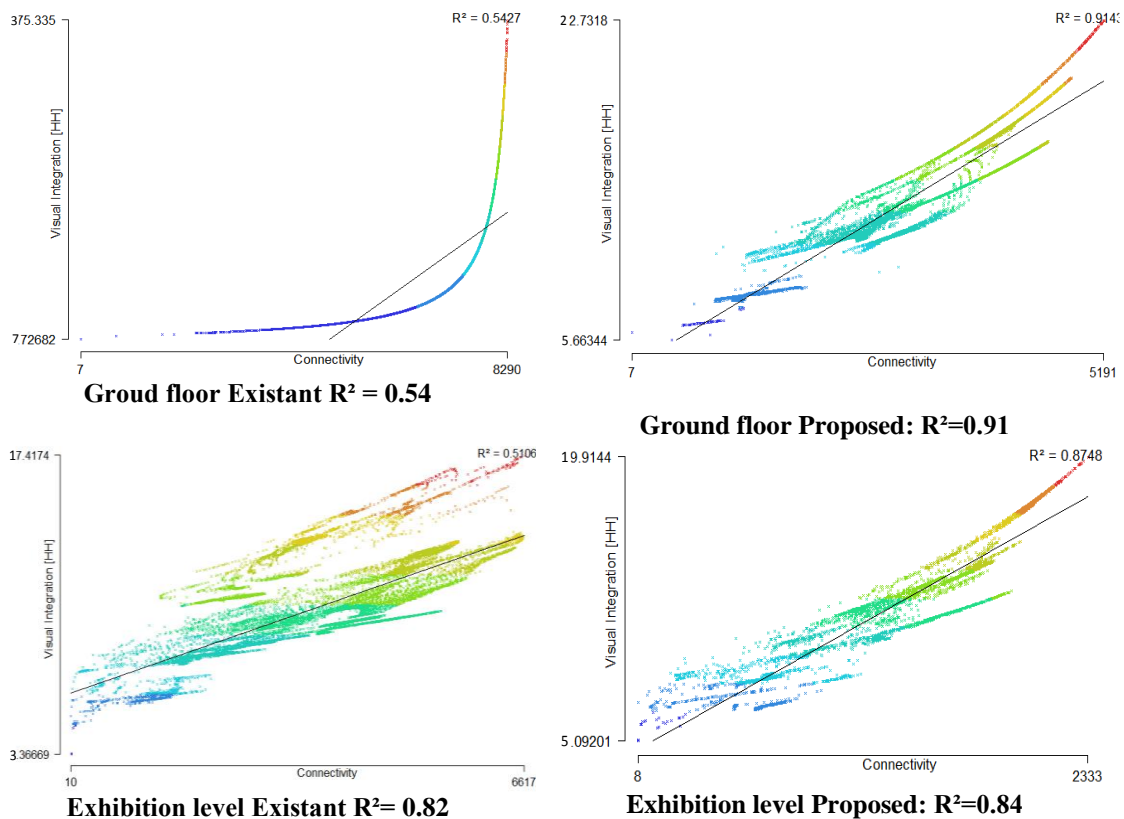


Figure 20. Intelligibility graphs of the existing and proposed museum space

3.5. The research limitations of and future developments

Using the commented route technique—Le parcours commenté in French—and in-person observation, we were able to identify a number of visitor behavioral responses to the route and the exhibition as a whole. Because the museum was closed due to the pandemic and only a small portion of the public could access it during the events, it was impossible to conduct a questionnaire survey with a diverse sample. This section will be completed with a study of environmental factors like light, heat, and even sound. The expansion of the research field will enable us to more precisely define the visitor behavior in the museum, and the suggested corrections will not only address the visitor's course and attention, but also his perceptions and sensorialities, which will clarify the overall actions to be made.

4. Conclusions

We found that the El Moudjahid Museum of Bejaia experiences spatial dysfunction as a result of inconsistencies in the museum's spatial organization and layout during the period of our research. In order to attract people, it was initially decided to leave vast fields of vision open in every sequence. Unfortunately, this openness has led to a few problems, including diminished visitor focus in the area where they are trying to find their way, deconcentration from the exhibit, and visitors having trouble navigating despite the presence of a guide for huge flows.

The current spatial design of the museum has practical faults since we ignored the issues related to architectural conformation and all ambient signals (colors and textures, the use of light and sound in the exhibition). As we've seen in examples of visitors who came alone or with a companion, as well as in group visits, the nature of the exhibition and the museum space encourages the visitor to look for the route to take while being drawn to the displays along the way.

To address the issues with the exhibit and the chaotic path that prevented a clear definition of the museum area, the usage of space syntax was more than essential. We identified the most visually integrated and related parts using space syntax. Following the exposed works, come the unshaded works. It was a decision because all of the exhibition components are detachable and can be rearranged in accordance with the direction we wish to take.

The space syntax gave us the opportunity to assess our suggestion, and as a result of this assessment, we were able to suggest a path that was better suited to the architectural space's shape and the requirements of the exhibition. We were able to validate the suggested route using the new knowledge that the study of justified graphs provided for us.

The solution suggested in this study nicely complements the suggestions made to fix errors at the scale of the spatial composition. This option was also considered for the post-Covid-19 era, therefore we presented a new spatial configuration that fits the Museum of History's design pattern and will have a good impact on the behavior of the route's visitors. This concept can be taken into account under regular circumstances (i.e., without a pandemic); it will not only enhance integration and visual connectedness, but it will also redirect visitors' attention back to the exhibition once the museum route is clear.

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