ACTA IMEKO
ISSN: 2221-870X
September 2024, Volume 13, Number 3, 1 - 8

Spatial evaluation of the museum experience in converted heritage: the case of the National Bardo Museum in Tunisia

Rym Bouhamed[1]

[1] *Institut supérieur des Beaux Art de Nabeul, Université de Carthage, Nabeul, Tunisia*

ABSTRACT
This paper addresses the evaluation of the conversion of the Bardo Museum in Tunisia. Indeed, buildings converted into exhibition spaces rarely adapt perfectly to their new functions. Following this perspective, we propose to answer two major questions: How can we objectively evaluate the conversion of the Bardo museum, which was originally built as a seat of power and residence purposes and converted into an exhibition space? What criteria can be used to evaluate it while respecting ICOMOS international charters?
Through the spatial analysis carried out on the subject, our approach allowed us to highlight the spatial properties of the museum using the "Depthmap" simulation based on "Spatial Syntax", a questionnaire, and the observation technique of "Wayfinding". We have developed an objective analysis tool to evaluate the reliability of the conversion and the challenge of transforming a traditional and historical space through its architecture into a space that will fulfill a new function. Hence, we deduced through this method that this conversion is a "partial success."

Section: RESEARCH PAPER

Keywords: conversion; evaluation; space syntax; castle; museum

Citation: R. Bouhamed, Spatial evaluation of the museum experience in converted heritage: the case of the National Bardo Museum in Tunisia, Acta IMEKO, vol. 13 (2024) no. 3, pp. 1-8. DOI: 10.21014/actaimeko.v13i3.1771

Section Editor: Fabio Leccese, Università Degli Studi Roma Tre, Rome, Italy

Received February 10, 2024; **In final form** September 5, 2024; **Published** September 2024

Corresponding author: Rym Bouhamed, e-mail: rym_bouhamed@yahoo.fr

1. INTRODUCTION

In Tunisia, a wide array of buildings has been converted for diverse uses. These structures primarily consist of public facilities and former palaces dating back to the 19th century, which have been transformed into restaurants, hotels, museums, or cultural spaces. This conversion not only ensures their preservation but also reintroduces them into the socio-economic and cultural fabric of the country. However, the process of repurposing these buildings for their new functions can present challenges due to constraints imposed by their traditional architectural layout. It necessitates striking a balance between preserving the form of the original building and accommodating its new purpose.

The transformation of the Bardo Palace in Tunisia is notable for being one of the most remarkable conversions. This palace, built in the 15th century during the Hafsid era under the reign of Abu Omar Othmen (1436-1488), is located on the outskirts of the Tunis medina. Its name is derived from the Spanish word "Prado", meaning "garden". Over the years, the palace underwent several transformations and extensions during the reign of the Mouradite beys, under Hammouda Pacha Bey (1631-1666). Restored and embellished, it became "the permanent residence of the dynasty", evolving from a simple palace into a city housing around 800 people, according to Paul Sebag, who describes it as a residential and official complex for the sovereigns of Tunis. In the eighteenth century, the Husseinite beys enlarged the Bardo by adding a mosque, a courtroom, and a room for beylical audiences, complete with fortifications. An esplanade later replaced the southern wall.

The Grand Palace was built during the reign of Muhammad Bey (1855-1859) and completed by his successor, Muhammad al-Sadok Bey (1859-1882). It consisted of several buildings.[1]

It was officially inaugurated on 7 May 1888 under the name of the "Alaoui" Museum, in homage to Ali Bey, its founder. It was given its current name, the National Bardo Museum, shortly after independence in 1956.

A prime example of this is the conversion of the Bardo Museum, where the ultimate objective was to conserve and showcase the archaeological artifacts within the spacious rooms of the palace. However, because of European influences museology in the twentieth century, the space underwent a redesign to effectively communicate a specific message. This involved reconstructing the museum's old decor and

implementing changes in line with "analogue museology" [2], all aimed at enhancing visitors' experiences within the museum. Notably, the extension inaugurated in 2012 exemplified a harmonious blend of contemporary and ancient elements, providing visitors with a deeply emotional experience.

During our site observations, we identified spatial orientation issues that prompted us to assess the morpho-spatial quality and evaluate the success of the palace-to-museum conversion. To achieve these objectives, we adopted a mixed-method approach, employing the Depthmap simulation technique based on spatial syntax to validate or refute our initial hypotheses. Additionally, we utilized a questionnaire and the wayfinding observation technique.

This research has certain limitations. The Depthmap software does not consider specific architectural aspects like three-dimensional shapes and double heights. Additionally, we lack the required equipment to measure ambient factors that could impact users, such as temperature, light levels, humidity, and other environmental elements, for comparison with the Depthmap software results.

2. EVALUATION THROUGH SPATIAL SYNTAX

Scientific evaluation involves processing and interpreting data in accordance with the rigorous requirements of scientific research. Its aim is to adapt to real situations of deliberation and decision-making, encompassing all data related to the research subject, regardless of its quantitative or qualitative nature. According to the CSE: "This eclecticism is not synonymous with confusion: unlike an ordinary discussion, conducted without any formal method, evaluation endeavours not to mix the different types of arguments, but to rank them, weigh them, and link each to specific conclusions" [3].

The practice of evaluation includes various technical activities such as observation, measurement, and analysis. Although it is not a scientific discipline in the conventional sense, evaluation serves as an institutional activity and is destined to become one of the pillars of public governance. More than just a knowledge tool, it adheres to specific requirements and values: rigour, impartiality, transparency, consideration of diverse viewpoints, and a commitment to uphold the general interest [4].

Constructing an evaluative judgment requires a "regulated practice of argumentation," much like the proceedings of a trial that follow formal rules regarding the status, validity criteria, and relative weight of arguments [5].

To provide a more detailed interpretation of the simulation results in our case study, we will define the theory of "spatial syntax" and present its analysis tools. The theory of spatial syntax is founded on two fundamental principles:

Space is an intrinsic aspect of human activity and one of its integral components. Human activity is intertwined with space, leading to three interactions that should be considered: moving, interacting with others encountered along the way, and observing the surroundings within a visual field [6].

Secondly, the theory is based on predicting the orientation behaviours of users within each space. It quantifies the environment as a set of variables predicting specific behaviours and anticipates orientation behaviours in public spaces by targeting people's tendency to move towards spaces with higher levels of integration. In other words, these spaces function as transit nodes and are more connected to other places [7]. It is through the analysis of "spatial configuration" using this theory that we can translate qualitative and quantitative architectural plans.

2.1. Methods and tools

In 1984, Hiler et al demonstrated that spatial syntax is a set of theories and techniques that analyze the topological relationships of spaces to quantify the properties of spatial arrangements, such as distribution, non-distribution, symmetry, and non-symmetry. These properties make the space more integrated than others in an environment known as a system, which means that the more integrated the space is, the more closely it is accessible from all other spaces; otherwise, it is considered an isolated space [8].

2.2. Space Syntax" measures

Spatial Syntax" is used to carry out calculations to provide information on the morphological quality of space using maps produced by the "Depthmap" software [9]. The software was created based on the theories of spatial syntax. This method of analysis is computer-assisted. Its aim is to communicate precise information on the spatial configuration of buildings.

There are two types of measures: first-order measures such as connectivity, control and integration, and second-order measures such as the correlation of local and global first-order measures. The combination of these two measures provides other results for the spatial configuration.

In addition, intelligibility, as a key property of spatial structure, is an indicator of the quality of an easily navigable environment and is calculated using the ratio between the integration measure and connectivity. The system is said to be "intelligible" when the value obtained is greater than 0.5, which makes it possible to deduce that there is connectivity and that it is well integrated into the system. [10]

2.3. Observation by Wayfinding technique and survey

The use of a field survey allows us to confirm or refuse the results obtained during the analysis carried out with the software, allowing us to compare the results of simulation with reality. We began the survey with discrete "wayfinding" observation which “often employed descriptive analytical methods for human movement and behavioural patterns” [11].

The qualitative study conducted through the survey allows us to compare the simulation results with reality. We will determine the paths chosen by users in the museum. This method provides precise data on users’ choices and preferences in terms of routes [12].

3. PLANS AND PRESENTATION OF THE BARDO MUSEUM

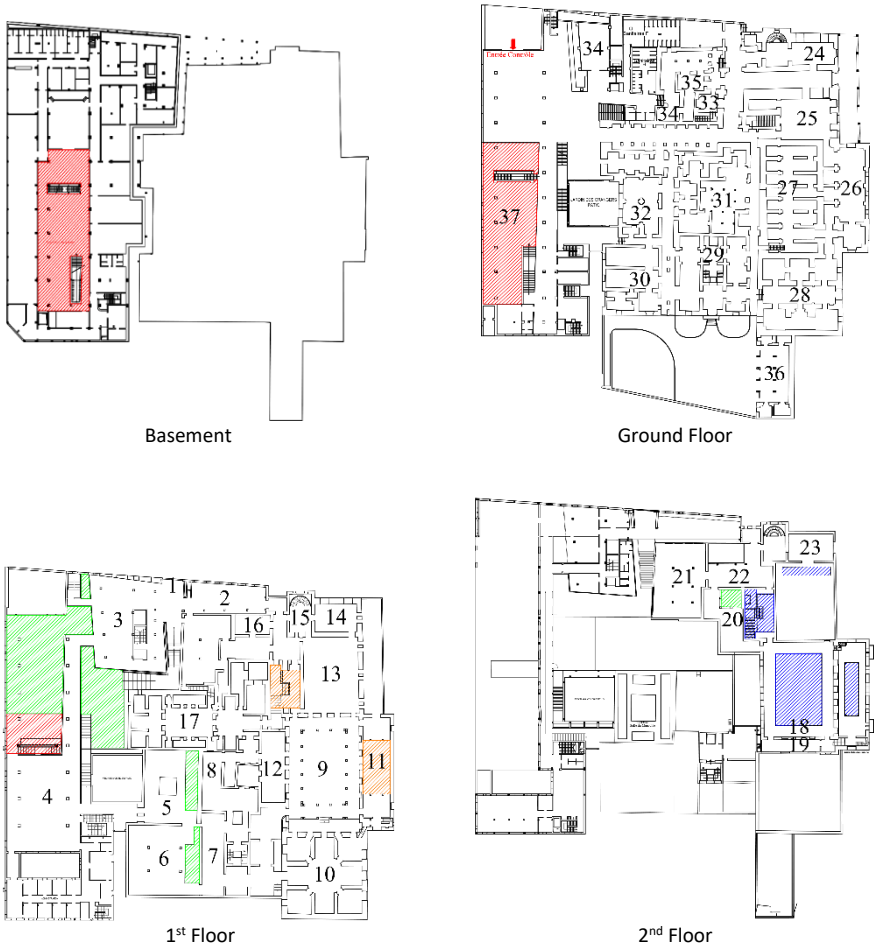
The museum covers a total area of 15,000 m², including a historic area opened in 1888 and a 7,000 m² extension inaugurated in 2012. The extension was essential to accommodate more visitors and improve the quality of their experience. In Figure 1, the new section of the building is on the right.

Figure 1. Bardo Museum: façade showing extension [13].

Figure 2. Bardo Museum lobby: Photographic documentation of the reception area (Source: Author).

The museum has four levels and is divided into two areas: the extension leading to the historic palaces. As can be seen from Figure 2 and Figure 3, the entrance is through the extension area of the building, which is characterised by a wide, almost panoramic field of vision, with triple heights. Through the extension we can move towards the old part of the museum.

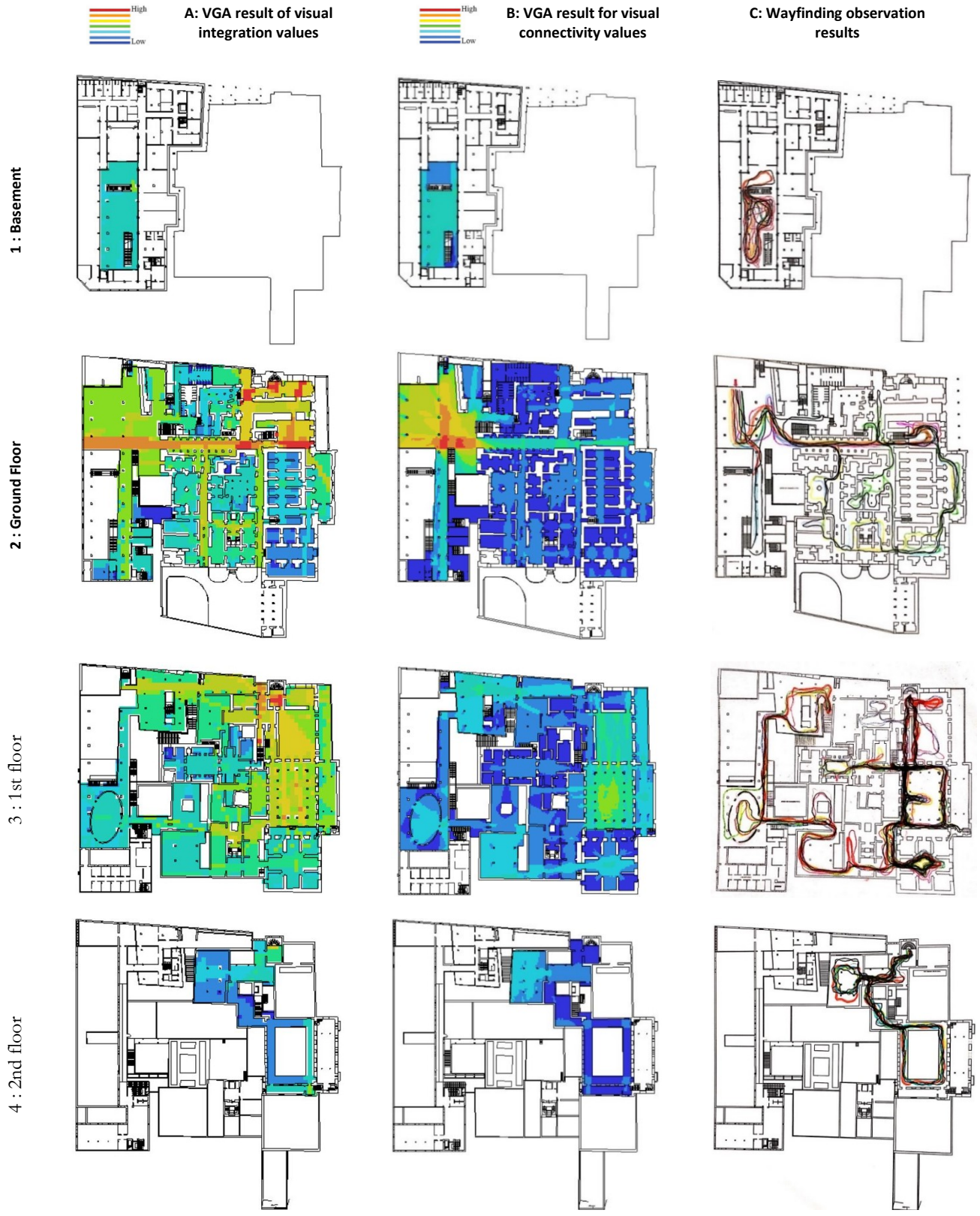
The basement is accessible by two staircases from the reception hall. It is dedicated to high-quality temporary exhibitions. It comprises a vast rectangular room with an open view through its double height, which communicates with the upper floor. The morphological analysis of this space focuses solely on the area marked in red (Figure 3), while the rest of the



GROUND FLOOR
24-Room of the Emperors
25-Room of Constantine
26-Room of the Ecclesia Matter
27-Room of the sarcophagi
28-Room of Jerusalem
29-Room of Kairouan
30-Room of Mahdia
31-Room of Tunis
32-Room of Thuburbo Majus
1st FLOOR
1-Room of the Virgil alcove
2-Room of Bulla Reggia
3-Room of the Mahdia wreck
4-Room of the Punic
5-Room of the Carthage mausoleum
6-Room of marine mosaics
7-Room of the Numidians
8-Room of the Hermaion
9-Room of Carthage
10-Room of treasures
11 Room of Althiburos
12-Room of Uthina
13-Room of the Roman villas
14-Room of Thugga
15-Room of Thysdrus
16-Room of Ulysses
17-Room of the petit palace
2nd FLOOR
18-Carthage gallery
19-Room of the lamps
20-Room of the Minotaurs
21- Room of Acholla
22-Room of Diana the Huntress
23- Room of the Bardo

Figure 3. Plan of the Bardo Museum, Tunis, Tunisia (source: author).

Table 1. VGA analysis of integration, connectivity, and Wayfinding observations: Bardo Museum (source: author).



basement is reserved for the storage and preservation of items under restoration.

The room is inspired by Roman villas, with a row of columns 40 metres long and 20 metres wide, and a ceiling height of 6 metres. It is soberly decorated in white, without ornamentation, and hosts temporary exhibitions and cultural events.

4. EVALUATION OF THE BARDO MUSEUM

Table 1 presents a visibility graph analysis "VGA analysis" of the museum's integration, connectivity, and field observations. The most integrated and connected spaces are represented by a red colour that transitions to orange, while the spaces turning

from yellow to green and blue indicate increasing segregation. The graphical maps of visual connectivity exhibit values that reflect a relatively similar hierarchy of integration values.

The analysis results reveal similarities between the two floors' dominant axes on the integration and connectivity plans which are approximately alike and converge (refer to 1 A-B-C and 4A-B-C in Table 1). This indicates that the most integrated spaces are also the most connected spaces within the system. Additionally, spaces with high connectivity values are easily accessible from different directions and are more frequently visited.

Figure 4 illustrates the intelligibility curve, which represents the ratio between the measure of integration and connectivity, denoted by $R^2 = 0.23 < 0.5$. This value indicates that the museum is not highly "intelligible." In other words, it is not easily understandable or coherent in terms of its spatial organization.

From this analysis, we can conclude that the museum suffers from both poor connectivity and poor integration into the overall system. When we examine the connectivity and integration maps, we notice a significant similarity in the distribution of configurational values for each aspect. This similarity further confirms that the space is lacking in "intelligibility," exhibiting deficiencies in integration, connectivity, and coherence with its spatial configuration.

Table 2 illustrates the maps that represent the user's potential movements in space. These lines are paths that cross several spaces in their directions. From the figures in Table 2, we notice a strong similarity between the results of the "all lines analysis" (Column A) and the "Wayfinding" observations (Column C). For the basement (1A and 1C), we have two important axial lines in the middle of the space, and for the ground floor (2A-C), we note that the most important axial lines are in the corridors, with optimum visibility for visitors.

These axes face the main entrance and lead down to the basement. The second major line runs from the entrance to the

"Driba" up to the "Constantine" room; it is perpendicular to the second line and passes through the "rue de Kairouan" corridor, between the "Thuburbo Majus" and "Patio of Ceramics" rooms.

These axes are oriented towards the main entrance and lead down to the basement. The second major line runs from the entrance to the "Driba" and extends to the "Constantine" room; it intersects perpendicularly with the second line and passes through the "rue de Kairouan" corridor, situated between the "Thuburbo Majus" and "Patio of Ceramics" rooms.

On the 1st floor (3A-C), there is an area of intersection between the major axes, located between the "Carthage Room," the "Sousse Room," and the "Treasure Room," along with lesser axes (shown in blue). Moving to the 2nd floor, we find strong axes in the "Acholla Room" and the "Room of Diana the Chaseress," and less strong axes (indicated in dark blue) in the "Lamp Room" and the "Carthage Gallery."

The figures in Table 2, column B, represent the multi-agent analysis maps obtained from the movements of fifty virtual agents using Depthmap. Blue indicates areas with few agents walking around, while red signifies higher agent activity. These agents move around the ground floor (2B), predominantly in the central hall towards the main thoroughfares. Most of them follow the axes that converge at the reception hall and disperse into various rooms, resulting in several low-traffic areas.

On the first floor (3A), we observe a strong presence of launched agents in the "Sousse Room" and the "Roman Carthage Room," a moderately strong presence in the "Mahdia Room" and the "Apartments Room," and a weaker presence in the "Marines Room" and the "Punic Room." The central space on the first floor, including Room 2, experiences the highest foot traffic and is thus the most frequented area by visitors.

In contrast to the lower floor, the upper gallery (4A) is better suited to receive visitors. The smooth flow of movement between the first rooms and those accessible via the footbridge ensures that visitors can move around freely.

Column C of Table 2 provides the maps from the Wayfinding analysis. Through these maps, we can observe a partial correspondence between the areas visited by visitors during our survey and the values obtained with Depthmap. Moreover, it highlights that the areas most frequently visited by visitors align with those identified through the multi-agent analysis.

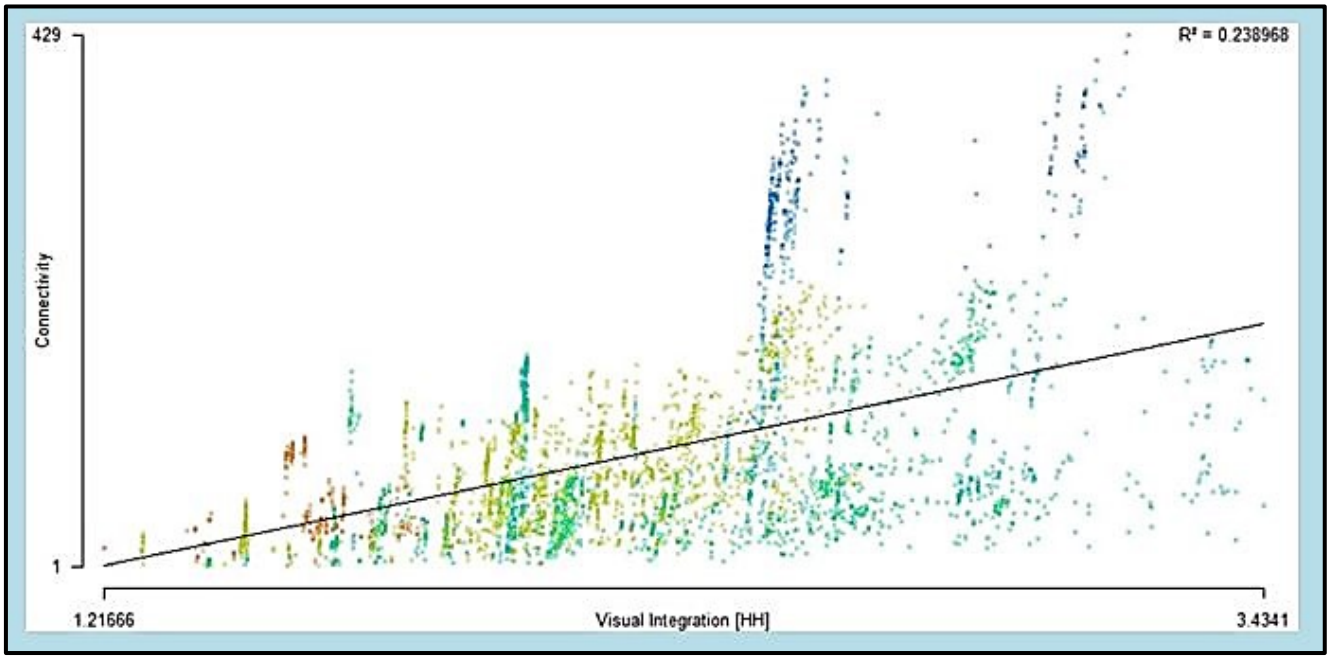
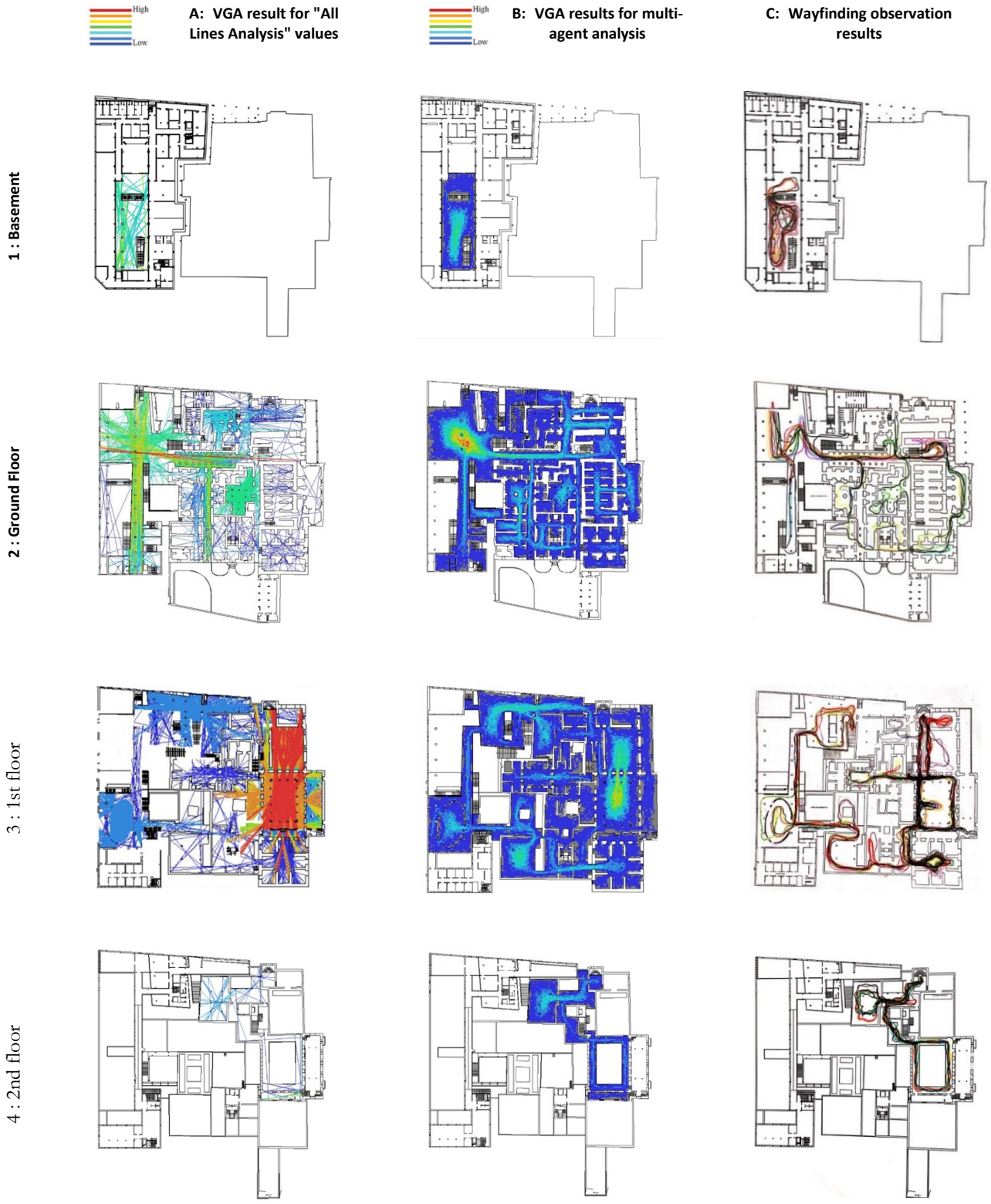


Figure 4. Results of the VGA for the intelligibility values of the Bardo Museum (source: author).

Table 2. VGA analysis of integration, connectivity, and Wayfinding observations: Bardo Museum (source: author).



5. DISCUSSION OF THE RESULTS

We have drawn relevant conclusions from the evaluation of the museum's conversion by correlating the methods of "Spatial Syntax," "Wayfinding" and the survey. Through spatial analysis, we have highlighted the museum's spatial properties, and the diverse techniques yielded consistent and conclusive results.

Both the "All line analysis" and "multi-agent analysis" agreed with the findings obtained from the VGA analysis. These methods identified the most integrated, connected, and thus "intelligible" spaces, which align with the areas visited by virtual agents in the "multi-agent analysis". These spaces also emerged as the most accessible in the "All Line Analysis."

Using syntactic configuration analysis, we identified various spatial characteristics. The circulation axes analysed through

VGA, Multi-agent, and all Line Analysis exhibited high values in spaces that were linear and rectilinear. These spaces proved to be the most connected, integrated, and thoroughly traversed. In contrast, the most complex spaces, featuring multiple changes of direction, had lower configuration values, resulting in lower intelligibility. Several rooms within the museum demonstrated this complex and deep spatial configuration in relation to the number of steps.

Additionally, we observed that the width of these axes influenced the results. Wider and more accessible axes tended to be better occupied by visitors. Furthermore, the depth of the spaces significantly impacted the configuration values. Rooms with substantial syntactic depth generated lower configuration values, while those with low syntactic values yielded very high configurational values.

Upon applying this measure, we concluded that the museum has a considerable depth, which led to heterogeneous values throughout and rendered the overall layout less intelligible. In conclusion, our comprehensive evaluation, integrating "Spatial Syntax," "Wayfinding" and the survey, has provided valuable insights into the museum's conversion and its spatial characteristics. This analysis sheds light on potential areas of improvement to enhance visitor experiences.

Additionally, we have observed that the presence of obstacles, such as walls, staircases, and recesses, significantly impacts the visual and physical accessibility of the space, making it more complex and challenging to grasp. The museum's numerous compartments contribute to its depth and morphological complexity, leading to disruptions in the itinerary.

6. CONCLUSION AND RESEARCH PROSPECTS

The spatial configuration of the subject under study exhibits several anomalies. We find that the space is "unintelligible," poorly connected, and lacks integration, except for a few zones.

We obtained notably high values for integration and connectivity in the reception area and along the two main axes: the alley leading to the "Constantin Room" and "rue de Kairouan," and the alley leading to the basement on the ground floor. Similar results were observed on the first and second floors, and they were validated through the axial "All Line Analysis" and the "Multi-Agent Analysis." Correlating these results with the Wayfinding outcomes revealed strong correspondences. Additionally, we observed that several rooms received few visitors.

To complete our research, we used a survey to explore other factors determining the success of the conversion of the Bardo Museum. We analyzed the results of the survey which contained information on the quality of the museum based on compliance with the conversion criteria set out in the International Charter for the Conservation and Restoration of Monuments and Sites (Venice Charter 1964) [14].

Conversion is not a random process; it is based on structured data that designers must respect when carrying out any work on the built heritage. This implies a thorough understanding of what already exists, respect for its logic and constructional details, and the appropriate adaptation of form to function. We used these criteria as a reference for each visitor in the survey provided after the visit, in line with the wayfinding method.

Visitors considered the overall space satisfactory, except for orientation issues, as they faced considerable difficulty navigating through the space. However, the overall ambiance, security, and services were still appealing to them.

Satisfaction was also expressed with the concept of conversion, as it ensured the building's preservation. Regarding ambiance factors, users found the space satisfying in terms of lighting, both natural and artificial, odours, sound, etc.

On the downside, the space suffers slightly from a lack of media exposure, with most visitors learning about it through word of mouth. Few visitors are aware of it through social networks, despite such means of communication being essential for publicizing and promoting a venue.

Visitors confirmed their lack of awareness regarding the museum's significance and its national and international reputation. Yet, it stands as one of the most important museums in the Mediterranean basin and the second most important museum on the African continent, following the Egyptian Museum in Cairo, in terms of its rich collections [15].

Based on the survey results, we can infer that some of the conversion assessment criteria outlined in ICOMOS international charters have been met. Therefore, we can consider the conversion a "partial success." Nonetheless, the museum continues to offer a spatial quality of considerable richness through its overall ambiance, services, and artworks.

This study provides a solid basis for considering improvements to the visitor journey at the Bardo Museum. We suggest improving signage in less frequented areas and possibly incorporating attractive features such as artworks to draw visitors to these areas. These proposals are economically viable and can significantly improve the visitor experience of the museum.

Established on the results of this study, we will develop the following points:

We intend to enhance this research by increasing the number of subjects studied to generalise our results.

We can apply this method not only to the conversion of palace spaces into exhibition spaces, but also to a variety of reconversion uses. In addition, we plan to supplement this research by exploring new, more advanced methods for calculating the ambient factors that contribute to visitor comfort by using for example, “the OpenStudio/EnergyPlus plug-in (National Renewable Energy Laboratory, Golden, CO, USA). OpenStudio is a building energy simulation software platform based on EnergyPlus, which is a widely adopted program for comprehensive analysis of energy consumption in buildings, encompassing heating, cooling, lighting, ventilation, and other energy-related aspects” [16].

REFERENCES

[1] P. Sebag, Tunis. Histoire d'une ville, éd. L'Harmattan, 2000, ISBN 2-7384-6610-9, p.136. [In French]

[2] F. Matri, La reconversion des palais traditionnels en musées aux XIXe -XXe siècles à Tunis : Al-Sabîl: Revue d'Histoire, d'Archéologie et d'Architecture Maghrébines. 2018, 5(22). Online [Accessed 11 September 2024] [In French] https://www.academia.edu/37599172/La_reconversion_des_palais_traditionnels_en_mus%C3%A9es_aux_XIX_e_XX_e_si%C3%A8cles_%C3%A0_Tunis

[3] B. I. Perret, Principes méthodologiques. Paris, La Découverte, 2008, ISBN 9782707154873, pp. 7-30.

[4] B. I. Perret, Principes méthodologiques. Paris, La Découverte, 2014, ISBN 9782707183385, pp. 3-6.

[5] Araba M, Mazouz S. Apports de la syntaxe spatiale à la vérification de l’intégration d’un quartier d’habitat spontané dans le système urbain. Bulletin de la Société royale des sciences de Liège. Janvier 2018, pp. 121-135. [In French] DOI: 10.25518/0037-9565.8234

[6] J. Peponis, C. Zimring, Y. K. Choi, Finding the building in wayfinding, Environment and Behavior, 1990, 22(5), pp. 555-590. DOI: 10.1177/0013916590225001
[7] B. Hillier, J. Hanson, The Social Logic of Space, Cambridge, Cambridge University Press, 1984, 22 pp.
[8] J. Pinelo, Integration of Depthmap, A Practical Handbook for Applied Space Syntax Research, Bartlett School of Graduate Studies, UCL, London, 2010, 13 pp.
[9] B. Jiang, C. Claramunt, Integration of Space Syntax into GIS: New Perspectives for Urban Morphology. Transactions in GIS, June 2002, 6(3), pp. 295-309. DOI: 10.1111/1467-9671.00112
[10] A. Ozbil, D. Yesiltepe, G. Argin, G. Rybarczyk, Children's Active School Travel: Examining the Combined Perceived and Objective Built-Environment Factors from Space Syntax. Int. Journal of Environmental Research and Public Health, 2021, 18(1), 286. DOI: 10.3390/ijerph18010286
[11] J. H. Lee, M. J. Ostwald, L. Zhou, Socio-Spatial Experience in Space Syntax Research: A PRISMA-Compliant Review. Buildings, 2023, 13(3), 644. DOI: 10.3390/buildings13030644
[12] R. Bouhamed, Morphological Analysis of the Kheireddine Palace converted into the Museum of Tunis City, Proc. of the IMEKO Int. Conf. on Metrology for Archaeology and Cultural Heritage, Rome, Italy, 19 – 21 October 2023, pp. 581-586. DOI: 10.21014/tc4-ARC-2023.109
[13] Agence arch/an, Amira Nouira architecture. Online [Accessed 11 September 2024] [In French] https://www.nouira-architecture.com/
[14] Charte internationale sur la conservation et la restauration des Monuments et des sites : Icomos, IIe Congres International des Architectes et des Techniciens des Monuments Historiques, Venice, Italy, 25-31 Mai 1964. Online [Accessed 11 September 2024] [In French] https://www.icomos.org/images/DOCUMENTS/Charters/venice_f.pdf
[15] S. Zaiane, Le musée national du Bardo en métamorphose: Téoros, 27-3 (2010) pp. 18-28. Online [Accessed 11 September 2024] [In Frensh] http://journals.openedition.org/teoros/69
[16] J. Ma, T. Inoue, Q. Fang, K. Li, M. Li, A Study on Optimal Opening Configuration for Art Museum Exhibition Space Considering Daylight Performance, Indoor Thermal Comfort, and Energy Consumption, Sustainability 2023, 15(23), 16431. DOI: 10.3390/su152316431