COMPARATIVE MUSEOLOGICAL ANALYSIS OF THE SPATIAL AND SEMANTIC CHARACTERISTICS OF EGYPTIAN MUSEUMS

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DECLARATION

I hereby declare that all information in this thesis is attained and presented in accordance with academic regulations and ethical behavior. I correspondingly declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original in this work.

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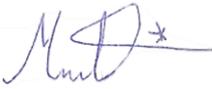
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With sincere love and gratitude,

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</div>

To my parents……

ABSTRACT

Due to the rising interest within the Egyptian government to redevelop and rebrand the country as a touristic destination, which was always a major source of income to the country, the government set out to build new museums that would be big, new and magnificent that will turn the eyes of the world on them again. However, in the process so many of the older museums are going to be neglected, especially after having some of them lose their key exhibits to newer ones, raising the question of what would happen to those museums? This issue is addressed by trying to first identify the potential of those museums, which is done by employing the quantitative and descriptive methodology of space syntax that was developed by Bill Hillier in 1980, to help characterize the spatial characteristics and the semantic (display arrangement) properties of the configuration and its subsequent effect on the overall experience. In this study three different museums were analyzed, all hold significant history and heritage in the museological history of the country, and possess some commonalities that justified a rational comparison between them. The results revealed that some museums were more functional and intelligible without the current display arrangement, while others didn't get affected by it at all. Besides that, most of the exploration and movement patterns were recorded to shift to the local scale upon the implementation of the gallery, whilst intelligibility dropped in all of them causing an overall reduction in the legibility of the global structure. And finally, despite sharing some similarities and narrative structures each museum produced a different quality of experience that was influenced by all the prior factors that changed the overall experience. The study recommends the use of this data to help guide future renovations, rearrangements, or even expansion projects of perspective, showing what elements can be utilized for the optimum design intent. On top of that, it is recommended to further build on those findings first by verifying them in the field, and then expanding it whether towards a more museological or architectural focus.

Keywords: Museology, museum development, visitor experience, space syntax, display arrangement; Egypt.

ÖZET

Mısır hükümetinin, ülkenin her zaman önemli bir gelir kaynağı olan ülkeyi turistik bir destinasyon olarak yeniden geliştirme ve yeniden markalaştırma konusundaki artan ilgisi nedeniyle, hükümet büyük, yeni ve görkemli olacak yeni müzeler inşa etmeye başladı ve bu sayede dünyanın gözlerini üstüne çekmeyi başardı . Ancak bu süreçte, özellikle bazı eski müzeler kilit sergi mekanlarını ve eserlerini yenilerine kaptırdı, bu durum karşısında müzelere ne olacak sorusunu gündeme geldi. Bu sorun, ilk olarak, 1980 yılında Bill Hillier tarafından mekânsal özelliklerin ve semantik (gösterim düzeni) karakterize edilmesine yardımcı olmak için geliştirilen, mekân sözdiziminin nicel ve tanımlayıcı metodolojisi kullanılarak yapılan bu müzelerin potansiyelini, konfigürasyon özelliklerini ve bunun genel deneyim üzerindeki etkisini belirlemeye çalışarak ele alınmaktadır. Bu çalışmada, tümü ülkenin müzecilik tarihinde önemli bir yere ve mirasa sahip olan ve aralarında rasyonel bazı ortak noktalara sahip üç farklı müze karşılaştırmalar ile analiz edilmiştir. Sonuçlar, bazı müzelerin mevcut sergileme düzeni olmadan daha işlevsel ve anlaşılır olduğunu, bazılarının ise bundan hiç etkilenmediğini ortaya koydu. Bunun yanı sıra, galerinin uygulanmasıyla birlikte keşif ve hareket kalıplarının çoğu yerel ölçeğe kaydırılırken, hepsinde anlaşılabilirlik düşmüş ve küresel yapının okunabilirliğinde genel bir azalmaya neden olmuştur. Son olarak, bazı benzerlikleri ve anlatı yapılarını paylaşmasına rağmen, her müze, genel deneyimi değiştiren tüm önceki faktörlerden etkilenen farklı bir deneyim kalitesi üretti. Çalışma, optimum tasarım amacı için hangi unsurların kullanılabileceğini göstererek, bu verilerin gelecekteki yenilemelere, yeniden düzenlemelere ve hatta perspektif genişletme projelerine rehberlik etmesi için kullanılmasını önermektedir. Bunun da ötesinde, önce sahada doğrulanarak bu bulguların üzerine daha fazla inşa edilmesi ve ardından daha müzeolojik veya mimari bir odaklanmaya doğru genişletilmesi tavsiye edilir.

Anahtar Kelimeler: Müzecilik, müze geliştirme, ziyaretçi deneyimi, mekan sözdizimi, sergileme düzenlemesi; Mısır.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

EMC:	Egyptian Museum of Cairo
ICOM:	International Council of Museums
MIA:	Museum of Islamic Art
MoMA:	Museum of Modern Art
UCL:	University College London
VGA:	Visibility Graph Analysis
UNESCO:	The United Nations Educational, Scientific and Cultural Organization

CHAPTER 1
INTRODUCTION

1.1. Overview

For a long time now, the field of museum studies had undergone various changes and development, starting from witnessing some of them change from monument to an instrument (Lu, 2017), or in other words a "machine for showing art" (Serota, 1998, p. 32), showing the shift in the world of museology that oscillated between prioritizing functionality or the aesthetic of the museum space (Macdonald, 2007). However, the main cultural and social role of a museum as a place where people go to view and engage with the exhibits still remains a function to this very day, and in order for the visitors to achieve this, they have to traverse spaces that are either guided or determined by the physical structure of the space or the object arrangement of the gallery as the experience is always related to those two aspects within a museum (Sirefman, 1999), whether it be a classical, renaissance or a modern style building.

Over the years, the two fields have been integrated together after the recognition of architecture and its effects on the museum experience, this effect was embodied in the spatial layout of museums and the spatial relation of each individual space with each other and the whole, this wasn't yet a dedicated field until the rise of Space syntax that was pioneered by Bill Hillier and his colleagues at UCL to understand the relation between the built environment and the social behavior of the visitors or commuters of the space (Hillier & Hanson, 1984). Space syntax relied on syntactic variables and tools that facilitated and further explored the potential of the built environment and represents it in a form of graphs or scatter diagrams, Some of the main component of space syntax has been developed and pioneered by Hillier & Hanson, (1984), as the axial map, which was later developed on by other researchers like Turner and Penn (2005), other key tools include the isovist, introduced by Benedikt (1979), which is a syntactic measurement tool that provided a description of the surroundings from a specific point within the space, as well as the convex map that was developed and explored by Bafna (2003), and finally one of the main tools that facilitated

this study, was due to the introduction of agent-based simulation by Penn and Turner (2001), which was primarily used to predict peoples movement in different settings like traffic congestion, crowd control as well as the social function of buildings layouts. This constant development reflected the high level of interest amongst researchers in the use of advanced tools to further understand and evaluate the spatial behavior of visitors in a built environment (Nubani et al., 2018).

Space syntax and syntactic analysis techniques shed light on the strength of spatial configuration in determining visitor movement and exploratory pattern (Choi, 1999; R. Li & Huang, 2020; Tzortzi, 2015), and also contributed to examining different design alternative like for the Tate Britain Museum (Dursun, 2007), this reflected that a more cohesive global structure improves intelligibility within the layout. Furthermore, space syntax developed a link between the social science and architecture by analyzing the relation between the spatial layout and the museological intent (Tzortzi, 2011), as well as showing the effect of exhibition arrangement and its control of visual field and accessibility to generate movement and interaction with the exhibits, while maintaining the intended narrative (Peponis & Wineman, 2002; Psarra, 2005; Zamani & Peponis, 2010), highlighting the amount of knowledge the designers can be armed with, when designing, restoring or renovating a museum building to match the full extent of their design intention.

1.2 Background of Research Problem

Egyptian Museums has gone through a lot of issues and difficulties through the ages, the history of museum development in Egypt is defined by colonialism and imperialism until the twentieth century, where Europeans mainly France and Britain, created museums to preserve and house some of the excavated artifacts, that was mostly dug out by foreign campaigns (Mahmoud, 2012), The foreign influence within the Egyptian museums, Egyptology and a various part of museology, constitute a major part of the issue that hold traces in today's museums, where the western-style architecture can be seen from the building façade, as well as the curation style that adopted the European standards. The National Museum of Antiquities, currently known as the Egyptian Museum of Cairo is one of the most known examples of such cases (Fjerstad, 2007). Which for a long time stripped

the locals from the power to represent their history and their culture, which due to some rebellions and outcries against the foreign administration of the museums and artifact monopoly, that is said to have halted various other museum constructions, and development in the area (Mahmoud, 2012).

Other than the outside influence, and after the total independence in 1952, the Egyptian government suffered from some internal issues of their own financially and politically, that halted so many projects and developments in the field, and due to a low educational level in museology due to the non-existence of the field in Egyptian universities aside from Egyptology and also due to restrictions applied on the field by the Europeans that was in charge at the time, the nationalist movement expanded excavations and exploration but didn't have enough knowledge on how to preserve and exhibit those artifacts thus leading to them ending up in museum buildings' basements (Hawass, 2005), however on the longer-term some laws were put in place by president Gamal Abdel Nasser, to kickstart a more protective future for the Egyptian excavations and antiquities (Mahmoud, 2012). This notion was followed by a set of plans to improve, and redesign and modernize some of the museums like the Egyptian Museum, Islamic Museum, and the Coptic museum in cooperation with UNESCO, however due to financial and budgetary issues, most of the projects were abandoned in different times (Okasha, 1988).

1.3 Statement of Research Problem

This Thesis has been inspired by the recent interest in museum development in Egypt, that has recently witnessed the inauguration of the National Museum of Egyptian Civilization which is kilometers away from one of the cases that have been discussed in this thesis , and currently awaiting the opening of the Grand Egyptian Museum which is said to attract all eyes on Egypt, amongst multiple other museum projects that is underway throughout the country (Hawass, 2005), due to this, older museums are expected to be renewed, reorganized, or even expanded with new additions in the near future. Therefore, in order to do that, it is important to clearly identify the current spatial characteristics of those museums along with the current object arrangement, in order to create the ground work for the architects and curators that will be in charge of such tasks making it easier for them to

identify drop backs in the layout, and utilize the full capabilities of the configuration to achieve the most of the desired approach. In conjunction with the rise of new technology like Space syntax that can be used to test out layouts and predict its impact with cost effective approaches, and also acting as a benchmark for future museum designs in the country to be compared with it, and try to be a first step in setting up a guideline that properly presents the Egyptian museums in a way that creates a good spatial experience that adheres to the characteristics of the exhibits that doesn't only present artifacts that reflects the history of Egypt but it is a heritage for the whole world (Hawass, 2005).

The cases that have been analyzed in this paper have never been researched before from a spatial perspective, nor does it have been compared with each other to measure the different impact each design has on the experience of the visitors, whether spatial, or semantic before. Extending the stretch of this study to try to assist in revitalizing museum experiences even with the help of the display arrangement, which can be a vital tool for older, and more structurally vulnerable museums.

1.4 Aims and Objectives

This thesis aims at analyzing and comparing the different quality of experience offered by the spatial and semantic layouts of three different Egyptian Museums, which would set the ground stone for further research on the matter, with aims of improving the experiences in the current museums, as well as set guidelines for future museum developments and renovations.

The thesis followed a list of objectives to help structure an organized approach of achieving the aims:

1. To analyze and characterize the spatial configuration of each Museum layout individually;
2. To map and compare the layer of the spatial arrangement with the raw spatial configuration of the layout;
3. To evaluate and compare the cases together to identify the quality of experience created by each one;

4. To propose effective approaches for the future actions to undertaken in terms of layout design in Egyptian museums and aid in the future plan of museum development in the country.

1.5 Scope of the Research

This thesis has aimed at analyzing the spatial configurational structure of three cases in Egypt, each possessing a list of similarities and differences amongst each other, whether it be the date of construction, layout, administration, curatorial approach, exhibit theme, or museological principles at the time. The Scope of this thesis will focus on analyzing and discussing the spatial/ architectural aspect of museum design and its effect on movement and experience, avoiding profound discussions related to museology, like the type of artifacts in store, or how the exhibits are being displayed, and other elements like lighting and the educational message. Instead, this thesis will concentrate on analyzing and comparing quantifiable results that can be obtained while analyzing the spatial configurational structure of the three cases in question, each of which are possessing a list of similarities and differences amongst each other, whether it be date of construction, layout, administration, curatorial approach, exhibit theme, or mesological principles at the time, Moreover, The study will be limited to analyzing the current layout without proposing any further design alternatives, as it will further expand the scope and extend the study further.

The Study is also focusing on Museums that the author believes, based on recent literature has the possibility of improvement or can be flexible in terms of display arrangements, some of the excluded museums include the Greco-Roman Museum as it was noticed in the beginning stages that it possessed a strong sequential movement within its layout, presenting a very little area for improvement, another case being the Coptic museum which is properly documented however the museum is divided on three floors, making it harder to follow the same criteria of comparison that covers only one floor of the museums, aside from being sequential as the former case.

This thesis was made possible by the advancement in technology that led to the rise of space syntax technology that has been employed in this study to analyze the spatial configuration

of the museums, on its own first as to identify the raw characteristics of the space, and then compare it with the current exhibition layout, to first identify how the object arrangement affects the spatial layout and exploration, then the study has aimed at comparing the three cases together to identify how the three cases and their spatial layouts affected the overall experience? and facilitate a discussion of what can be the elements that contributed the most to each of the results? while suggesting and recommending future actions to be taken in terms of the design layout and future researchers in the discipline.

1.6 Limitation

The study has been limited by certain things, primarily the worldwide pandemic lockdown that imposed flight restrictions as well as the closure of so many facilities including cultural buildings, this reason limited the study to a more computerized approach that relied on simulation in place of the more typical approach that involves visitor tracking and observation, that tails visitor movement and stop times as well, however as will be explained in the methodology the approach employed was reported to present 55% correlation with the actual movement of the visitors in a given space (Penn & Turner, 2001). Moreover, the thesis has been done on only three cases, those of which their information was found in open-source websites, or they had properly documented history, and for some virtual tours and 3d layouts were constructed compared to various others where little to no information was available. Besides that, the paper is limited to analyzing the museum's existing spatial configuration as well as the current exhibition setup without proposing any further alternatives in order to maintain a narrowed down scope of the paper, and this analysis has followed the descriptive methodology that is supported by quantitative results; therefore, no surveys or questionnaire has been taken for the results of this paper.

CHAPTER 2
MUSEOLOGY DEVELOPMENT

2.1 Rise of Museum Studies

Museology is a discipline that revolves around the study of museums and all that surrounds them, like their history, philosophy, how they came to be established, any further development, their aims, policies, educative role or aim, and their social role as a public space (Vergo, 1997). Its definition varies from one country to the other, mostly related to all museum-related topics. Museology comes under too many different terms, most of them used in an academic setting, for graduate level studies, or for museum staff and management. All Museums though follow the standard definition set by ICOM in 1971 that enforces the theoretical and practical interest in the field. ICOM, or international council of museums established in 1946, to preserve, maintain and develop museums and encourage and improve advancement in the discipline, theoretical and practical. The word museology derives from Logos which means study in Greek, and Muses which means goddess in Greek (Choe, 2004). Since the day museums existed and there has been unprecedented developments in the field and those changes required development in the studies side of it, theoretically and practically. The theoretical aspect refers to professionals and the ethical part of the field, and practical aspects deal with the elements that form the museum's collection (Desvallées & Mairesse, 2010).

The development of museology was kickstarted in Europe after the new technological advances that were being invented and done. Those advances were needed to help the curators and private collection owners know how to preserve and display their collection but it also gave rise to exotic artifacts mania that encouraged colonist countries like France, Britain, Italy, and others to bring back what they find or loot, and in our case, Egypt suffered a lot from this aspect transferring around 7000 antiquities in 1852 (Murray, 2007). One of the milestones that define the 18th century was making the museums accessible to the public, and so increased the interest in museology, and its development (Maroevic, 1998). Following

the effect of evolving studies in the field of museology curators in museums like the louver and the British Museum were encouraged to try new display approaches (Reid, 2003).

ICOM and several other schools have been shaping the improvement of museology, by emphasizing it as a science that is designed to determine similarity and differences, on one hand, and between the more theoretical aspect of it, like science, culture, history, society on the other (Mahmoud, 2012). The first major steps were taken by the Reinwardt Academy in the Netherlands, which was opened in 1976, that introduced significant findings integrating the theoretical part and the practical part of the studies together, that showed effects drastically in the field.

The traditional museology as mentioned earlier mostly focused on the museums and their settings and was treated as a thing that is used to house the collection only, whether in a thematic arrangement, chronological and etc. (Šola, 1987). In 1980 France initiated development in the field that reach worldwide in 1984, termed the new museology. This new museology focused on the social role of museums and adding new expressions approaches and new ways of narrative structure, bringing to light topics like the development of communities, educating the public, and creating a museum setting that has a future vision (Desvallées & Mairesse, 2010). Development that started in the west slowly reached the other side to the developing countries, following the footsteps of Europe, however some managed to develop their own museums by implementing traditional knowledge and proper access to technology, like Taiwan, Japan, and etc. However, unfortunately, In Egypt due to political issues and the enormous foreign interference in the region during that time, the government was not able to develop any museological programs of their own until a century later at the beginning of the 20th century, after the colonist had left and the foreign administration left way for locals to take charge, however, unfortunately until now, there still seems a great tendency to imitate what is usually done by the westerners, and this is to be analyzed in our cases.

2.2 Comparative Museology

Comparative museology is an extended field of museum studies that focuses on analyzing similarities and differences among museological forms, collections, and culture and their effect on museums and their displays (Kreps, 1988). Comparative museology came into being after the number of museums and museum practices increased after post-colonial times, resulting in the rise of new types of studies and curatorial approaches that emerged from all over the world, this field acknowledged the different types of museological approaches that started to take place worldwide and the realization that the western curatorial principles or museum concepts are no longer the standards or the must be followed approaches(Kreps, 2007), those changes can be mostly seen in formerly colonized countries like Egypt, and how some museums adopted a different style approach for their buildings and their display arrangement decision, this argument will be discussed in the following chapters. It was for a long time determined and deduced that trying to have all museums follow the same mold or standard, resulted in a display that disconnected the artifact from its setting, which weakened the cultural link with the locals and became a counterproductive approach (Macdonald & Silverstone, 1992). One of the primary goals of this field is to primarily set the foreign cultures free from the Eurocentric standards, and also help in liberating peoples' scope in the field of museology and encourage them to explore their own culture and its effect on museology (Kreps, 2003). Even though this is not the main aim of the paper, the paper will be discussing and analyzing the underlying effects of the European influence in Egyptian museology.

During the mid-twentieth century an increasing innovation took place that shaped the museum reality, those changes included from among many things the change in the museum building typology and the deviation from the neo-classic styles that started with the Glyptotek museum in Germany and rippled all across the world leaving a trace that can be seen almost in all former colonies, Egypt included. At first, the distinction was noticed based on geographical categorization, Brawne (1965) made some presumption on some museums trying to categorize them, stating that the Scandinavian museum design that highlights the natural aspect of the civilized life, that is opposite to the Italians approach that focuses on the display techniques. Other characterizations that were made, was the categorization of museum buildings done in countries like France, Germany, Austria, and Switzerland, that

have the tendency to create a neutral space, that would make it highly flexible in use. Another distinction was made by (Levin, 1974) which was based on two concepts: the museum as a temple, that not only includes neoclassical museum styles that look like temples instead any museum form that was designed with the aim of enshrining art, as in the case of the Guggenheim Museum in New York. And the other concept is the construction of the museum as a showroom that is reflected by the commercial type of the building as in the case of the Museum of Modern Art (MoMA) in New York. Since then, comparative museology has developed another branch that focuses primarily on the distinctions between museum buildings, which mainly stemmed from architectural and spatial qualities, this branch will be the primary focus of this study, using it to clarify the spatial description of the museums and understanding the overall effect on the visitor's experience.

Across the years, plenty of adopted the architectural criteria when comparing museums, most of which once again categorized the museums' styles but this time based on their spatial layout, first is the *museums that have traditional enfilades*, and the second one is identified as *open plan museums*, other criteria defined was the type of *museums that recycled old monumental buildings*, and lastly *a museum as a sculptural architecture*. From each type a set of spatial characteristics has been identified and developed over the years, one of the main spatial characteristics that were characterized first was the central courtyard, and the surrounding galleries, done first in the project for a museum by J.N.L. Durnad, which saw other museums follow on the same spatial structure with some alteration, i.e., of the Gypotek in Munich and Altes Museum in Berlin. After years of innovation, another spatial structure was adopted, which is the central top-lit space, and the sequence of spaces where visitors travel across and successively encounter various exhibits, as in the case of Guggenheim Museum (Tzortzi, 2007).

The open museum type was said to be derived from the crystal palace, in London, that set up the notion of transparency enclosing open spaces, that Searing (2004) stated this caused a change that relocated museums from palaces and temples to a simple box that has the main function of acting as a container space for the exhibits, a clear example of this would be the Centre Pompidou in Paris, which highlights the concept of flexibility in a museum.

The adaptive reuse of monuments into museum types was one of the first employed techniques that mostly started in the conversion of royal palaces, and it was better demonstrated in the Louvre as one of the famous examples (Von Moos, 2001). This museum type was assumed to be stated in the 1970s, and it went to be the most common approach in the world of museology, known for famous structures like the Tate modern, Hamburg terminal in Berlin, those approaches were intended to avoid the upstaging of the built museums of the artifacts and maintain the focus of the visitors on the main aim, which is view art (Tzortzi, 2007).

The fourth type, which is the museum as a sculptural architecture, this type of museum design flourished in modern times and was mainly inspired by organic shapes, which is best represented by the Guggenheim Bilbao. Those kinds of museums always sparked different views on the spatial structure of those designs. Von Moos (2001) viewed it from a perspective that highlighted an innovative approach in the construction of the spatial layout, creating organic and expressive forms that defies the traditional concepts, while Von Naredi-Rainer (2004) stated that even when some of those museum buildings are referred as "Plastic Architecture" that disregards so much of the traditional architectural principles, yet they still house some rooms that follow the traditional sequential exhibition rooms on a rectangular plan. This type of formal comparative criteria doesn't allow for a clear understanding of the museum's functional distinctions, but it helps to clarify and highlight the idea of common spaces in the spatial layout, where people would return back to a certain spot after or during their visit, which is fundamental to their functioning. Comparison between museum spaces has been identified as a hard task, as any museum space can be viewed from a deeper perspective as the statement by Rainer and it can render the classification invalid (Tzortzi, 2007), so a shift was made towards analyzing the configurations and its effect in circulation as it is widely acknowledged that movement across space is directly related to the overall physical structure of the space (J. D. Wineman & Peponis, 2010).

2.3 Museum Design and Circulation

Previously, whenever museum studies were mentioned very little discussion was done on the spatial layout and its effect on how people explore the space, it was mostly focusing on

the museum building as an envelope of content, and all the different categorizations that followed. However recently a rise in the literature research on museum circulation, shed light on the key link between the spatial configuration and how it influenced movement/exploration within the layout. Some museums that had their route define the whole museum design, for example, the Muse Mondial by Le Corbusier designed with the square spiral ramp, also another design by Le Corbusier was the conceptual design of the Museum of unlimited growth, In addition to the Guggenheim Museum and its spiral ramp (Brawne, 1965). Several authors have stated that circulation design in a museum is usually structured around a concept that determines the visitor's exploration and movement patterns (Kaynar, 2010). In the museums' circulation literature a term will be seen a lot, which is the word 'itinerary' which originated from a Latin word meaning journey, underlying that the importance of constructing a conceptual idea of a route is like constructing a discovery route through a story, which is the museum building and its content (Tzortzi, 2007).

2.3.1 Spatial Influence on Visitor Movement

Visitors' movement in museums has been primarily analyzed and measured from exposure to objects point of view, Objects were organized and displayed in a specific concept whether chronological and geographical or as a stylistic distinction, which didn't utilize the space element only the classification element of the exhibited objects. However, the spatial layout adds the element of physical realization to the classification principles or techniques mentioned earlier to facilitate understanding of the collection (Peponis & Hedin, 1982). Only when a visitor starts to explore the museum buildings is when they experience the spatial arrangement of objects. Different spatial layouts provide different results in terms of accessibility, other viewing routes can be structured in a way that forces the visitor to a specific destination restricting circulation choices (Choi, 1999). Within the literature 4 types of circulation patterns were noted with some level of consistency: first is the *sequential viewing pattern*, the second one is also a *sequential set of spaces however it allows for some other choices,* then thirdly, *the matrix circulation pattern (Constructivist exhibitions)*, and finally the spatial layout that became popular recently, *the free plan circulation* (Tzortzi, 2007).

Sequential viewing patterns started with the compliance of a spatial arrangement that required the creation of a sequential viewing order of exhibits. Most of these layouts were commonly found in reused monumental structures where the visitor would find long and narrow exhibition spaces, which back at the time was the ideal way of presentation and viewing experience. This time of exhibition arrangement remained popular until the nineteenth century however this approach still remains to be employed, yet with different variations or a mix of other arrangements employed. Some of the most recent examples of this arrangement style are the famous Guggenheim museum with its spiral arrangement of spaces, and the linearly connected corridor spaces at the Louisiana Museum in Denmark, even though they might sound totally different in terms of their layout properties they spatially equal, as their spaces are organized in a way that structures a continuous movement (Brawne, 1982).

The second type that basically comprises of the first type however with a degree of choice was first seen in the Alte Pinakothek Museum in Munich, which basically had two parallel sets of spaces that are linked at several intervals to distribute movement towards the main galleries. This style was further developed under the aim of creating autonomous exhibition rooms, ones that can be directly accessed from the main circulation route, and to avoid forcing visitors to pass through it to reach another room (Tzortzi, 2007). A recent example of this would be the Kruller-Muller museum in the Netherlands, which provided a sequential route while also offering a more selective route that branches from the main axis to other auxiliary spaces (Brawne, 1982).

The third pattern which is the constructivist viewing pattern is the kind of space that is connected like a network with no dominating main arteries or directions and offers an alternative route to reach any point in the layout. Some has argued that this spatial layout can be too complex for visitors to comprehend that they will be confused or they will lose track of their route (Von Naredi-Rainer, 2004), while on the other hand, some argue that this layout approach free the visitors from the curator's control, and allows more freedom for the visitor to explore the alternative route, where they are expected to miss out on some elements, therefore creating their own understanding of the layout (Black, 2012).

And finally, at the opposite end, there is the fourth pattern which is the open-plan circulation, where the visitor has no constraints on any sequence, and the visitors have unlimited options of routes or patterns to take. The free plan circulation is produced by installing movable panels, and the artifacts themselves, that structures the spatial layout of the exhibition space (Tzortzi, 2007) Visitors in those kinds of environments has been observed to orient towards more accessible spaces, and exhibits that are more visually organized and grouped, that can help them construct their own understanding, Moreover the open-plan layout can have some curatorial constraints by applying thematic grouping in order to channel movement into a specific direction yet leaving the choices of randomness if wanted but constructing an underlying systematic viewing pattern that would reflect the curator's vision. Movement pattern observations in those layouts reflected also that the most accessible spaces got more visitors, as they can be seen from various different spots and it was followed as a practice that the important or the key exhibit elements be placed in locations that are accessible and visible from different points in the layout to increase the chance that they will be visited (Dos Santos Coutinho et al., 2017; J. D. Wineman & Peponis, 2010).

2.3.2 Social Dimension of the Museum Visit

Based on some of the literature, Museum visits weren't only limited to the physical effect of the layout on the visitor's movement pattern and route choices, or the strategy of object exposure. Various authors have highlighted that museums now have a secondary function that is a byproduct of the first which is the social effect (Tzortzi, 2011), which incubates the two overt functions of circulation and co-presence (Tzortzi, 2015). This dimension is observed as visitors are exploring the layout, and in the process, they become aware of each other. This has added a layer of museum visits where the visitors come to observe objects and be seen by other visitors (Choi, 1999). It has been shown how the spatial layout facilitates social encounter and enhances the social aspect of the visit, as they bring the visitors together in different locations within the layout, this social dimension enhances the sense of co-presence and co-awareness which was argued by Peponis & Hedin (1982) to increase the socialization of people into knowledge.

Previous researches highlighted some key points that were observed in relation to the social function in museums. One of the prominent observations was done at the Pompidou, where the results showed that within the layout the visitors were separated at some junctions along with their visit, but due to the layout structure they may re-encounter again at the main axial corridor that links to all the secondary halls, this layout due to the presence of a main axial link, increases the probability of re-encounter which in turn increases the sense of being together with other people, which is a fundamental aspect of a museum visit (Tzortzi, 2011). Another example is of the Guggenheim museum, where the layout integrated both aspects of museum visit together, viewing exhibits and seeing other people in one place, as Peponis (1993) stated this layout produces a route that creates 'a built choreography of movement and encounter'. Also, the Pompidou exemplifies these characteristics even more by uniting the people who are in the exhibition or within the building layout see and be seen by the people using the piazza, Peressut (1999) metaphorized it as the visitors in the Pompidou being the performers on stage and the people in the piazza being the audience. On the other hand, museums that limit circulation or identify as the type of layout that exert sequential movement pattern like the Tate Modern, where visiting group tends to start together and stay together along the whole visit, appearing in a way to be efficient in the organization of space and assuring that all spaces will be visited, yet it was found to be less socially exciting, as the link between global and local movement is not existent and the effect of re-encounter is no longer applicable in this stage as in the former example of the Guggenheim and Pompidou (Tzortzi, 2011).

2.4 Space Syntax in Museology

In order to analyze the underlying effect of the spatial configuration on the visitor's movement and exploration pattern, researchers have applied the space syntax theory, which was developed by Bill Hillier, this tool will be the tool of choice for this study, and in the next chapter, the methodology will be explained thoroughly. But before that, the study will cover the literature related to this topic that will help towards building a good understanding of all former researchers and findings, especially that space syntax has drawn a lot of attention to the importance of space and its effects on the museum experience.

This interdisciplinary research focusing on the effects of spatial configuration on the exploratory pattern has been done before in several studies. Starting with the most prominent and significant one. First of which to be done on museums was made the research made by Peponis & Hedin (1982) which was done on the National history museum to apply the analysis on two of the existing exhibition spaces, measuring their descriptive properties and the underlying issues of transmission of knowledge. The article compared the Birds gallery and the Human Biology Hall, The Birds gallery didn't change much since the construction date, while the latter has been renovated to house more advanced exhibition techniques, like diagrams, models, video projections and therefore the spatial layout has slightly changed due to the changes in the spatial object arrangement. The Bird gallery is organized along a straight corridor with a very shallow depth, where all the spaces are organized are arranged on either side of the aisle at right angles, while the Human Biology Hall is organized in a sequential exhibition that offers choices, which means that in order to reach some spaces the visitor must path through other points in the layout, and therefore the depth within this part of the complex varies between two to three spaces, which makes it deeper than the Bird Gallery. This difference in the layout has a different effect on how people use the space, In the case of the Birds gallery, the visitors have easy access to all parts of the gallery as it is easily visible from the central aisle, which gets people to slow down and observe their surroundings while the Human Biology hall is so interwoven that objects blocks the visitors exploration way, and deep within this gallery exists an axis that connects all the gallery parts together but it is not integrated with the global structure of the layout, making it hard to comprehend locally and globally. The results show that the Birds Gallery has the kind of a layout that embedded knowledge scheme in its spatial form and was able to achieve a proper classification which makes it easier for the visitor to identify the category within this gallery boundaries as it doesn't lie on any other ring circulation routes or have so many boundaries that weaken the categorized theme resulting in simple arrangements that make all the displays syntactically equal. While on the other hand, the Human Biology Hall results showed that the axial fragmentation makes it hard to grasp all the spaces from one point, which gives those spaces a more suggestive approach to the visitor, in which they decide where to go next, so the attention changes from focusing on the space itself into what link does the objects in the other has with this room. Therefore, the focus shifts to the spatial object arrangement and the classificatory approach employed to organize them, resulting in

an individualized visit for each visitor. The overall message intended by the paper is to show that space can play a part in the transmission of knowledge by the articulation of the space, and becomes an active member in the structuring of the social element of space (Peponis & Hedin, 1982).

Another study was done by Tzortzi (2003) on the Sainsbury Wing, which focused on analyzing the spatial layout of the exhibition and its relation to curatorial intention. The study showed that visitor's movement was justified by the spatial configuration, where visitors relied on the local structure of the layout more than the global one. This study also explores the powerful use of the spatial arrangement of objects, as they are placed in a way that complements the powerful axiality of the spaces, where visually appealing and eye-catching paintings would be placed at the end of a long axial space. This approach made it possible to break away from thematic arrangement or categorization, in a way where visitors would see different paintings of the same artist in different rooms but look visually connected. It is however has been argued that exposing artworks from such long distances can deprive the visitor of the sense of discovery in their experience, and could result in a rush of information that is received and has to be comprehended in every turn. The study results show that even when the configuration can interfere with the curatorial intent, they both produce a successful space that doesn't aim to develop a special connection between the visitor and the art, however, it aims at creating a more general emphasis on the global aspect and developing a relationship between the exhibits and the people (Tzortzi, 2003).

Another well-known research was done by Dursun (2007) focused on the application of space syntax in the design process, and its effects on the design process, by focusing on the design and studying its effects to reach the desired result. This paper was one of the first that try to understand the underlying social meaning of space, the first analysis was done on an urban scale on the famous Trafalgar square, where the aim was to improve the public space network of the pedestrians, the results showed that with the help of space syntax they were able to see the problems of the area, and monitor the people's usage of space that enabled them to create a more walkable, and accessible square. Our main focus from this study lies in the analysis done on both the Tate Britain and the British Museum. First, in the case of

the Tate Britain, the aim was to develop a new extension for the existing building, and the author was appointed to find out the best layout proposal and how it will affect the overall integration, besides using space syntax, visitor tracking also was employed to first analyze the people's visiting pattern to input it in the system and use it to predict visitor's movement in the proposals. One of the startling findings was that visitors tended to prefer the left side of the building that looks symmetrical, even in the presence of a strong central axis. Then after applying space syntax on the three proposals, the third one was chosen as it was the one with the most ineligible layout and created a good connection to the core that would derive people deeper into the layout while still being able to comprehend their position in the whole complex. This study showed them that by analyzing the design before construction, the designers had the chance to evaluate and develop their ideas based on the evidence they got from the analysis. The third and last case in this paper was to analyze the effect of the central hall designed by Foster in the British Museum, and from the perspective of how it functions in the overall layout and how does it play a role in the structuring of the social factor of the experience, and how does it affect visitor's circulation. The results that a modified proposal of the original one done by foster, created a more intelligible structure as it has a combination of long axial lines and circulation rings which provides multiple choices for movement within key locations. This paper highlighted the importance of using space syntax in the design stage or in the renovation stage as it provides an evidence-based approach for the designers to see the effects of their design in real-time while providing quantifiable variables that can help in developing their proposals (Dursun, 2007).

Another study by Choi (1999) had the same aims of trying to understand the relationship between the spatial structure and the visitors' movement pattern of exploration and encounter, in this study the author choose to do the analysis on eight different museum configurations. Each of the configurations was selected based on whether they had an exhibition pattern of clearly defined rooms or a free plan, whether the circulation pattern is sequential or grid-like. Results showed some varying results first of which that the number of people observed in a given space has no relation to the configurational properties, moreover, within some layouts number of observed visitors correlated with the local pattern or the connectivity variable in museums. However, another analysis amongst people visual from surrounding convex spaces, showed a correlation with the number of people visible,

not only in the local structure but also in the global setting. Moreover, a high correlation was found between the number of people observed in spaces that has a vision to other convex space where exhibits were visible. Connectivity and visitor frequency showed a correlation amongst them. Integration on the other hand had little effect on the tracking score compared to the local network. The paper concluded that amongst all the layouts, they can be distinguished into deterministic and probabilistic and that visitors' itineraries can be organized and controlled by adjusting the syntactic properties. And those curators and designers can use those data to work and develop layouts and infer the possible experiences, that visitors would go through.

Tzortzi, (2011) measured different museum spatial patterns in order to see how different layouts affect the delivery and the realization of specific messages or effects, the articles go on to compare two museums that seemed similar in scale, function (as in the type of exhibition) and acquire equal urban setting being an urban landmark in their respective cities, those two cases were the Pompidou in Paris and Tate Modern in London. Besides that, another comparison following the same approach was done on the two cases of the National archeology museum in Athens, and the New Acropolis Museum in Athens. The first comparison showed that the layout of the Tate modern was one that was set to present, and focus on a more appreciation of the artworks, as on the global scale it managed to even out the probability of being in any of the exhibitions, however, focused on having on equalizing accessibility of galleries, and minimizing the effort in reaching the galleries, and it created a sequential exhibition that gets people from here to there without thinking. While for the Pompidou the contrary takes place, the layout is not approached from a functional rigid point of view to full fill a task, instead, it is made in a way that contributes to the presentation of the collection. The layout merges the two elements of space and objects to attract and guide movement, which gives the gallery the property of representing opposite to presenting which happened in Tate modern, and those are the qualities that create a museum experience. The other two comparisons between the National Archeological and the Acropolis also presented some interesting findings. Starting with the National Archeological, the neo-classical layout analysis showed that when the main axial line was blocked it changed into a circulation ring that increased integration overall, moreover it showed that segregation of some exhibition areas doesn't necessarily mean less tracking score, as those exhibitions can be famous and

will attract visitors regardless of the integration level or its total depth within the layout, and finally due to the rigid structure of the space the analysis showed that the visitor circulation was display-led which means that the visitors throughout their itinerary are presented with choices that present objects that may or may not influence the visitor to enter the particular space. While the Acropolis on the other hand linked all the spaces indirectly with each other through distant views, however, the visitor is greeted with different views from each different spot, emphasizing historical sequence and giving a better understanding of the history and how it relates to the present. Moreover, the circulation pattern in the open layout spaces was recorded to be oscillating, meandering, and encircling, which reflected the Space-led behavior, that reflects the effect of space on the movement choices, and finally, the different cross-visibility throughout the itinerary plays a part in improving the social element of the museum experience for the visitors. The paper at the end concluded with some of the results where, it grouped them in spatial and museological classification and framing, differentiating between them and how each one achieved those different criteria based on its spatial layout.

The literature review shed light on the richness of spatial thinking in museology, one of the oldest studies which highlighted the parallel ideas in space syntax and museology, was the book "Space is the Machine" by Bill Hillier (1996). The most noticeable ones are the points that recognize that architecture has a direct effect on museum experience, not only in the physical form of closed spaces but also as a network of spatial relations, referring to a term called configuration (Hillier, 1996), which will be mentioned in detail the following chapter. Where the space syntax methodology will be introduced and explained along with the intended methodology that will be undertaken for our cases.

CHAPTER 3

SPACE SYNTAX METHODOLOGY

3.1 Overview

In order to reach the answers the study are looking for, the study adopts the quantitative approach of Space syntax, developed back in the 1970s by Bill Hillier at the Space syntax laboratory, at the University College London, to help in analyzing the spatial layout at different scales as a set of *configurations* of related spaces, and describing the relationship between each other and the whole, along with their effects socially and functionally on the overall layout (Hillier, 1996; Hillier & Hanson, 1984). Space Syntax focuses on developing and analyzing the relation between the users and their inhabited environment, those inhabited environments exist on different spatial scales: Urban scale, Neighborhood scale, and Architectural scale (Hillier, 1996; Hillier & Hanson, 1984). 15 years after his first research and teaching of the space syntax, Hillier alongside his colleagues at UCL founded the Space Syntax Limited London which became widely used in the practical world, in cases like the British Museum and Trafalgar square (Y. Li et al., 2020). Space syntax understands the language of lines and facilitates a good understanding of space layouts, in addition to examining peoples' movements by analyzing the spatial network in the space (Y. Li et al., 2020), that uncovers the underlying meaning of the social spaces, which generates secondary theories on the effects of spatial configuration on various social or cultural variables (Dursun, 2007).

3.2 Understanding Spatial Configuration

As mentioned earlier Space syntax is structured on the idea that the elements within a layout and how they function are not perceived and measured as individual spaces instead it is about the complex relations between the spaces between each other and the whole, and their effect, which is referred to as *Configuration* (Hillier, 1996, 1998; Hillier & Hanson, 1984). The configurational properties are not concerned with the size and shape of the layout; however, it is more focused on the overall location of space in the layout, or how does it influence

motion within it, more like an abstract comprehension of the space. For example, as shown below from the famous example by Hillier and Hanson (1984), they show that different connection amongst the spaces and the outside results into different configurations, The Figure 3.1a below shows a and b all connected with each other and the outside, which is labeled as space c, opposite to Figure 3.1b that has them connected to the outside and not each other, or where only one of them is connected to the outside, which means that you have to pass through a to get to b from c as shown in Figure 3.1c. This shows that from a syntactic perspective, space is differentiated by means of configurational properties and not dimension. But in order to understand and properly interpret this data a configurational language is to be followed (Tzortzi, 2007).

(a-c) Space a and b have different link with each other and space c

| (d) Symmetric and distributed link with space c | (e) symmetric but not evenly distributed relations with space c | (f) symmetric and linear relation with space c and each other |
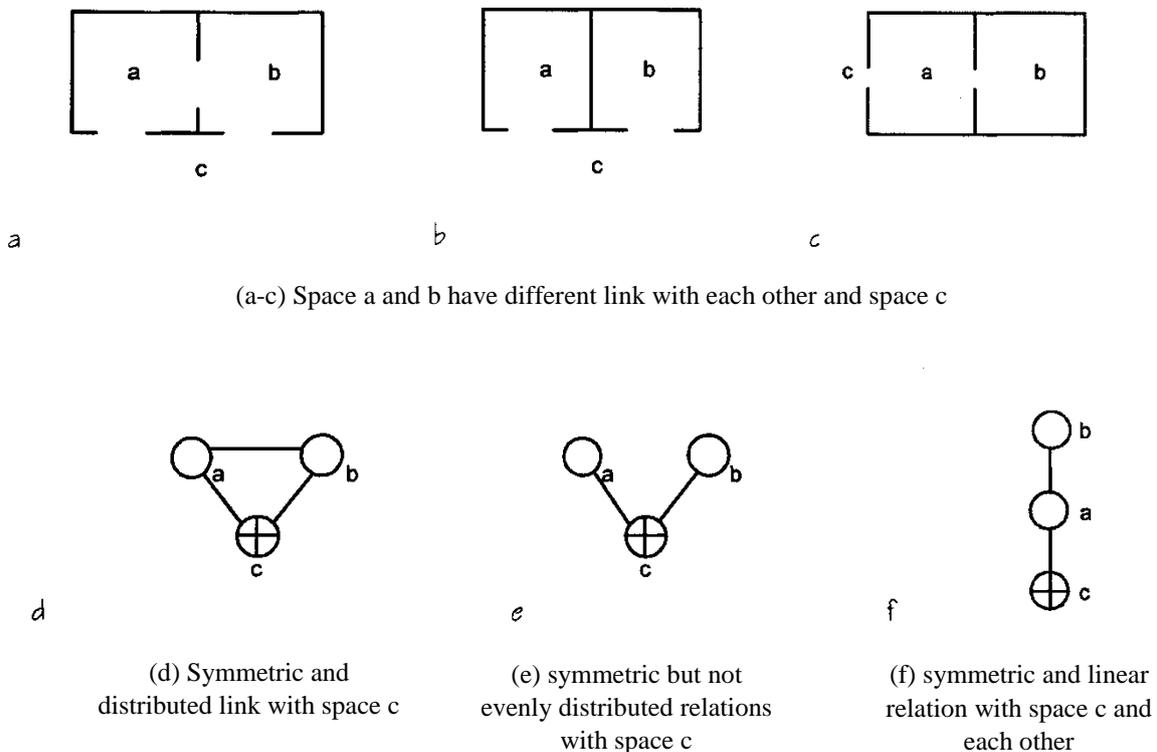
Figure 3.1: Showing the different configurational properties based on the variations of connections (Hillier & Hanson, 1984).

3.2.1 Representation of Spatial Configuration

First of all, configurational analysis refers to defining the spaces of a complex. And as mentioned earlier space here is not looked upon as a background setting, instead it is a fundamental element in shaping human behavior. So, in a way Space Syntax acts as a tool

that allows us to see space in a different light, it shows how people occupy the space, and how do they experience it as a part of their everyday life. Hillier gave an interpretation of how space syntax language defined a person's use of space: "People move through space in lines, interact with other people in convex spaces and experience space as a series of differently shaped isovist, or visual fields" (Hillier, 2005, p. 5).

Syntactic analysis employs three significant ways that identify the layout of a complex and represent it into spatial elements that visually represents the spatial configuration in the building as illustrated in Figure 3.2: (1) the convex map, which represents the fewest and the most connected spaces that are required to cover the whole complex, and (2) the axial map, which shows the longest straight lines that are needed to cover the whole convex spaces, it also reflects the relationship between the spaces on the global scale. Upon studying complex layouts like museums, it has been argued that it is effective to layer the convex and axial analysis on top of each other forming what is known as *convaxial* representation, where it shows the rooms that are linked to all other places that have a direct line of sight or a visual link (Tzortzi, 2007; 97). (3) the Isovist (or visibility graph analysis), which is defined originally from Benedikt's idea (1979) as the total area visible from one point, in order to explore a certain space varying points should be analyzed within the convex space, those points will represent all the visible areas from each point giving a more comprehensible understanding of the space, and their visual connection with each other (Choi, Y. K., 1998).


(a) Convex map   (b) Axial map   (c) Convaxial map
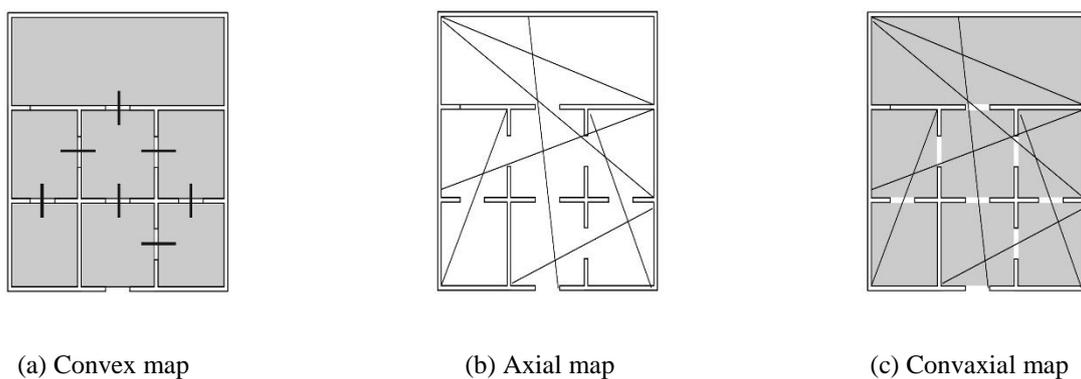
Figure 3.2: showing the different kind of maps used to represent spatial configuration elements (Author).

23

Spatial configuration as attested earlier are understood and represented visually, and one of the ways that can present them apart from the ones mentioned earlier is in the form of a graph, where the spaces are presented as nodes and the relation between them is presented as links. This is graph is known as a *justified graph*, as shown below in Figure 3.3, it makes it easier to visualize the difference between the spaces, by justifying or measuring the difference from a specific point, that is shown in this graph as the root, where everything stems upwards based on the other spaces connected directly to it or others spaces relations to the main root, the further they are from the main point the deeper it is from the root, as shown in Figure 3.3 (Hillier and Hanson 1984). Those graphs also reveal noticeable syntactic properties, for example, things like the symmetry and asymmetry of the layout, or the properties of *distributedness* and *nondistributedness* based on the number of routes branching from each space, also referred to as tree system, or whether it creates a ring of circulation, which is referred to as ring system (Tzortzi, 2007, p. 99). Those terms and ways of reading the graph will be highly important when interpreting museum spaces.

As mentioned earlier the idea behind spatial configuration stems from measuring the different spatial properties of each space with the layout, and see the different relations each other has amongst each other and the whole (Hillier et al. 1987a; Hillier 1996, 2005). A very famous example made by Hillier to explain this notion goes as follows: By using a simple layout like in the Figure 3.3a, b below **,**and mark with a grey space where it is intended to measure the depth of each space in relation to this space, starting by marking the grey zone with zero (for 0 depth) and then it will show how many different spaces do you have to travel through to get to each other different space, and the further it gets the higher the number is, for example in Figure 3.3a there are 4 spaces that are one space away so marked with 1 and 3 spaces 2 spaces away and so on. Adding all the spaces together provides an idea of the depth of all spaces in the layout from the grey point specified earlier. In other words, the total depth of this particular point to the surrounding spaces is 16. One way that can ease in the understanding of this, is by visualizing the layout in a justified graph that clarifies the concept of depth, which is a key syntactic measure that will facilitate our understanding of our cases in the next chapter.
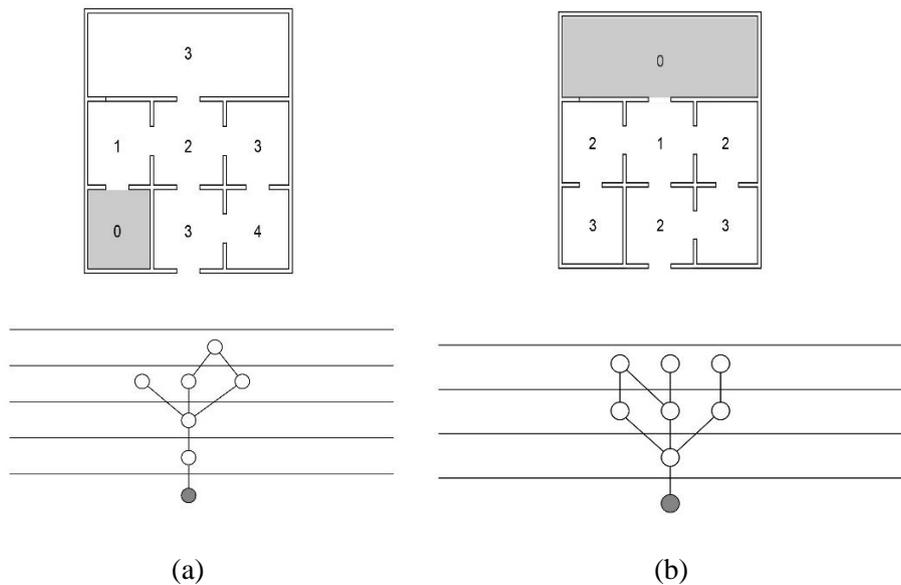
Figure 3.3: Showing the different spatial relationship with respect to different points with the layout. Simplified by plotting the justified graph below each layout (Hillier, 2005).

When using a justified graph, it can classify each space with identity, depending on its location within the local context, which means the relation to each other's only. As shown in figure 3.4a each space is labeled in different letters, where an *a*-space are dead ends that have no further connections. Secondly, *b*-spaces are kind of spaces that usually lead to a dead-end or multiple dead ends, meaning that they have multiple connections as well, however, most of them channel back the same direction. Moreover, *c*-spaces are the ones that have 2-connections with other spaces, and are a part of at least one circulation ring, so movement doesn't have to come back the same way it went. Finally, d-spaces are spaces that has more than 2 connections and lies on two major circulation rings, and provides more alternative ways back, mostly known as a gathering space and a movement space. This kind of analysis is usually known as space type analysis (Hillier, 1996; Hillier & Tzortzi, 2007; Tzortzi, 2007). One simple way to use this analysis to interpret graphs can be shown in the figure below it shows in Figure 3.4b, c, where it can show the two extreme examples of layout commonly found in spatial layouts of museums, the first in Figure 3.4b shows the layout that dictates a similar sequence for everyone and in the same viewing order, this approach is usually done by curators to dictate a specific narrative imposed by the curator, however very low social potential, an example of this is the Tate Britain. The other extreme is in Figure 3.4c, which shows a grid-like layout that connects each space to all its

25

neighbouring spaces forming a complex which makes it harder to visit in an orderly manner, however, this layout undermines the curator's control on the visitor and allows the visitor to discover something new every time they visit. Most museum layouts comprise sequential spaces (c-space) and choices spaces (d-space), and it is the variance in ratios of those spaces in each museum that determine the experience of the visitor (Tzortzi, 2007).
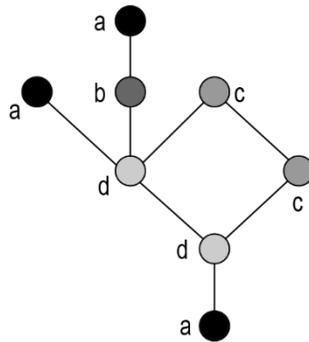
(a) Different classification of space typologies according to their position
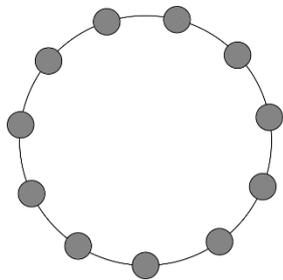
(b) Singular ring of connections   (c) Grid link of connection
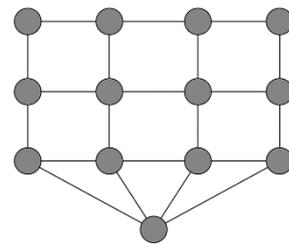
Figure 3.4: Shows spatial typologies and its effect on the spatial configuration
(Hillier & Tzortzi, 2007).

3.2.2 Measuring Syntactic Variables

In order to further refine the results, obtained g from the analysis above, and achieve a more precise results, quantifiable variables need to be measured and obtained from the convex, axial, and isovist maps introduced above.

The first variable is Integration which is a fundamental syntactic variable that records a value based on the number of other spaces that must be passed through in order to reach all the other spaces in the system, and based on the concept of depth. Then there is Connectivity, which measures the connection patterns of each space with its adjacent spaces, which can be identified as the clearest variable in syntactic analysis (Nik Khah et al., 2020). Therefore, Integration is used to outline the global relationship of the spaces to the system as a whole, and connectivity is used to outline the local relationship of the adjacent spaces with each other. High integration values reflect a high level of directly connect spaces within the system, and lower values reflect less connection, or in other words, show more segregation to other spaces in the layout. In order to determine the integration level, we can use the justified graph and plot the spaces and determine by assigning each space to the root and connecting each space to it to determine more or less which spaces are more integrated. The other way is by using the visual language of colors where red represents the most integrated and blue the least integrated. This highlights the important feature of Space syntax analysis that simplifies a pattern into a set of colors that constitutes values, that intuitively makes it easier to interpret the integration core of any given complex (Choi, 1999; Hillier, 1996, 1999; Tzortzi, 2007; J. Wineman & Peponis, 2010).

Another basic variable that resembles the total layout system is *intelligibility*. It is the most essential variable of any spatial complex, as it shows the relation of the part to the whole. A spatial layout is said to be *intelligible,* or comprehendible when the visitor in a particular part of the layout understands the relation of this space in accordance to the others in the network as a whole (Hillier & Hanson, 1984). Thus, *intelligibility* is described as the degree of correlation between local measures (connectivity), and the global measures (integration) and this applies on all scales urban, neighborhood, and architecture (Tzortzi, 2007; J. Wineman & Peponis, 2010).

The third variable that can be measured is the Isovist that is used to examine the level of visibility, this tool has a 360° field of vision, representing an observer's point of view (Klarqvist, 1993) as shown in Figure 3.5a**.** Turner et al., (2001) argued that spaces compel people to orient themselves to what they can see and based on that decide where to go next.

Turner has also developed the idea of isovist into something more practical and add another quantitative variable to space syntax and that is *visibility graph* which is used to measure the degree to which any point in the spatial layout is visible from any other point (Desyllas & Duxbury, 2003). The use of visibility graph analysis facilitates for analyzing multiple visible locations in the complex and measuring their local and global spatial properties and link all those variables to the perception of the built environment (Turner et al., 2001) as shiwn Figure3.5b. In order to explore visibility relationships in a spatial network, it will be needed to do a visibility graph analysis (VGA) (Hillier, 1996). Visibility graph analysis is one of the most complex methods in syntactic analysis; it is calculated based on the intervisible locations and provides descriptive and quantifiable result from a built environment, where red is the point that permits the most views, and blue the lowest and yellow being the point in between that encourages imagination (Anevlavi et al., 2017). Using a compound point of isovist analysis produces a visibility graph. Navigation in a built environment and spatial patterns are highly affected by the visibility features of the visibility graph features (Jouibari et al., 2021). Visibility graph is also said to be connected to behavioral affordances, like orientation, wayfinding, legibility, and social interaction (Montello, 2007). In a study done by Desyllas & Duxbury (2003), that compared the axial analysis and visibility graph with the main correlation variable being the pedestrian behavior, the study found a more significant correlation between movement and visual space, revealing more predictable results from the VGA than axial analysis.
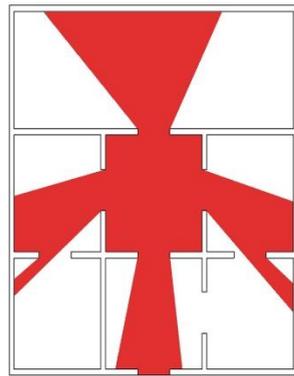
(a) Isovist
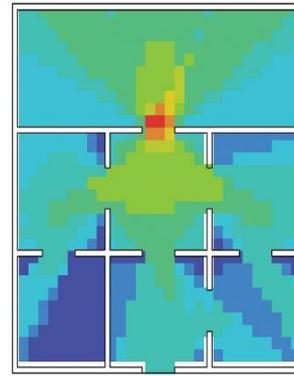
(b) Visual Graph Analysis
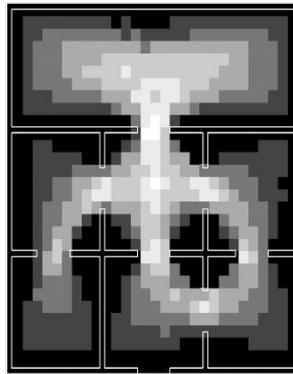
(c) Agent Based Simulation

Figure 3.5: Example of an isovist map, visual graph map and an agent-based analysis.

3.3 Using Agent Based Model to Analyze Visitor's Movement Pattern

Usually in order to measure the visitor's activity within a museum, and to measure the effect of the spatial layout on the visitor's itinerary a regular observation and tracking approach would have been employed where a random set of visitors are tracked around to study their movement pattern and correlated it with the overall results and the spatial configuration variables in order to understand the underlying effect of the building layout, However due to the impending situation caused by the pandemic the study is adopting an alternative that was developed by Penn and Turner (2003) where they created a simulation software to represent how an individual or a population move and interact with the spatial configuration.

Known as Agent-based mode, and mostly used on two different scale groups, identified by Helbing & Molnar (1998): urban scale simulation and architectural level/microsimulation. Agent-based started first as a predefined movement simulation to see how an agent would move from point A to point B, measuring congestion, and simulating movement behavior in cases of fire evacuation and etc. However, Due to an increased focus on the aspect of "unprogrammed" movement to be applied in applications or environments where exploratory behavior is expected (Penn & Turner, 2001). After the introduction of the VGA as a representation method instead of the line map (axial), a much higher resolution analysis of the built environment was obtained and was identified as a better predictor of movement patterns compared to the predecessor the line-based analysis.

The current agent-based simulation program was developed to work with space syntax, syntactic variables, precisely the VGA that provides the program an idea of what is visible from any given location. The VGA that is used to act as the look-up table also has the information of the local connectivity and the global spatial relation, allowing the agent to deduce the affordance of the environment. This information that is stored allows the program to have the agent analyze the local surrounding spaces and identify the path that will have a higher potential of further movement, Moreover, it can store the mean depth concept identified previously, which also aids in the simulation, and finally, it uses this information to simulate motion throughout the whole spatial complex, computing possible number of agents at each location in the layout, in (Penn & Turner, 2001) as shown above [Figure: 3.5c]. The agents were programmed to look out and identify junctions as a former sociology thesis done by Conroy-Dalton (2001) found out that people in virtual environment scan the space when crossing junctions finding cues to know how to properly orient themselves, that's why the agents are programmed to operate in the same manner mimicking human behavior. When tested in the field the analysis presented a very similar results to the actual observation results, moreover as the decision-making process of the agent was based on the surrounding variables, the agent was programmed to change direction only after at least three steps has been taken in order to smooth out the randomness of the simulation, producing results that are very closely linked to the axiality of the layout including corridors and ring circulations.

The Agent-based simulation model represents a simpler concept of human movement where it is motivated by linear links and that people naturally move towards what they see without considering how far it, as the individual move further decisions can be taken during the process, whether if the visitors are encountered by a junction, where the individual will observe the local surroundings and consider a possible route change, in case of museums this could be for an exhibition room that attracted attention and so on (Conroy-Dalton, 2001). During all tests, the Agent-based simulation showed a range between 50% to 80% correlation with the observational tracking results making it the second-best alternative for our analysis (Penn & Turner, 2001).

CHAPTER 4

CASE STUDIES

4.1 History of Museums in Egypt

The Cases in question that will be discussed in this thesis are a part of a long history guided by colonies and corruption, the idea of Museums in Egypt stemmed from the effort of Egyptians to return and maintain their cultural heritage and their monuments that were taken during the French and the British invasion. This notion started in the reign of Mohamed Ali Pasha, but due to some political issues and a shortcoming of funds, all efforts had failed. In the nineteenth century during what is referred to as the "Museum Building Boom" that followed the fall of Napoleon (Giebelhausen, 2007), saw an intensive act of collecting, a lot of which was transported from Egypt to Europe, due to the lack of awareness to the value of their antiquities (Mahmoud, 2012). Later on, the Europeans founded and organized several Museums in Egypt, like the Egyptian National Museum in Cairo (currently referred to as the Egyptian Museum) in 1890, and also museums like the Islamic (formerly known as Arabic) Museum in 1891 (Reid, 1996).

During this colonial-era Egypt and its politicians fought for the independence of Egypt, thinking that it would result in helping them regain control of their cultural heritage (Reid, 1996). After several years later in the 1950s under the leadership of Gamal Abdel Nasser and the Free officers, the Egyptians were finally able to take control over their national museums (Mahmoud, 2012).

However Soon after it was realized that the Egyptians didn't have proper training and resources to manage and preserve their culture, therefore UNESCO stepped in to help fund and manage the museums and also lead new museum constructions across the country, but all those efforts didn't prove to have a specific aim or strategy towards development as mentioned by Dr. Zahi Hawass (2005).

Egyptian Museums are an example of the colonial influence on the development of museums, whose museums were dominantly developed and managed by European entities (Beaucour et al., 1992). One of the first new museums that were built in Egypt came into fruition by efforts of an Egyptian government official, who got his education in France and was inspired by their culture (Commins, 1999), who then passed down the idea to Mohammad Ali Pasha who was fascinated by the idea and eventually announced in 1853 the construction of the first museum in Cairo to house Egyptian antiquities, however, due to strong influence over Mohammed Ali, efforts to prevent the preservation of Egyptian Antiquities on Egyptian soil, and all-important antiquities were exported to Europe (Mahmoud, 2012). Even with all of this opposition the first open museum in Ezbekiah was opened, but it is was primarily functioning as a storage space for the artifacts that were blocked from traveling outside the country, this project took until the twentieth century to be implemented (Wood, 1998).

The French influence in Archeology in Egypt during the time of Mohammed Ali was very strong, led by the French Archeologist Auguste Mariette, who led supervision and excavation of key sites in Egypt and also proceeded to appoint French citizens to the antiquities service office, which was a governmental project that supervised, and approved archeological missions, while also having the power to carry out their own (*Supreme Council of Antiquities (SCA), "A Brief History of the Supreme Council of Antiquities: 1858 to Present,"* n.d.). In order to protect the French dominance over the excavations, and to try to satisfy the Egyptian government who was getting increasingly angry from the antiquities trade, he worked on influencing the Pasha to build the first museum, which came into fruition in 1863, where Augustus organized its display based on the aesthetic value which faced some backlash during the time, but no changes were made nonetheless, and this museum presented the first national museum to be constructed in the Near East region (Mahmoud, 2012). During the time span of (1838-1936) the Egyptian antiquities, services underwent 8 different French leadership that was always focusing on enriching the louver museum collection and worked on developing its displays (Kohl, 1998), while the Egyptian museum was left to act as a storage space where collections were roughly exhibited (Mahmoud, 2012).

In the following subsections, I will be presenting a history of all the four cases in chronological order, which will be analyzed later in the paper, explaining their history, what lead to their construction? who designed them? and how the spaces and the exhibition layout are designed? In order to give a clear understanding of our cases.

4.2 The Egyptian Museum in Cairo (EMC)

The idea behind this museum started in 1889 after the first national museum of antiquities in Bulaq had no more capacity to house the excavations and the newly discovered artifacts, and the lack of spaces put the artifacts in a critical situation that urged Khedive Ismail to first move all the artifacts to one of his residences in Giza temporarily opening in 1890 but even this one wasn't enough for the number of frequent findings that was taking place during this time and a new one was required to be built. Years later after an international competition took place for the construction of the New Egyptian museum of antiquities and after the evaluation of seventy-three projects, the winning design was of the French Architect Marcel Dourgnon (Fjerstad, 2007). In 1902 the Museum was finally opened to the world, making Mohammed Ali's vision come true and giving hope to the whole generation, comprising of a library, laboratory, security, and an empty plot that extends until the Nile for future extension plans and even placed some foundations for extra wings (Abou-Gazi, 1988). This Museum was the first-ever museum in the region to be constructed as a museum instead of revamping a palace or other buildings (Kuppinger, 2005). Unfortunately, though the museum was managed by the Europeans until the 1950s (Sherif, 2002).

The Egyptian Museum in Cairo was very contemporary for its time, designed with the intention of representing classical antiquity. Inspired by the Egyptian temple, the museum has a monumental open central hall that is surrounded by a secondary colonnaded hall (Fjerstad, 2007), however, the exterior of the building was widely affected by the west, resulting in a western new classical style façade (Sherif, 2002). Which was a sign of colonial imperialism to assert the superiority of the European Civilization on the colonized subjects (Mahmoud, 2012) in Figure 4.1.

Figure 4.1: Egyptian Museum façade today (Asfour, 2014).

The exhibition was designed following conception set up in the late nineteenth century, arranging exhibits chronologically, the museum has a large collection ranging from the predynastic till the end of the pharaonic period with some Greco-Roman artifacts to fulfill the chronological order (Reid, 2003). The curators primarily focused on organizing them based on aesthetical values which deemed to cause issues before in the national museum of Bulaq. Moreover, some artifacts were too heavy to be placed on the upper floor and too large for the Halls (as to ensure proper visibility for them) so they were placed on the ground floor, and the first floor contained the funerary collection in chronological order. The museum layout has changed a lot of times due to rapid increase in the collection causing a continuous rearrangement, until most of the exhibits were overcrowded so the rest was all sent to the storage basement (Fjerstad, 2007), According to Zahi Hawas, this basement has thousands of artifacts 80% of which were never documented (DuQuesn, 2007). The overflooding with artifacts ruined the organization's layout primarily set up, and turned it into a big storehouse that housed thousands of Pharaonic artifacts for ages to come until recent times (Kuppinger, 2005). Very few efforts were taken to bring the museum back in order but all was halted during the world war and no significant changes were recorded afterward for a very long time until the announcement of the construction of the new Grand Egyptian Museum in the Giza Plateau that would empty some spaces up allowing for an opportunity to reorganize the spaces again. The Egyptian Museum will remain as one of the oldest and most important

museums that once showcased and exhibited, and continue to exhibit the excavation findings and be a symbol of the first museums in Egypt.

4.3 Museum of Islamic Art (MIA)

This Museum is one of the very few museums to display Islamic art in the region and the only one currently in Egypt (Bruls, 2018). Formerly known as the Museum of Arab Art, tracing its history back to times defined by the occupation of Egypt by the French (Marsot, 1969), and then later on by the British forces. Established in 1902 following the Neo-Mamluk style shown Figure 4.2 by the Conservation Committee of the Arab Art, and run by the European committee until the Coup of 1952. Before the coup the museum's displays were directed towards the Europeans rather than the locals or the Arabs in general, after the coup some changes started taking place including nationalizing all the aspects of the museum, from the operation and technical workers to the displays which resulted in rearrangement of some of the exhibits but due to limited budget during that time no major alterations took place, and for a long while very little attention was given to the museum and very little budget was assigned to it for any sort of major renovation, mostly due to the very little attention that was received to it by the visitors and the general public. However, after some events that took place on the global scale (the September 11 attack), a ripple effect took place that resulted in the increased interest of the Islamic art and collections that started a motion of renovation in 2003 that was also led by a French designer Adrien Gardere, which caused some issues again with the public, as no Egyptians were appointed on the project (Berger, 2017).

Figure 4.2: Museum of Islamic Art (Berger, 2017).

Gardere aimed to create a narrative and a flow of movement within the museum. Directing movement from the entrance through the entrance visitors going right will see the chronological arrangement of antiquities covering all the Islamic empires (like the Umayyad, Abbasid, Tulunid, Fatimid, Ayyubid, Ottoman, and Mamluk empires) and after seeing all the rooms the visitors would gather again in the central axis corridor where they could go to the other side of the building, where the exhibits are organized following other criteria (like by region, and material, and by themes like textile and calligraphy), all directed towards educating the visitors, while providing a proper and a clear context through the order (Berger, 2017). In the world of Museology, some criticized the exhibit choice and the organization of them, as a masterpiece of each empire and not a proper progression of Egypt's history, and that he could have followed the criteria of his predecessor in the EMC and choose according to aesthetic value which also resulted in conflict, stating that this narrative is one that is programmed and tell another version of history that only shows triumph and genius without reflecting the social and political conflict in these eras, eventually telling the European version of the story (Duncan, 1968). In 2014 the Museum and its exhibits were damaged by a car bomb that exploded across the street of the museum targeting the Security Directorate, after this unfortunate event a lot had thought that a new renovation would start this time under Egyptian leadership, and rearranging to their correct interpretation of Islamic Art history, Instead the government decided to restore it back to the 2010 layout by Gaudi citing lack of funds and resources and the absence of alternative proposals (Berger, 2017). The museum was opened to the public again in 2017.

4.4 The Nubia Museum

Nubia named after the ancient god of gold, as the region was known for its gold mines, and was once a portal for trade between Egypt and Africa. Back in 2500 BC, Nubia was independent of Egypt, in a consistent back and forth, however they enjoyed independence for a long time along with a stable economy for ages even during the Roman empire they maintained independence under Roman sovereignty. Nowadays Nubia is a part of the Egyptian governates and lies on the borders between Egypt and Sudan. In 1971 the Aswan high dam was scheduled to be opened that would result in the flooding of a sizeable part of the northern region of Nubia, therefore in preparation for these 40,000 Nubian artifacts was relocated and to save the existing monuments and temples, a lot of wheels were set in motion to help preserve them before the flooding. UNESCO along with the Egyptian government

decided to construct the Nubia Museum in Aswan in 1997 to create a safekeeping for the findings and exhibit them (Baker, 2001).

The Nubia Museum is the first-ever museum in Egypt to be fully funded by the Egyptian government and designed by the Egyptian architect Mahmoud El-Hakim and executed by the Arab design Bureau, however, the Nubia region expedition of saving all the Nubian heritage and excavations was supported by UNESCO. Built near an ancient quarry, the Museum consisted of a three-floor building, along with some exhibits that were placed outdoors that included examples of Nubia architecture. The Museum's mass was dictated by traditional design elements like following the topography of the site and orienting the main elevation of the museum to face the Nile, and structuring a portico to shade the main entrance to the museum (Baker, 2001) shown in Figure 4.3.
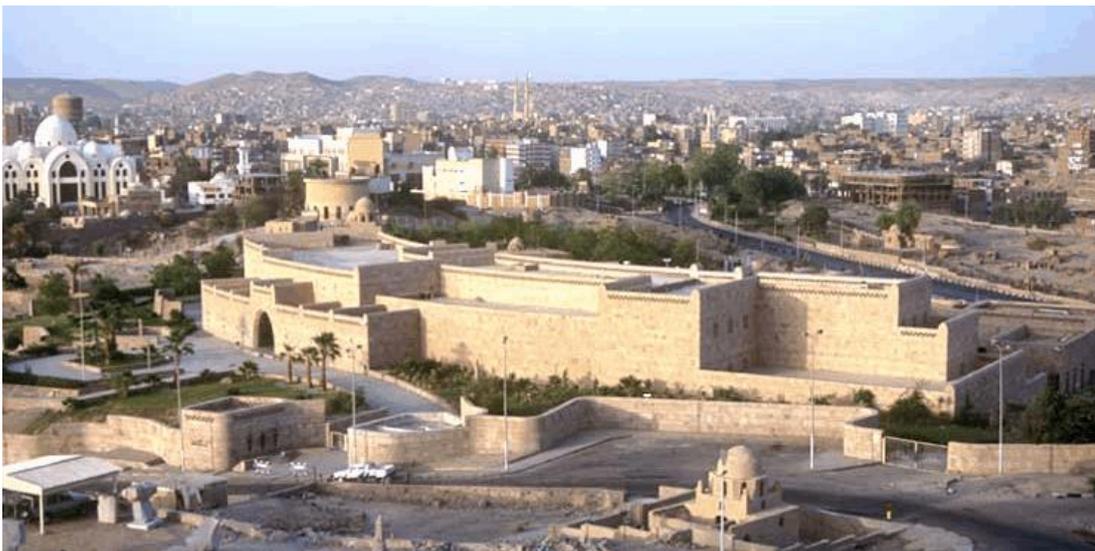
Figure 4.3: Nubian Museum complex tracing the topography of the site (Fjerstad, 2007).

The Museum's design concept curated by Pedro Ramirez, who aimed to guide the visitor through the exhibition halls in the museum and then out to the external exhibition spaces, wherein all exhibition spaces, a chronological order has been presented. When entering the ground floor, the visitors are greeted with a large set of stairs that leads them to the main exhibition hall in the basement, along with rooms showing history of the Nubian people, and on both sides of the central hall lies the educational centers. The Ground floor on the other hand houses the shops and a temporary exhibition hall along with a lecture hall, and finally,

the floors plan houses the administration office, library and a cafeteria. The layout of the museum was stated by the visitors to be spacious and allows for a clear and easy flow around the exhibits which overall shows an example of a museum that acts as a community center for education and discovery, and as a good reflection of the cultural heritage of the Nubia, culture whether from an architectural perspective or a mesological perspective making it win the Aga Khan award for successful integration of the past, present and the future in 2001 (Baker, 2001).

CHAPTER 5

COMPARITIVE MUSEOLOGICAL ANALYSIS OF THE CASE STUDIES

5.1 Overview

This chapter will present and analyze the three cases with each other, the Egyptian Museum of Antiquities, commonly referred to as Egyptian Museum of Cairo (1902) designed by the French Architect Marcel Dourgnon, and the Nubia Museum (1997) in Aswan designed by the Egyptian Architect Mahmoud El-Hakim, which highlighted the first museum to be designed by an Egyptian national since the colonization, and the Museum of Islamic Art (1903) by Alfonso Manescalo.

The three case studies possess some set of similarities that qualifies a comparative analysis amongst them. The three cases in question here are popular national museums of antiquities and history, that hold great significance in the heritage of Egypt and its culture. Moreover, all cases house prominent collections of national artifacts and showcase a collection that spans multiple generations, and links between prehistory and the 20th century, which was divided across all cases addressed here, some artifacts were even moved out from the EMC upon the inauguration of the Nubia Museum due to the overlapping of their arrangement order. But what sparked this study is what differentiates all of them, what makes either of them unique from the other, from their different layout approach, to an almost a century gap that witnessed a lot of changes in the museology and architecture, and the type of approach that every designer and curator intended in the designing of the space and display.

In this chapter, the three cases will be analysing, supported by the literature discussed earlier, and adding on it by applying the syntactical analysis for the spatial structure. The study followed a specific approach that presented the analysis in a constructive manner, that has started by analysing the spatial configuration; its spatial layout the easily noticeable ones to the more underlying properties, and the relation of each point in space to the other, then the

analyses of the visual structure of the space; its arrangement and control of the visual field, and how does it shape the overall understanding and navigation within the space, followed by the analysis of movement, done by the agent based simulation (explained in chapter 3), that present the movement pattern of the visitors and how it is shaped by the layout, as we;; as analysing how the space divides visitors across the layout, followed by the analysis of the spatial display arrangement, that will add a layer on the existing layout, examining its effect on movement, view, and exploration, and the relation between the objects displayed and the narrative structure, and how it changes the spatial configuration of the museum, lastly analysing the overall museum experience, where all the cases are compared based on all the former analysis and supported by their background to better understand and characterize the type of experience of both museum, alongside other defined criteria, which is shown in Table 5.5 at the end of the chapter.

5.2 Egyptian Museum of Cairo

The Egyptian Museum of Antiquities, commonly referred to as the Egyptian Museum of Cairo, being one of the first National Museums in Egypt, designed by the French Architect Marcel in 1902, that was opened to house all the excavations that were found in the country from the predynastic till the end of the pharaonic period (Reid, 2003), this demanding design brief resulted in shaping this 119 years old museum layout, and how it affects its curation and organization of space, and how does it affect the type of experience does it hold. The analysis of this museum will be limited to the ground floor only, as it constitutes a more area of interest, and shows more signs of flexibility in the layout compared to the more rigid layout and organization of the first floor. The analysis will first analyze the properties of the Egyptian Museum of Cairo first, and then the Nubia next, and ending the chapter with the comparative analysis and discussion.

5.2.1 Exploring the Spatial Configuration

Starting with the Egyptian Museum that was introduced earlier, as one of the oldest and most renowned, focusing on the ground floor, where most of the artifacts are placed and organized in chronological order from the predynastic till the end of the pharaonic period with some Greco-Roman artifacts as well. First, the space layout will be explored, highlighting the major layout design, axiality, and plotting it down in the nodes and links to strip the geometrical aspect from the analytical process and deal with it in spatial and syntactical terms.

Convex and Axial Analysis

As mentioned earlier, this museum was designed with the intent of housing the expanding treasures of the excavations that were taking place at the time, therefore it is noticeable from the axiality and from the general layout, that it has common characteristics of the neo-classical/Victorian museum buildings (likes of Tate Britain, and National Archeological Museum of Athens), in terms of modularity, and the order of the spaces, reflecting a sense of order in Figure 5.1.
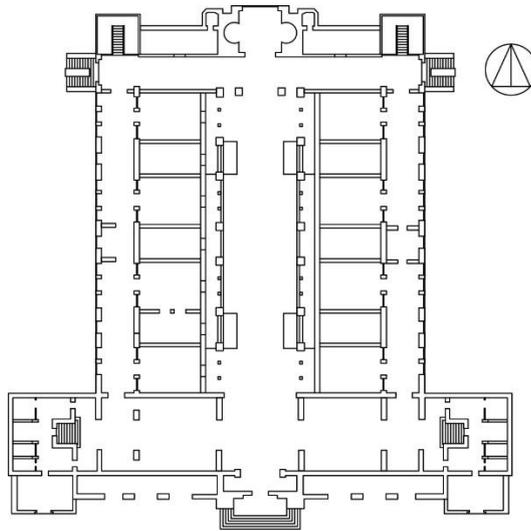

Figure 5.1: Ground Floor plan of the Egyptian Museum of Antiquities (Author).

Starting with analyzing and identifying the layout as a set of convex spaces which was explained in detail in the previous chapter, helps us analyze the link between every point in the local and global network. Convex map is known as the fewest and fattest convex spaces that a user traverses through to reach the whole layout. The graph presented below [Figure 5.2] shows the number of convex spaces in the layout and their depth and integration with relation to their neighboring spaces and the whole. The convex spaces were done with consideration of all the walls that enclosed space, more prominently noticed in the southern corridor or the Entrance hall, this minor difference in choosing the space had a major implication on how space is interpreted, as without dividing it the way it is shown, it would have given the same integration intensity as the northern corridor, however as shown the integration core shift from being in the entrance to being at the northern corridor, showing

that the global link isn't directly related to the local circulation pattern and that the entrance hall and spaces around it don't give any guidance on where to go next, which might explain why the kings' tomb exhibition was placed in the room that is directly linked to the integration core of the building, as to guarantee visitor frequency. Spatially this simplicity in design intention causes confusion to the visitor as any route could be the desired route intended by the curator when entering the building, primarily the curators organized the chronological order starting from the west wing and all the way to the other end, in this case, the higher integration of the west wing can act as a good guiding factor, which would predict a west side bias that will be discussed more in the upcoming sections.
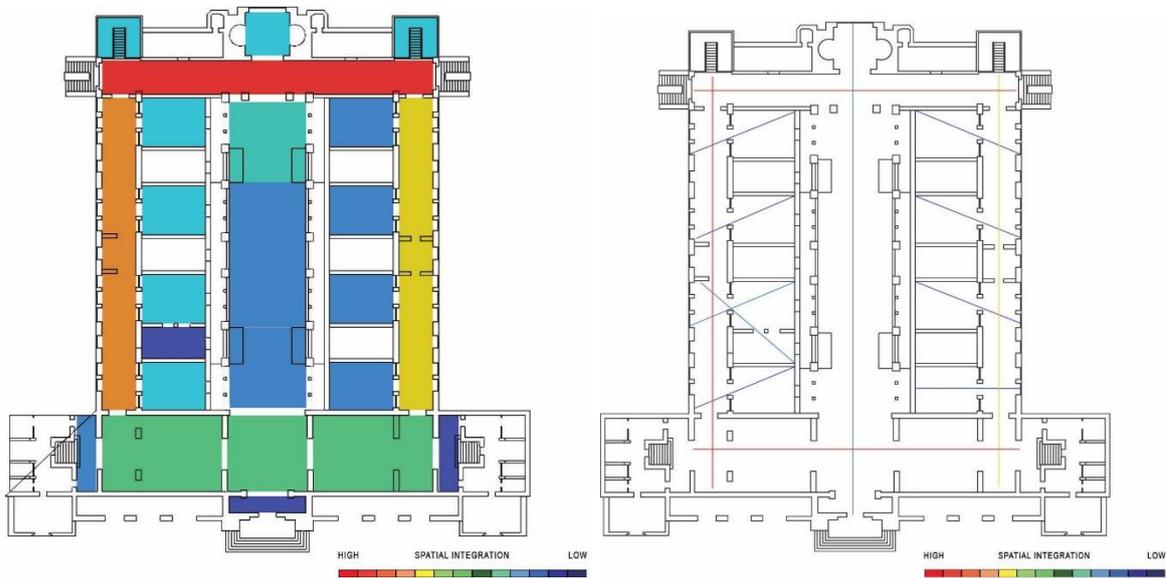
(a) Convex map integration   (b) Axial map integration

Figure 5.2: Convex and Axial map analysis in EMC (Author).

Moreover, a notice is shift towards the axiality in the layout, being a key property, traversing through the whole layout horizontally and vertically, and most importantly the central axis that penetrates the whole museum passing through the central hall and reaching to the other end creating a global scale link. Along the eastern and western axis, lies the modular gallery spaces that are aligned like a tooth of a comb along the two axial lines, that houses exhibitions and acts as a dead-end in the spatial point of view. This axiality and the rooms

that were created due to its implementation created the sort of spaces that are equally valued, which was a key property in an expanding museum collection. This powerful axiality is instantly felt especially from the strong central axis, as it is not obstructed or crossed with any other traversing axis lines. One way in which the study can also test the linear visibility of the space and the effects that it can produce from guiding movement and suggesting next step destination is by producing convaxial maps, this is done by layering the two maps together, seeing how many convex spaces are being traversed by each axial line, and the longest line of sight that can be created from one convex space to other spaces in the complex, as shown in the figure below [Figure 5.3], during the time that people travel through the side corridor they will get glimpse of the deep exhibition rooms, just enough glimpse that can get them interested, those axis corridors are expected to have the most movement within them, for example the eastern axis passes through 3 different convex spaces and connects with 4 different convex spaces, that gives you an idea of the expected movement and presence of people in the layout, however as will be discussed later, this layout doesn't encourage object comparison, nor social encounter. By measuring and analyzing both the convex integration and convaxial integration measures an assumption is made on the overall museological intent and how the results have a strong effect on the overall museum experience.

Figure 5.3: Convaxial map applied in the EMC, to show integration, using the axial index developed by Hillier (Author).

Creating a linear dynamic that encourages central exploration, and the presence of few axial lines, and especially ones that cross the whole length of the space, reflects a space structure that is shallow. This notion is shown more with the help of the justified graph that represents the depth of the space in relation to a specific point in the complex. As shown in Figure 5.4 the justified graph reflects the types of spaces in the layout, along with their depth that uncovers some of the spatial qualities of the space, that builds up to how the spaces are used and experienced.

Space Depth and Typology

The J-graph of the EMC, representing the shallow depth based on the varying depth illustrated on the graph, the shallower it gets the more restricted and limited, compared to deeper complexes as it represents how much control the curators and the designers had on the visitor's itinerary. The j-graph also shows the gathering spaces that culminate in the entrance part of the layout, as well as on the other end of the layout, and on both sides, showing the spaces where most of the visitors will backtrack towards at one point in their visit. This also highlights the two circulation rings that become evident after noticing the series of *d-spaces* that create one major ring along with the two smaller ones that exist on

both sides of the central axis, highlighting the dominating circulation pattern in the layout. Each circulation ring consists of a series of *a-spaces* that represents the modular gallery rooms explained earlier. Now as mentioned in the previous chapter, that a layout with more *b and d spaces* reflects on the sequential layout pattern, which intern increases segregation and depth of other spaces in the layout while having more *a and c spaces* represents a better connection on the local scale and creates spaces that lie close to a circulation ring, as in our case with the side galleries *(a-spaces)*. This layout constitutes around 62% of *a-spaces*, where most of the exhibits are currently placed, aside from the ones placed in the central atrium which are a combination of c-spaces that constitute of around 12.5% of the whole layout, and are classified as sequential spaces, so a visitor that decides to follow the central route will have to continue the same route until reaching the other side, the effects of this layout will be discussed in details later on. And lastly, around 25% of the spaces in this layout are *d-spaces* which are all one step away from the *a-spaces* the layout resembles an urban layout where most of the choices are few steps away from the axis. Overall, the layout consists of a higher number of *a-spaces* and *d-spaces* which shows that this layout isn't sequential and that on the global level it makes it easy to reach all points of the layout within just a few steps, as shown it takes 6 steps to reach all the spaces in the museum from the entrance. on the locally, all the exhibitions are connected to the main ring circulation, which shows that this layout doesn't provide the layering approach of the general exhibition and detailed, and further reflects on the idea of equal value exhibition. This museum layout follows the idea that ' a large museum requires a simple plan' (Serota, 1998, p.14) which was aimed at making the structure easy to use, and flexible with whatever exhibits are placed, as well as aimed at dividing the peoples' visit of the museum to three divided sections that make it legible for the visitor (Serota, 1998). And that the excess of *c-spaces and d-spaces* provides a distant view for the visitor, which allows the visitor to understand the linearity and its relation to the global layout.
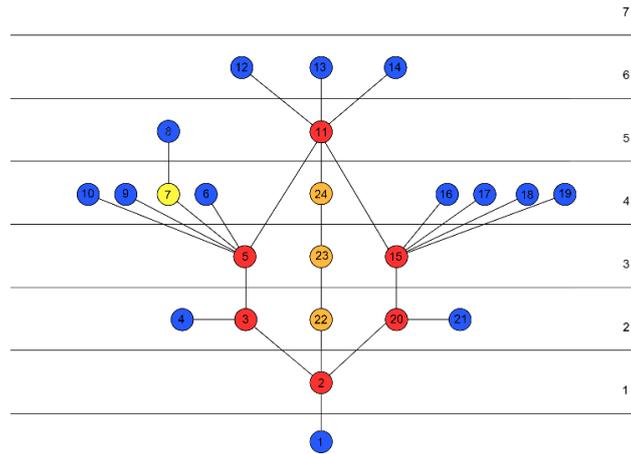
Figure 5.4: Showing the justified graph of the EMC from the entrance; a-spaces are in blue, b-spaces yellow, c-spaces orange, d-spaces red (Author).

5.2.2 Exploring Visual Structure

After learning about the spatial configuration of the space and their relationship to each other, and grasping an idea of the layout structure that will be experienced by the visitors, it is important to analyze the visual morphology of the space in order to understand how the spatial structure is perceived and how does it influence the museums to experience in terms of movement and encounter.

(a) narrow and unidirectional   (b) Line Isovist   (c) short vision in deeper spaces
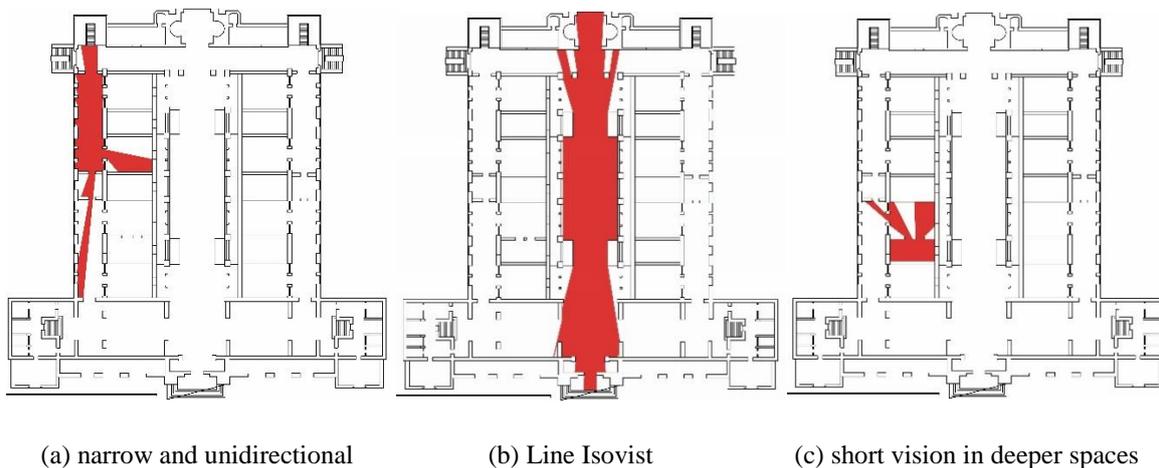
Figure 5.5: Isovist created from multiple points within the layout (Author).

In order to do that, the author starts by creating an isovist which presents the visual field of the visitor in 360 degrees and it shows what can be seen when the visitor is static and when

in a linear form of movement by making an axial isovist, As shown above [Figure 5.5b] the line isovist graph shows a unidirectional space that highlights spaces instead of relations, and it gives a clear idea of the space of global layout that facilitates visitor's orientation while in the same time, as the visitors move through the corridor the rooms are being revealed with what it encloses, but due to the shallow structure it doesn't give any further deep spatial links, which results in the creation of a term known as a *static impression* (Tzortzi, 2011). However, this layout type creates a type of movement that is linear and reveals the exhibitions for the visitors in a sequential pattern which would encourage concentration as the visitor's vision doesn't penetrate any other neighboring rooms that would distract them from the local layout as shown in Figure 5.5a, c.

To further analyze the visual structure of the layout, the author has applied the visual integration analysis (VGA), in order to know the level at which each point is visible in relation to the other points in the complex. Using the Visual Integration analysis, the study found out that the entrance hall along with the connecting spaces between the main axial hallways all has high visual integration which means that they are all the integration core of the layout in which circulation can easily be directed towards surrounding spaces, integration describes how one space can be reached through other spaces through the least amount of movement (J. D. Wineman & Peponis, 2010) shown in Figure 5.6a. This integration is showing that globally there is a good hierarchy of spaces and a good connection between major axis, and based on the layout and the symmetrical nature of it, the visitor can choose an itinerary that will guide them towards a route where he will be met with certain exhibits and then connect him back to what is referred to as gathering spots where the visitor will be met with another axial line that will continue to guide his movement, in a given case where a better connection exists with the other spaces, a strong visual integration exists. Visual integration as mentioned earlier is related to measuring the global integration of the spaces in relation to the whole, on the other hand, connectivity is used to show the relationship of the spaces with relation to their adjacent neighbor, in other words measuring the level of connectivity of the spaces on the local scale. Connectivity maps are used to explain that spaces that have a greater number of connectivity the more relationship it has with other spaces. As shown below in Figure 5.6b EMC shows that most of the spaces have one or two-way access options only reducing the overall connectivity level, and showing that some

exhibits can be skipped as the visitors doesn't have to pass through them to get from one point to the other reducing their chance of visitation in a way can be referred to as segregated which a less likely to be visited or seen and that it will be very weak in attracting visitors (Psarra, 2005), and this connectivity levels also have a direct correlation with the number of visitation/ number of visitors in the given space (Choi, 1999), meaning that the exhibition layout needs a modification on the local scale to make the deeper exhibits more accessible.


(a) Integration map   (b) Connectivity map
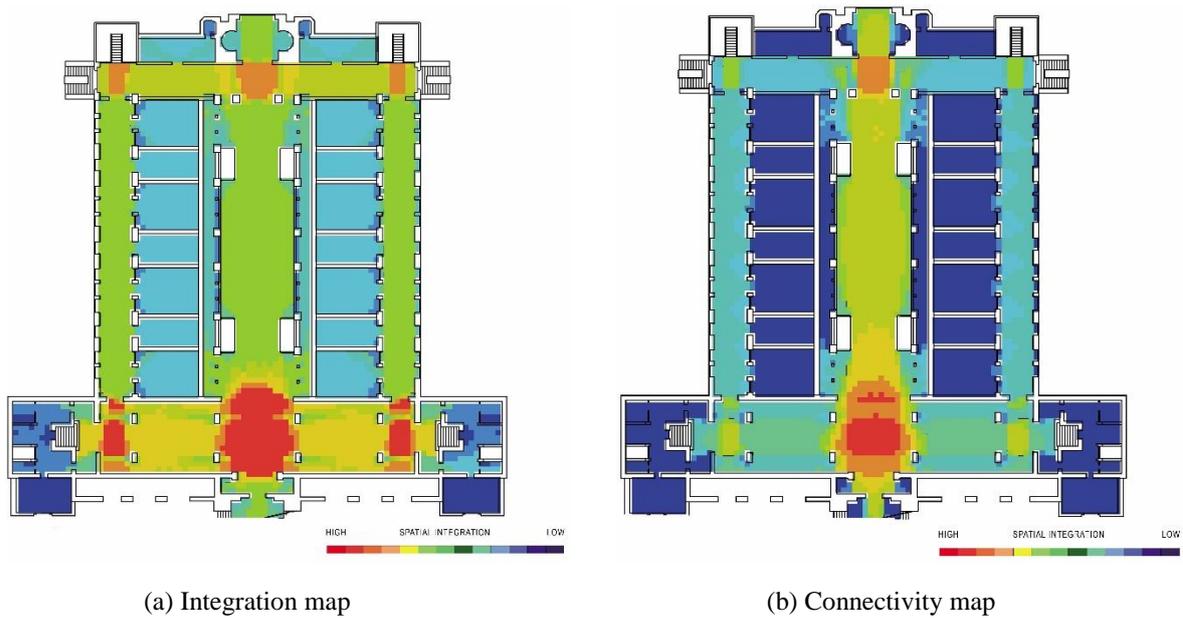
Figure 5.6: Visual graph analysis for the EMC (Author).
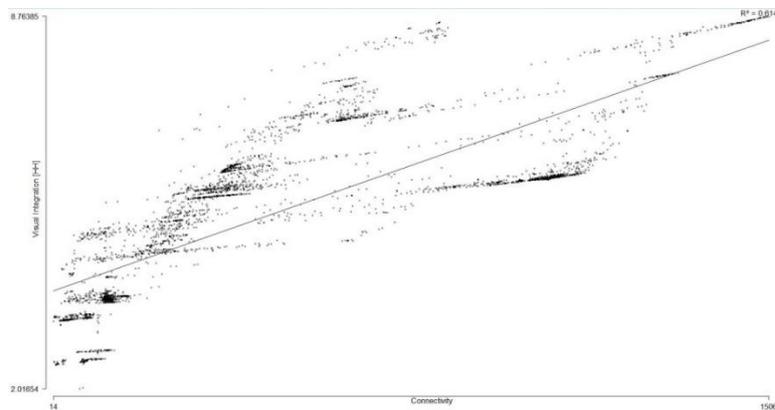

Figure 5.7: Scattergram showing the intelligibility values of the EMC raw spatial configuration.

With those (integration and connectivity) values found, the results obtain something called syntactic intelligibility, which is the correlation between connectivity values with the integration values, which deduces whether the visitor can understand the general layout of the whole, from the local connection spaces. In EMC the intelligibility is at an acceptable level ($r2= 0.615$) as shown in Figure 5.7, owing to the fact that the layout is simple and comprised of two major circulation rings, therefore the visitor can understand the layout of the space on the local level, making it easier for the visitor to take the decision of where to go next knowing that he won't lose track of what he already visited and what is yet to be seen. Intelligible layouts make it easier to predict the number of visitors at a given space in relation to integration and assess the number of visits that each space can receive (Choi, 1999). Another clue that was obtained by knowing the intelligibility levels of the layout is that, the layout that is more intelligible meaning that it offers enough views for the visitor to easily understand where to go next, and therefore the visitors have a better understanding of the space and have more freedom to choose where to go next, which results in a high probability that all the rooms will be visited with the same frequency as every other room in the complex.

5.2.3 Visitor's Movement, Exploration and Encounter

After setting up a good understanding of the spatial configuration of the layout, now the study can explore its effects on the visitor's movement pattern and how it influences their itinerary. Firstly, it is important to review the design intentions set up by the designer to influence movement and facilitate the object arrangement within the museum. As said in the previous chapter the intent was to create a flexible museum with equally organized spaces where it can house and organize artifacts easily, with very little focus on the hierarchy as most of the elements were valued equally at the time. Therefore, this arrangement dictated that the layout be simple, with well-defined linear axis routes.

As mentioned earlier in this step of the analysis, due to some limitation the common way of tracking visitors is not possible, and it was mentioned in the limitation part of the thesis, therefore the has employed the use of the Agent-based model that is a visitor movement simulation tool that was developed by A. Penn & Turner, (2003) that gives results that correlate to actual movement with around 55% accuracy rate, which would be good enough

to give us an understanding of the movement pattern and how also act as a predicting element of where people might go, and It can also help the study to test different design alternatives and it effect on the visitor movement, and the overall experience with virtually no cost and less effort, and as a matter of fact that wayfinding or visitor movement isn't the main focus of this study, it won't be of too much significance on the overall evaluation of the cases.

The analysis was performed by deploying 10000 agents in this simulation, the and analyzed with the same representation technique instead it is made in greyscale and intensity to further differentiate the two types of analysis shown Figure 5.9e, as shown the results was in a way predictable, where the linear axis and the perspective it creates upon entering attracts the visitor towards the end of the axial line, the center axis recorded almost 56% of the total around the site, and based on the graph, the tracking score reduces as the depth increases, owing to the spatial type of the exhibition rooms, amongst all the exhibition rooms, a range of 4% to 8% of the total number of visitors has been tracked in the exhibition, where there is a very minor difference between the two axial links on both the eastern and western sides, at least very little to be mentioned, not showing any bias, as shown before in the Tate Britain paper by (Dursun, 2007), where the visitors tended to walk on the peripheries of the layout, and the closest was the left side upon entrance, and the left side contained more linear connections that provided more distant visibility for the visitor making the space more legible therefore the visitors preferred it on the right side, in our case however they are symmetrical and possess equal characteristics so no bias was expected. The movement pattern of the visitors will be in most part identical routes taken by groups where they will start together and more likely are going to end together as there is only a little chance of route choices and a very shallow spatial network, that would facilitate exploration, instead of a mere progression of exhibitions from point a to b.

Visitor's movement in museums also generate something referred to as 'virtual community' named by Hillier (1987, P.248), that reflects the social factor of space that takes place when people become aware of each other apart from the exhibits creating an element of co-presence, and as mentioned in earlier chapters, co-presence has a level correlation with intelligibility (Peponis & Wineman, 2002) In the EMC layout the people tend to meet in

spaces that function as gathering and distribution spaces, or in the entrance hall, as it is vast and connects to three axial corridors, however, the sense of co-presence here can be limited due to the nature of movement pattern, as mentioned earlier a group of visitors entering when choosing a route will tend to continue this route until another set of direction changes are presented and in our case, and as defined by the justified graph, the choices are limited, therefore the social encounter element is weak.

5.2.4 Exploring Spatial Object Arrangement

As mentioned earlier, the EMC isn't experienced as just a set of spaces, as portrayed earlier, the reason is that author wanted to analyze the spatial configuration on its own first to get a better understanding of the spatial properties, and how it shapes the movement and interaction, adding this layer to the analysis will show how the current spatial arrangement affects the current layout, in terms of integration, connectivity, intelligibility, and encounter, and its overall effect on the experience. The objects that were mapped are the ones that existed in between the spaces (at the center of the space) or along the axis in a symmetrical pattern as shown in the Entrance Hall, and elements that affected the distant vision or obstructed movement as could be done by big statues or long protective casing, excluding from this section all the objects that were organized in the traditional manners as on the wall and etc. shown in Figure 5.8.

(a) Artifacts aligned along the wall   (b) Artifacts organized in the center of the axis

(c) Smaller statue artifacts placed in the center of the axis

(d) The main atrium display arrangement organization

Figure 5.8: Shows the types of display arrangement in the corridors of the EMC.

This layer addition, on top of the spatial configuration, caused some noticeable changes, first, the visual integration maps was applied shown in Figure 5.9a, b, the figure shows the dissipation of the integration cores that formerly occurred in the entrance hall and the end of each linear corridor, as well as the complete visual perspective that was offered in the central atrium all the way to the other end, this area isn't blocked in terms of circulation but due to the height and the overcrowded exhibits that hinders visibility, yet encourages exploration. The graph further shows that the global network link has been reduced drastically compared to the spatial layout, meaning a possible change in the intelligibility values. However, the local network that is presented by the connectivity map in Figure 5.9c, d, shows rather a

different perspective, the figure shows increased visibility between most of the spaces on the local network especially the exhibition spaces showing a rise of around 20-25 % increase, which shows more connection on the local scale. The intelligibility levels as shown below, dropped slightly (r^2=0.57), reflecting on more consistent use of the space, and that is a notion that is reflected in the movement simulation, as shown the visitors tracking score is now spread all over the map, with a more tracking score noticed on the western hallway, due to the clear viewing pattern with non-obstructive objects. Moreover, the results has shown a rise in tracking scores in the exhibition rooms which also reflects on the higher connectivity values, to prove this a scattergram was done for both cases as shown in Figure 5.10, where the original layout showed low results of correlation of (r^2= 0.36), while when the spatial object arrangement was mapped, the results increased to (r^2= 0.42). This shows that despite having disrupted the linear perspective established by the architecture of the space, the exhibits have the positive effect of slowing down movement, which results in contemplation and constant decision making that leads to direction changes and therefore increases the tracking count of the visitor on deeper spaces in the layout. This effect was discovered before by Alan Penn & Turner (2001) where he observed that people tend to stop and discover their surroundings whenever they are met with an obstacle or whenever they reach a junction, resulting in much evenly visited spaces.


(a) Visual integration w/o display   (b) Visual integration w/ display
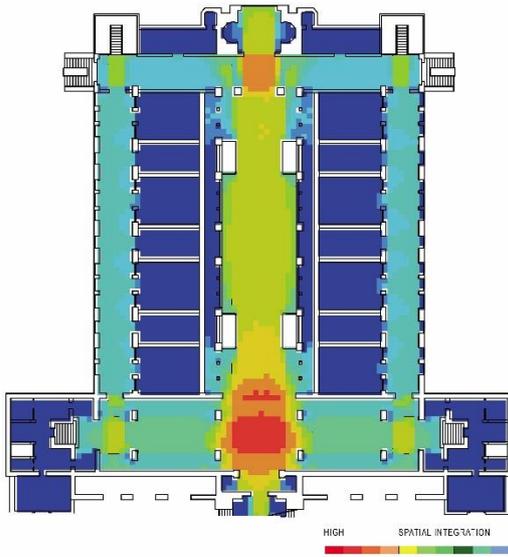
(c) Visual connectivity w/o display


(d) Visual connectivity w/ display
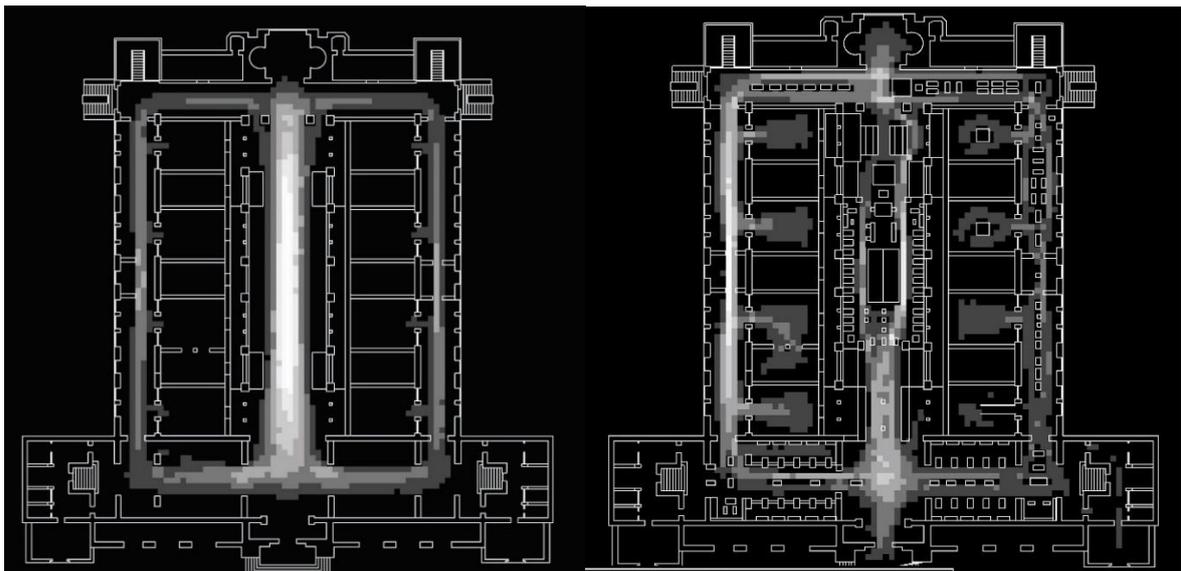
(e) Agent simulation w/o display

(f) Agent simulation w/ display

Figure 5.9: Maps showing the comparison in the EMC, between the spatial configuration and the Spatial object arrangement for different variables (Author).

<div align="center">
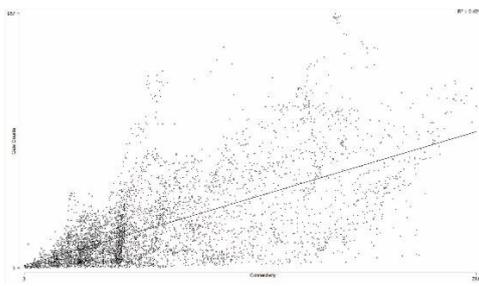
(a) the original spatial layout   (b) w/display arrangement
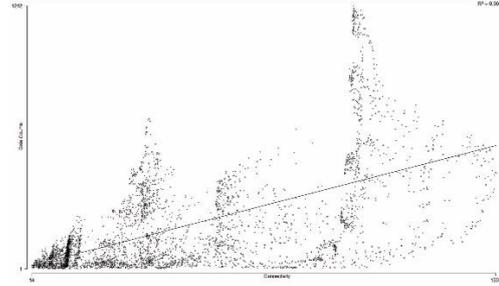
Figure 5.10: scattergram showing the correlation graph between the connectivity and visitor count in the EMC.

</div>

5.2.5 Museological Intent

After analyzing the whole spatial configuration and its effect on visitor movement, the study can develop an idea of the type of experience this museum can aim to produce and at the end of the chapter the quality of experience will be compared.

As all museums function as a place for knowledge transfer, it is also important to integrate this as an underlying focus and amongst one of the analysis criteria. The Egyptian Museum is structured in the neo-classical approach held some characteristics that were identified in European museums that were constructed in the 18th century, those kinds of structures including the Egyptian Museum had some determining features; long axial corridors, symmetry, and enfilade rooms. Those spatial properties create the kind of layout that enforces an autonomous movement that presents the information to the visitor in an organized fixated pattern, where there tends to be a chronological arrangement just as in a teacher delivering information in a specific sequence in order to ensure the transfer of knowledge. In our case the museum structure reflects on the equal importance of all the excavations based on the modular-sized exhibitions and their equal depth placement in the network, intending to create an equal visiting chance across the whole layout. In order to get a better sense of the curator's intent, the theory of classification and framing will be applied, which was mentioned earlier. The Egyptian museum's organization of the spaces and the intent was restricted by the layout, resulting in a high degree of segregation from most galleries especially the rooms lying on the axial corridors, and this result is supported by the calculation of the convaxial integration map that resulted in (0.58), that shows values between 0 and 1, where high numbers indicate a lower level of integration and vice versa.

What this means is that the layout applies separation between its content spatially that prevents the visitor to compare and contemplate the spaces with each other and that forces a more curated route on the visitors. While on the other, hand the museum showed a high value of framing which correlates to the mean convex integration value that is 0.90, thus implying a high level of control over viewing perspective and an equal museum experience to all the visitors.

5.3 Nubia Museum

The Nubia Museum was established 96 years after its predecessor to function as a museum of antiquities focusing on the excavations that come from the southern region, alongside housing some of the most important archeological excavations from Africa and the Middle East (Baker, 2001). A museum that was constructed and designed, as well as curated by a totally different administration from the EMC, whereas mentioned before the Architect, Mahmoud El-Hakim, who designed the award-winning museum. The paper will now analyze the museum spatial properties, following the same methodology and structure applied on the former case, where the comparisons will be discussed at the end of this chapter, and a criteria table will be set to establish some of the key differences and the effect on the overall experience. As done in the previous case, first the analysis and identification of the striking differences that can be easily observed upon first look, and then the syntactic analysis will follow.

5.3.1 Exploring the Spatial Configuration

This Museum is the complete contrast of the former case, this layout doesn't only house exhibition spaces, instead, it houses a range of other functions one of the most important and innovative in Egyptian Museology, which is a fully dedicated section for the educational sector where trips and courses and lectures for new Egyptologists are held, along with international conferences. However, this paper will only cover the exhibition hall part of the museum that lies in the basement of the site, as the site has a topographical nature that the museum structure blends nicely with the topography of the site.

As the layout was made to fit the surroundings, the designer opted to design a curvilinear approach where the mass is connected to a reference point on the Northern side of the building (Backside). This approach resulted once again in the creation of a symmetrical

organization, even though it is not easily identified at first, as the overall layout secludes this fact and creates asymmetry, the layout on its own right is of a symmetrical nature in Figure 5.11. This layout doesn't possess any long axis hallway that traverses the length of the gallery, instead, it has two spaces that connect to the same space at the end which is the other end of the exhibition hall. Moreover, the spatial design doesn't reflect any specific exhibition spaces, made with the intention of an open plan layout, with no presence of 18th-century enfilade gallery spaces that dominated the EMC layout space.
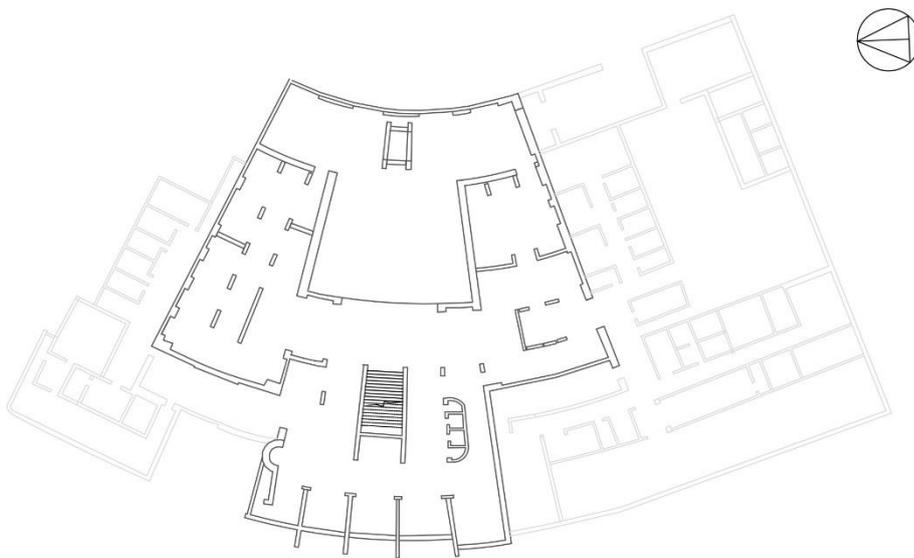

Figure 5.11: GF Plan of the Nubia Museum, Showing in darker color the gallery area, that the focus of this study. The surrounding areas are educational spaces (Author).

Convex and Axial Analysis

At this stage, the study will start by analyzing the configurational properties in order to try to understand the differences in the layout and its overall effect. First, the author wanted to identify the number of convex spaces present in the layout, and their relation to each other and the whole. As it is resembling some of the characteristics of an open plan layout, the spaces were identified based on the change of direction that would be required from each space to the other and the boundaries caused by the columns arranged on the axis. After plotting the map, the analysis was applied to find out the integration and connectivity of the layout. The results are shown in Figure 5.12a, that in regards to the integration map, it can be noticed that the integration core is present at the center of the layout which is also the entrance (Space no.2) of the layout that connects to the stair that guides people towards the

gallery, what can be also noted is that the integration decreases especially at the two opposite sides of the layout, on the contrary to EMC where the integration increased, instead, the integration here decreased due to the fact that the relation of one space to the whole is very weak, which will be enforced more upon the implementation of the intelligibility measure. Besides that, the convex integration map shows that higher integration values are shown on all surrounding spaces that the visitor might choose to determine their next destination that would result in confusion, and this is mostly amplified by the central access that is created to enter the exhibition area. However, by checking the connectivity layer, it reveals the number of connections each space has with its adjacent spaces, this map shown in Figure 5.12b, shows that within each other some of the spaces create sort of a common core, that links the spaces together and create sort of a gathering area that divides movement and helps guide people's movement by coming back or backtracking to a common identifiable space, however, this is only developed at few parts in the layout, (spaces no. 2,5,20).

(a) integration   (b) connectivity
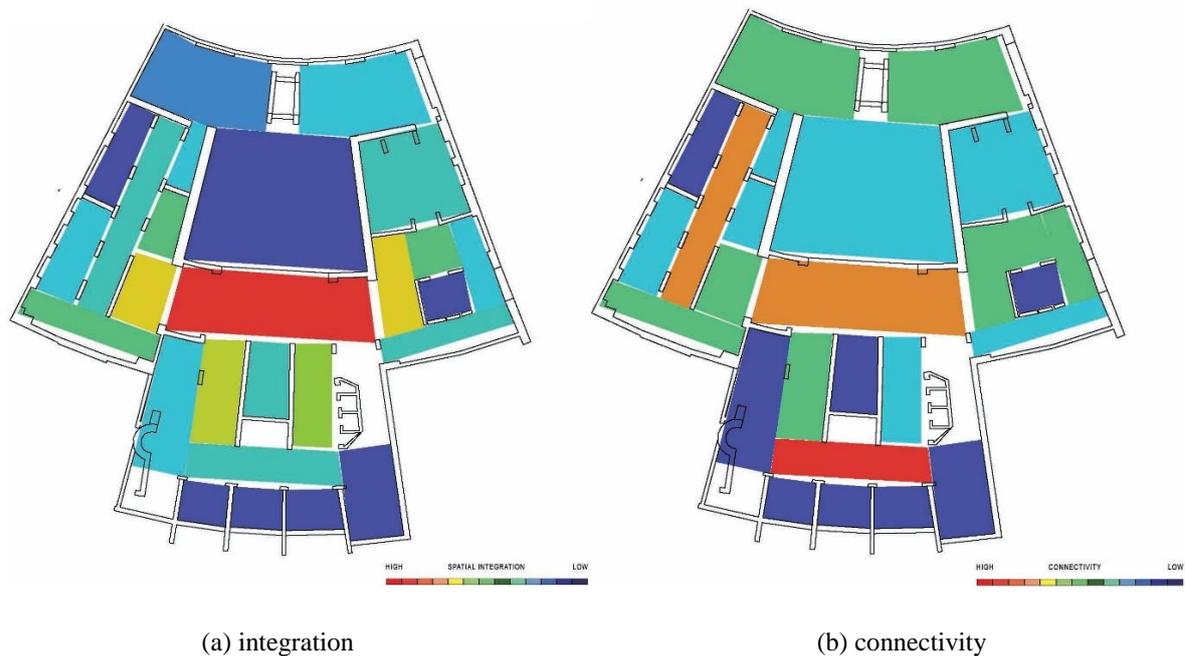
Figure 5.12: Convex map of the Nubia Museum (Author).

Next by applying the axiality, the study can identify the longest movement and the furthest linear line of sight that connects several spaces with each other. The axial map in Figure 5.13a, enforces the integration core identified by the convex map, except the axial map

shows an extended link that is created by the longest line of sight, that reveals a lot of exhibition spaces from the entrance hall of the gallery, Moreover due to the layout of the exhibition a complex overall axial organization is produced, they show a shallow integration core in the center were various spaces are available from the central space, however as shown the further it goes from the entrance, the integration of the spaces are reduced, as well as the long line of sight which reflects on a weak overall integration, resulting in weaker intelligibility. When correlating integration and connectivity together the intelligibility values came very low at (r^2= 0.32), reflecting the gap between the integrated core and the segregated spaces that are deeper into the gallery. This low intelligibility level means that visitors within the spatial layout of the Nubia Museum fail to develop an understanding of the local and global connection which might hinder any narrative arrangement or curatorial intent. In an effort to further understand the axiality of the layout, an overlayed version of the axial map and the convex map was produced in order to determine how many spaces are traversed by a single axial line, the results shown in Figure 5.13b, show that an axis line from the central space traverses through 6 spaces and then followed by the second most which is the central space as well as the axial line on the east. However, the central one looks more prominent compared to the more extreme situation on the eastern hall, both passing through 5 convex spaces. What this means is that there will be a tendency for people to go left compared to the right due to the long sight that they can see along with the different exhibits they can see in the visible convex spaces.

(a) Axial integration   (b) Convaxial integration
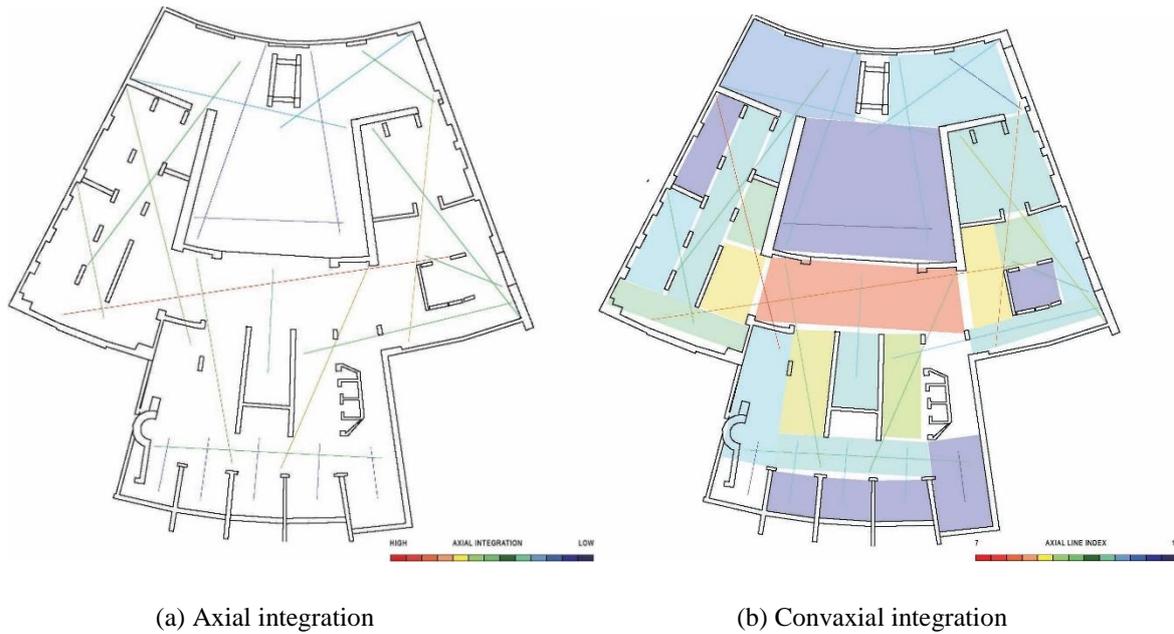
Figure 5.13: Axial and convaxial analysis in the Nubia Museum. Both having similar graphic representation from warmer to cooler colors except different variables.

Space Depth and Typology

In this section the study will analyze the spatial depth of the spaces as well as the type of spaces that are present in the layout, that will develop a deeper understanding of the structure, and the potential types of movement that can be produced from this layout, as different ratio between the spaces results in different integration intensity. The j-graph below in Figure 5.14, presents some of the spatial characteristics of the layout, first of which the space has a shallow step depth, showing a total of 6 spaces deep from the entrance, the j-graph also shows a dispersed layout contrasting to the previous case were the points diverged and converged in a deeper sector of the layout, at several points end with a dead-end where the visitor has to backtrack in order to continue the itinerary. Moreover, the graph also shows some circulation rings, the most noticeable one connects to the other end of the layout and then back to the entrance hall again, functioning as a gathering space on the global scale. This is evident as a high number of d-spaces are shown in the graph, that are identified as spaces that have more than two connections and are a part of a circulation ring. In the Nubia Museum, 32% of the spaces are made of *a-spaces* which is around half the number present in the EMC, which shows that most of the other spaces are ones that the visitor will pass through and that some spaces are more privately organized than others. Besides that, the

61

layout is made up of 20% *c-spaces* which are classified as sequential spaces where is the visitor is either given a choice of backtracking or continuing forward, and finally 44% of the spaces are *d-spaces* which as mentioned earlier encourages to encourage exploration as it is usually linked to multiple spaces and links to circulation rings. On the whole, the layout constitutes of more *a- and d- spaces* compared which means some spaces in the layout are made for contemplation and for individualized visits, while the other more dominantly d-spaces part of the gallery encourage exploration and increases the chance of an encounter, as well as increasing the local exploration route within the layout, that will be explored more later in this chapter. The spatial configuration shows a layout that was made with open plan museum principles in mind, which gives the curator more flexibility in organizing spaces but can present a challenge in case of a narrative arrangement which was the case in this museum.
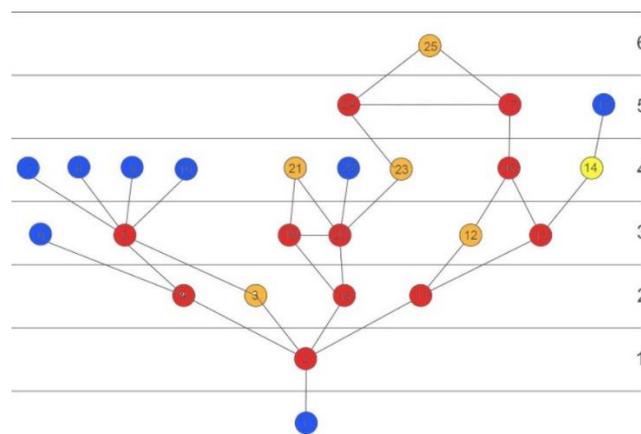

Figure 5.14: The j-graph of the Nubia Museum. a-spaces in blue, b- in yellow, c- in orange, d- in red (Author).

5.3.2 Exploring Visual Structure

The previous section touched upon the spatial configuration of the space, their relation to each other, and their preliminary expectation about the space experience, in this step the analysis will follow the same methodology by analyzing the visual aspect of the space, what people see within the visit, and how it affects their itinerary. Starting with a set of Isovist, as of the former case, they were drawn across four different points within the layout, resembling a standing still visitor, and capturing the impression they get from the overall visible surroundings and how good it affects the decision-making process. As shown in Figure 5.15, the figures show that from four different spots, the isovist showed that the space provided a concurrent perspective of different points within the layout, and specifically exposing the

deepest part with the space, which is the centra hall where the center piece of Ramses II is placed, showing that the central space exposes a huge part of the layout. Moreover, it can be observed that the left side of the layout has a more visual perception of the surrounding layout compared to the right side that reflects a unidirectional view and introversion, which can be utilized by the curator to place exhibits and artifacts that require a pause and contemplation, on contrast to the other layout that sparks curiosity and encourages movement. However as shown deeper sections in the layout shows very little about the global structure creating a very few visual connections with the surrounding. Which overall shows that this layout possess mix of two settings, one that invites concentration and the other that invites movement.

(a)

(b)

(a-b) Unidirectional vision in deeper zones in the layout

(c)

(d)

(c-d) Scattered and wide type of vision in central and shallow zones.
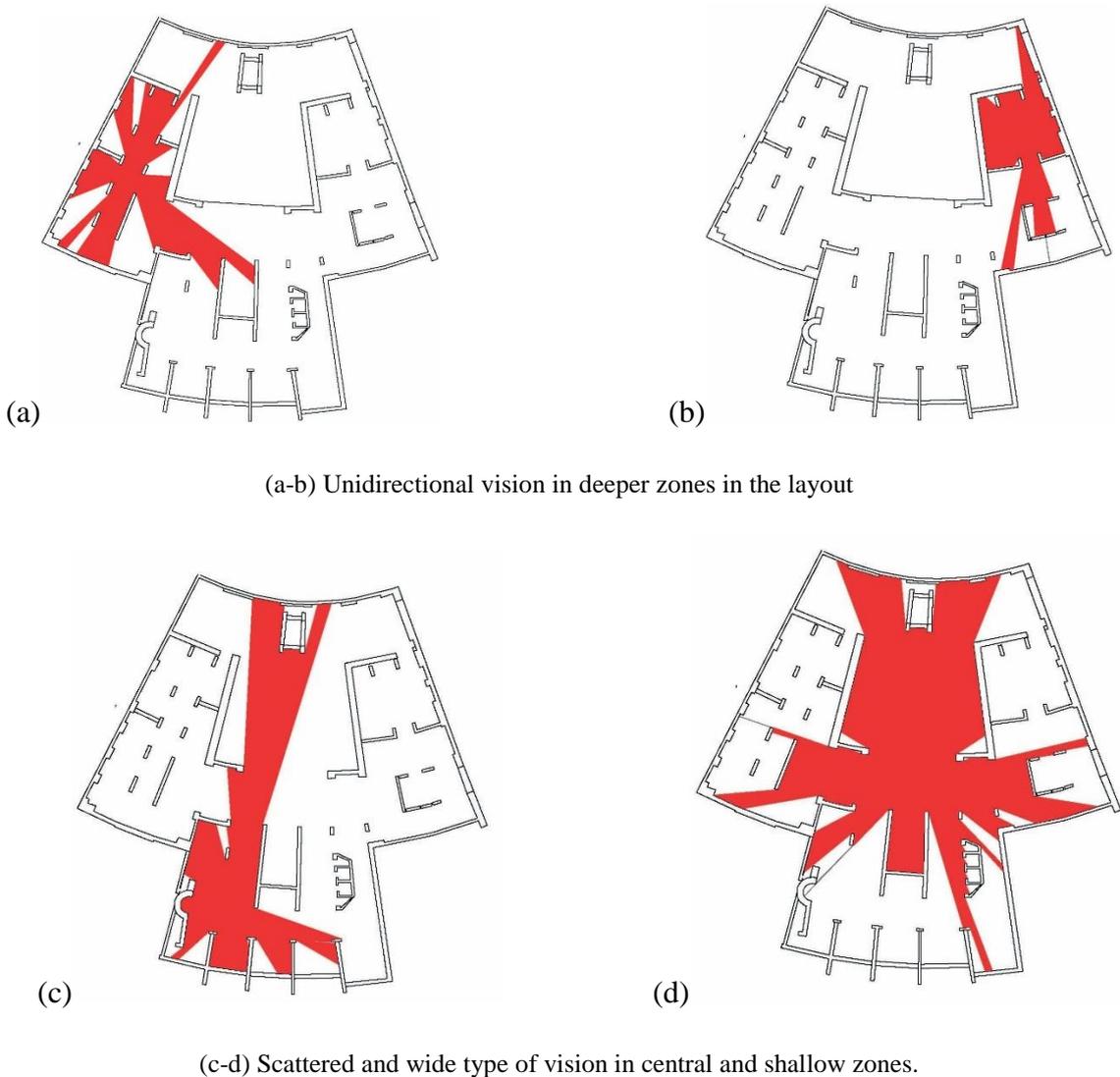
Figure 5.15: Isovist maps in the Nubia Museum showing the visual field from several points across the layout (Author).

After analyzing the type of views presented from different locations within the layout it is important to analyze the overall visual structure of the layout with relation to its surrounding spaces and the global scale layout. However, this case is different from its predecessor, as due to difference in levels, and high of display objects, the analysis will be employed on two levels, eye level (visibility), and knee level (accessibility) that would present a more detailed analysis of the space.

By doing the VGA it shows Figure 5.16a, c, it enabled the author to identify the central entrance hall as the integration core of the layout, which permits the highest level of visibility to the surrounding areas, as first introduced by the Isovist earlier. However, from an accessibility stand point, the integration core is very weak and dissipated, where various but little spots can easily link other spaces within the global layout together. Moreover, it can be noticed as well that the visual integration intensity reduces for both factors (visibility and accessibility) as the visitors get further away from the core, implying that the visitor will need to rely on the local visual link between the neighboring spaces. Visually the spaces are the extreme opposite of the EMC, as this layout doesn't provide a visual axis that allows the visitor to perceive all the space at once, instead, it starts to reveal itself gradually to the visitor as they explore it and go deeper within the network, thus creating a labyrinth-like layout where deeper visual information isn't as available as before, and relies on the visitor's exploration to further reveal the deeper spaces (Rolim et al., 2019). Then by generating the connectivity map shown in Figure 5.16b, d, it can be used to deduce the most visible locations within the layout by first analyzing the visual link between spaces, where the central core is the most visible spaces from various points within the complex shown by the high intensity of red in the central hall, revealing the most visible point in the layout which is visible from surrounding locations, while the accessibility factor it can be seen that high levels of connectivity culminating at the entrance core, and at the other end of the layout meaning that on a global scale those places with warmer colors represent the gathering spaces where people who diverged from the entrance hall at the beginning of their visit are expected to converge again at those points again, and then continue their journey to the other remaining or yet to be discovered parts of the museum.
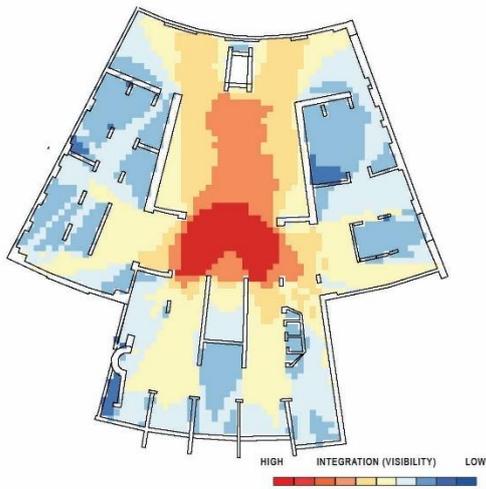
(a) VGA (visibility) integration
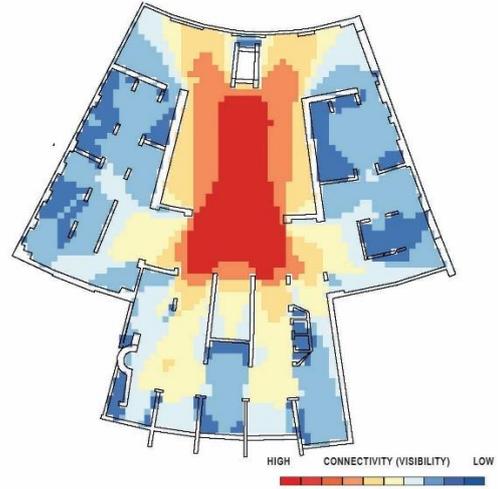
(b) VGA (visibility) connectivity
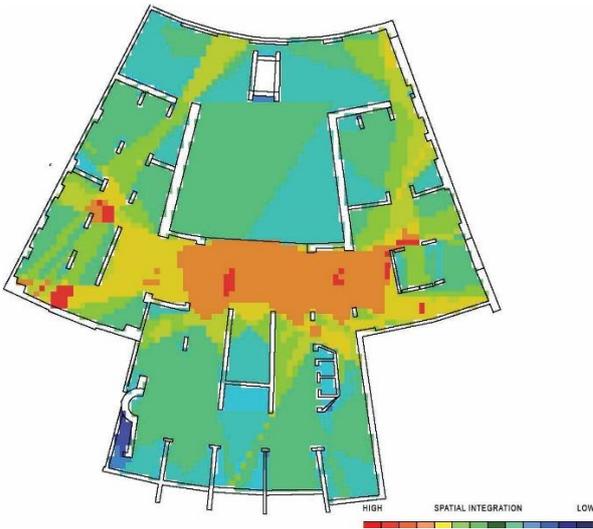
(c) VGA (accessibility) integration
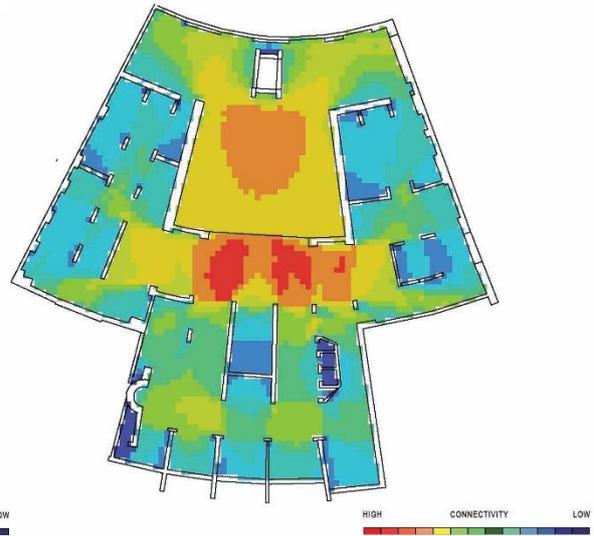
(d) VGA (accessibility) connectivity

Figure 5.16: Visual graph analysis showing the visibility and accessibility maps of the spaces within the Nubia Museum (Author).

(a) Accessibility (0.24) (b) Visibility (0.93)
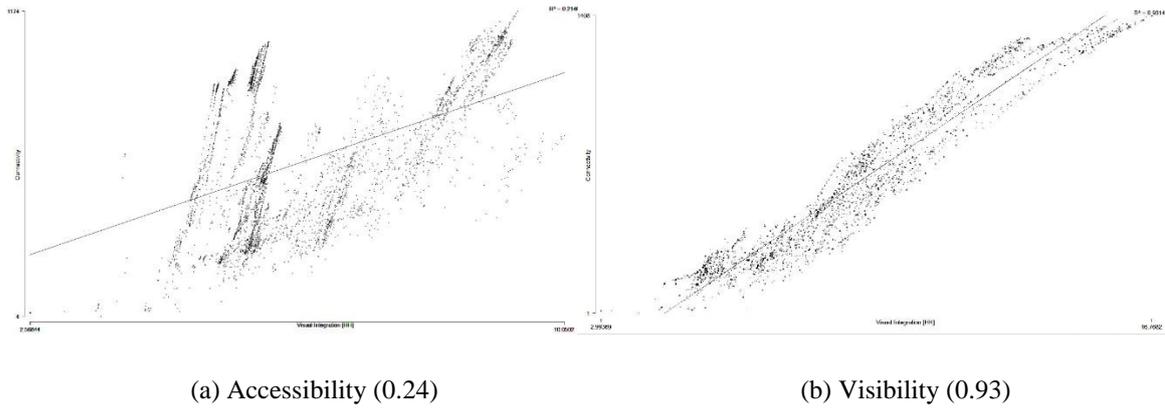
Figure 5.17: Intelligibility maps showing the correlation between the connectivity and the integration analysis in the Nubia Museum.

Using both values of integration and connectivity and plotting them on a graph we get the syntactic intelligibility, that presupposes whether the visitor can get an overall image of the layout from the local network. The scattergram above in Figure 5.1, shows the intelligibility level of around (R^2= 0.214) which reflects a very low understanding of the whole layout from the local network, what can also be said that contributed to this is the deep connectivity at the deep ends that can be seen in the graph showing up and down fluctuation, yet the overall was drastically below average hinting that there are so many segregated spaces within the layout. Having very low intelligibility values predicts a low tracking score on deeper parts of the layout, and that not all rooms will get the same amount on visitor score compared to the more integrated ones.

5.3.3 Visitor's Movement, Exploration and Encounter

Compared to the EMC, the Nubia museum's movement is not easily predictable, due to the fluctuating integration and intelligibility values, so by performing the Agent-based, it will show a better sense of the movement pattern and the social function that is produced by the space. Once again, in this simulation 10,000 agents were deployed in order to achieve the 50 to 55% accuracy rate that was developed and tested by Alan Penn & Turner, (2001), in an effort to get the closest movement pattern compared to the visitor tracking and observation methodology.

The results below [figure 5.19e, f] shows that the visitors possess an exploratory movement pattern, as there is not axial/or leading lines that would guide global movement, the visitors are finding their own route and exploring their surroundings in a individual manner, this exploration is supported by the connectivity level of the spaces, as they both have strong correlation (Choi, 1999). Based on that, the results reveal that within the layout, the highest visitor count was recorder at the three gathering spaces that was identified by the connectivity map, the north, central and the southern hall galleries recording visitor flow at around 23.9, 35.6%, 28.9 respectively, indicating that the periphery spaces have less visitation. What can also be noticed from the graph, is the number of rings and sub-rings created based on the visitor's walking pattern, which are divided across sectors of the layout offering multiple choices for the visitor, and highlights places for the curator to perhaps organizes some categories in the sub ring circulation parts. Not to mention that this way of movement and exploration, will that is primarily governed and influenced by the connectivity where it shows the connection with the surrounding galleries will increase the encounters that people will have amongst each other, especially that the gallery layout provides dense views through multiple spaces, making people aware of each other in the process, which could be an attracting factor to this space, as Choi, (1999) found in his study, strong integration links on the local level, makes more people visible within those spaces which in turn increased the overall number of people in the said space.

5.3.4 Exploring Spatial Object Arrangement

After analyzing the raw spatial configuration and identifying some of its properties, it is important to analyze and compare the difference that the object arrangement will do on the visual structure of the layout, and how it will affect, the movement pattern, especially in the Nubia Museum as it has mostly open spaces where exhibits are decided by the curator, to shape a specific narrative or to organized in a specific pattern whether chronological, thematical or geographically. In this stage as mentioned before all the syntactic variables will be measured and analyzed, and that all the mapped objects are placed within the central circulation route, and would result in a different visual link, and thus different movement pattern. As in the previous case the syntactic variables specifically the ones related to visibility are the ones that will be re-examined as the configurational space is a separate property that was analyzed to determine the raw spatial characteristic of the space, and this

layer will add an element that contributes to the overall museum experience, whether it improves it or not, however for this section, the syntactic analysis will be produced and interpreted, and at the end of this chapter, the museological experience will be discussed.

Upon mapping the exhibits, very few effects were expected, closer to none on the global structure, due to the nature of the space as an open-plan museum, that essentially imposes no boundaries and limitation on the visitor route and encourages choice and exploration. Despite the fact that this layout, based on the recent spatial configuration doesn't fully qualify as an open plan arrangement as some parts of the space create sequential movement and unidirectional views, and the spatial layout at some locations participates in the organization of the movement, compared to one of the renowned examples that are identified as fully open layout museums, such as the Acropolis Museum by Bernard Tschumi (1865), and the Sainsbury Museum by Norman Foster (1974). More effect is noticed on the local level, as some of the display settings occlude visibility and blocks movement, creating smaller circular rings or more segregated spaces, while some areas and views are not affected at all visually by the display arrangement, due to the difference in levels, clearly shown in the central hall, or due to low displays in Figure 5.18.
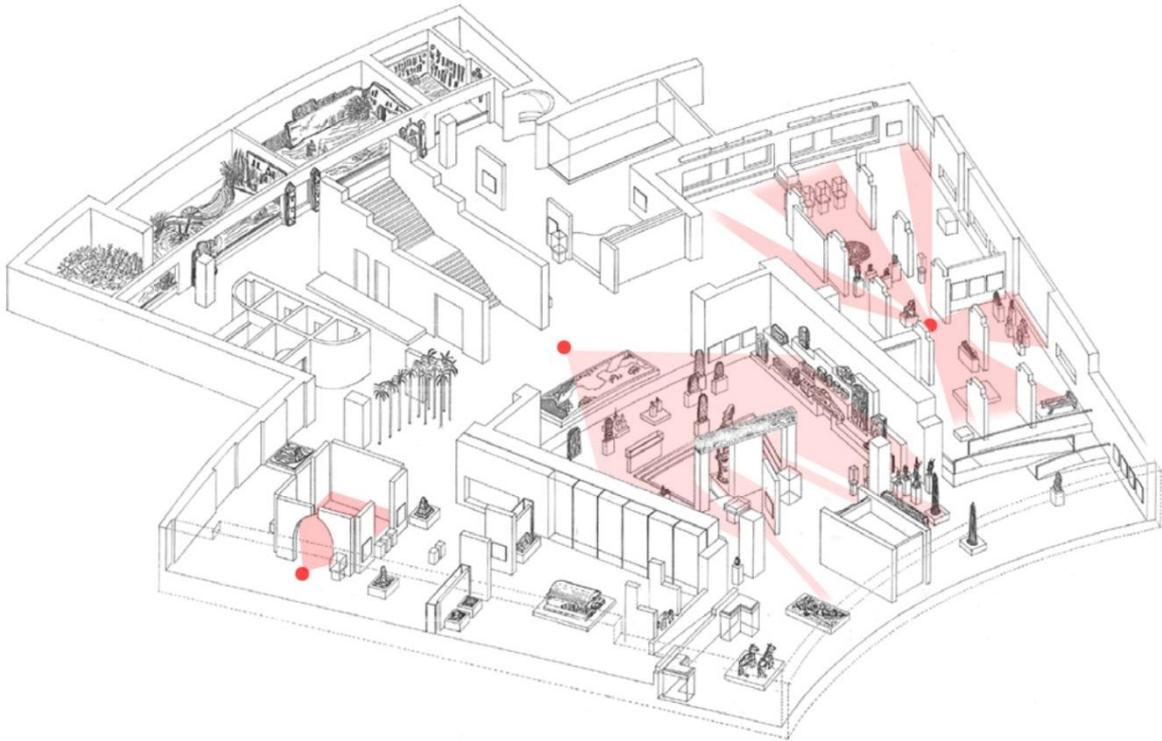
Figure 5.18: Isometric diagram of the Nubia Museum gallery, showing the different types of visibility and accessibility created by the display arrangement. Adapted from *Nubian Museum Drawings* (p. 8), Courtesy of Architect (submitted to the Aga Khan Award for Architecture), 2001.

By running the integration analysis in Figure 5.19 a, b, the results have proved a slight difference in the integration with the exhibits mapped, starting with higher integration values on the southern side of the layout as well as some segregations that took place especially on the east and west side of the layout due to the object placement that blocks the visual axis linking that linked the galleries, and causes a subdivision of the spaces into smaller spaces that more secluded compared to before. On a local scale, using the connectivity map shown in Figure 5.19c, d shows that a significant drop in the visual link of the spaces within the local network, meaning that fewer spaces can be perceived from neighboring spaces, this could be due to the fact that some spaces became enclosed by a circular ring of motion that either encapsulates another exhibition space or encourages movement so very few people can be seen while in this area, as they usually pass by, compared to more concentration and slow-paced spaces, which are the ones located deep in the hierarchy. This can be tested by plotting the scattergram between connectivity and integration to deduce the intelligibility levels, surprisingly the intelligibility level increases to ($R^2 = 0.48$) which is very decent

compared to the spatial configuration on its own which was ($R^2 = 0.21$). This result in Figure 20 shows that the intelligibility levels doubled, meaning that those objects didn't interrupt the movement, but encourages exploration. In other words, the visitor will develop a good understanding of the global scale by traversing through the local scale, this will, in turn, give the visitor the confidence to venture into a more individualized exploration route, that when traced will show a high level of meandering. This can be more shown on the agent simulation, that also shows the whole layout traversed in form of circular ring motion around spaces and exhibits, and shows an even spread of visitor frequency across the layout, but even more next to the entrance, but this is usually a given, as the closet spaces to the entrance point tend to get more traction (Falk & Dierking, 2016). However, based on the scattergram in Figure 5.20, that shows that a higher correlation now exists between the visitors' movement and connectivity ($R^2 = 0.41$) compared to ($R^2 = 0.20$), meaning that as they move in a specific point in the exhibition layout, other spaces are visible from this space and invite exploration, moreover the spatial object arrangement of the Nubia museum developed a viewing sequence that builds on the surprise, that encourages the visitor to explore beyond what they cannot see from a distance, as in the case of Castelvecchio museum (1956), and the approach that was taken by the curator to orient and place the paintings, where they were placed in the center of the room, facing the wall that made the visitor curious and thus attracted movement towards it that further enhancing the type of experience (Tzortzi, 2007). Not to mention that this form of probabilistic movement pattern, where the visitors are evenly spread across the whole layout, along with a long field of vision, that constantly exposes people within the surroundings whether in a close convex space or a much further one, the rich cross-visibility produced in this layout enhances the social factor within the museum experience, which proves to be more socially exciting that the former analyzed case.
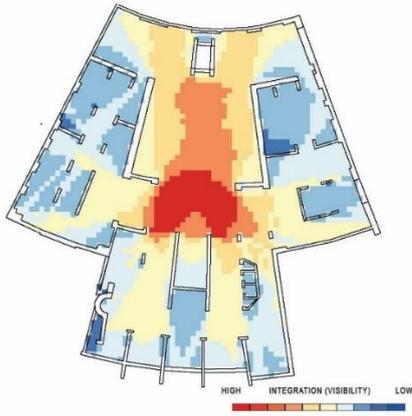
(a) Integration (visibility) w/o display
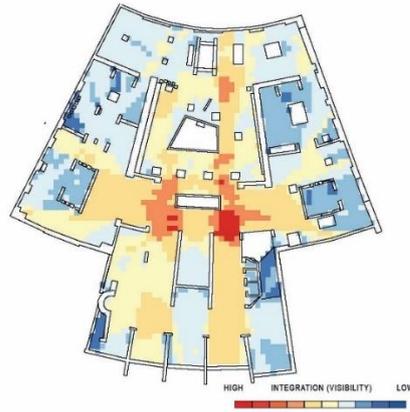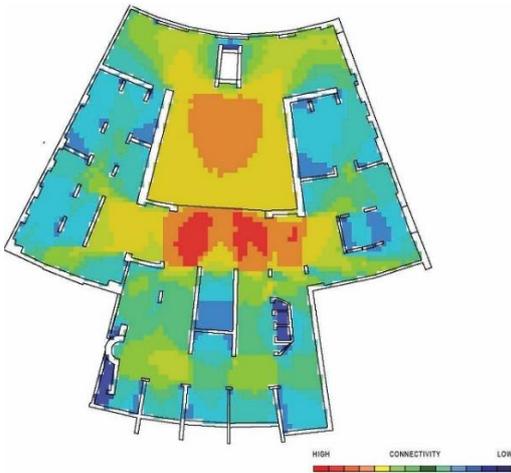
(b) Integration (visibility) w/ display

(c) Connectivity (accessibility) w/o display
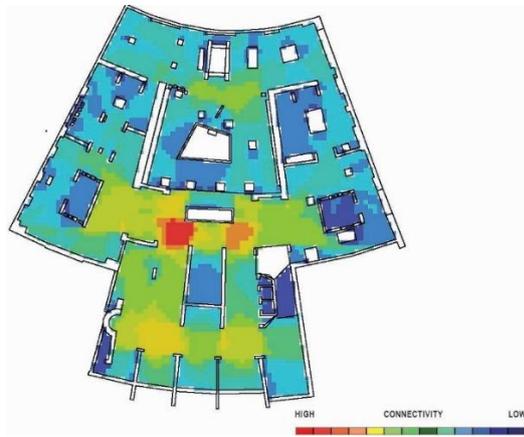
(d) Connectivity (accessibility) w/ display
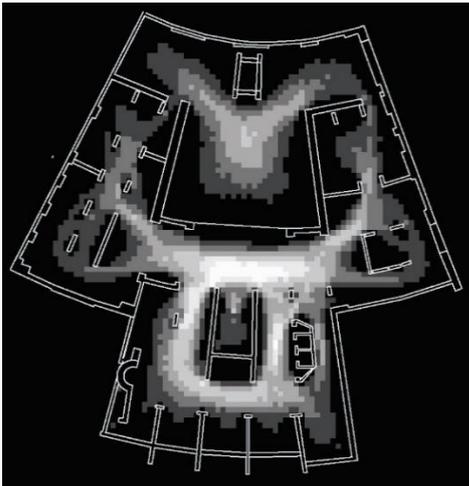
(e) Agent simulation w/o display

(f) Agent simulation w/ display

Figure 5.19: Maps showing the comparison between the two layouts of the Nubia Museum, the spatial configuration alone, and layered with the exhibition (Author)

(a) Existing layout (0.20)   (b) w/ display arrangement (0.41)
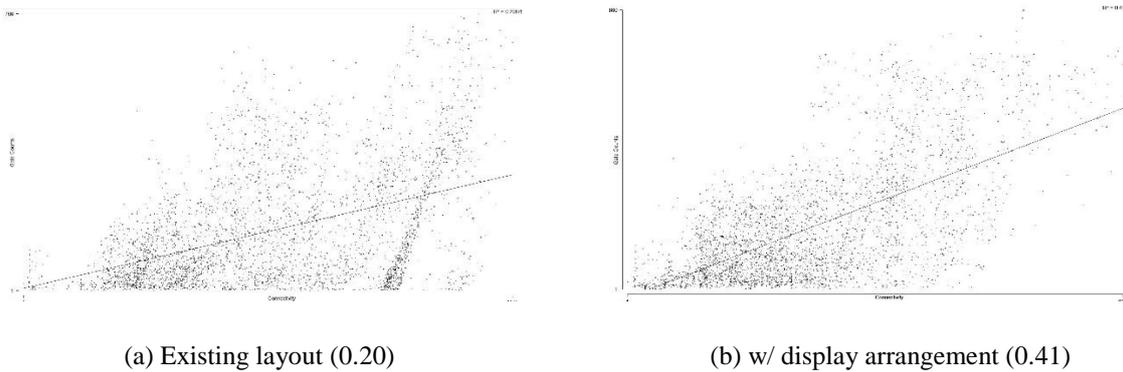
Figure 5.20: Scattergram showing the correlation graph between the connectivity and visitor count in the Nubia Museum.

5.3.5 Museological intent

All of those elements are placed and organized this matter to create an underlying museological intent that shows what the architect and the curator aimed to shape the experience in a specific way, whether thematic, geographic or in chronological order, therefore this section will analyze the aspect of the intent in relation to the existing configuration.

First to recall some of the aims that the curator wanted to achieve was to create a chronological arrangement of the artifacts primarily starting from one point and guiding the movement to and through the museum hall to the back of the building where the open area exhibits are placed. In comparison to the EMC the structure doesn't impose any movement, or any hard axiality, instead it represents an open-plan museum layout, where the space doesn't impose any influence on the movement, instead, the spatial object arrangement is the element that shapes the experience and is used by the curators to guide narrative or create an exploratory itinerary. In addition, as shown in the previous section the spatial object arrangement helped enhance all the syntactic variables in the space. Now by applying the classification and framing theory, where classification refers to the presence or absence of the boundaries and whether there is a visual link between the objects, while framing reflects whether it is a complex plan or not and whether those routes can guide a specific narrative. So in order to find the strength of classification in the layout, convaxial integration was used,

72

the result was (0.88) which shows a low convaxial integration, as lower values indicate higher convaxial integration levels (Hillier & Hanson, 1984), thus shows weak classification that signifies the open layout arrangement of the layout, meaning that the organizations are conceptually or very minimally enclosed by boundaries, which encourages comparison amongst other surrounding exhibits and encourages the visitors to develop an understanding of their own that is not imposed on them by the curator while providing the visitors a richer social experience as the unbounded spaces increases co-awareness and co-visibility. On the other hand for determining the strength of framing, the study adopted Pradinuk's approach (1986) which relies on the mean level of convex integration of the space, as it would measure how far is to go through all the neighboring spaces to cross all the other spaces in the network, the mean integration value is (0.83) which means that the current layout allows for some control over the movement sequence, that is approached by the spatial object placement and the overall layout that controlled the visual field, that enables the creation of a narrative or a chronological organization of objects which was utilized by the curator of the Museum.

5.4 Museum of Islamic Art (MIA)

The third and last case here possesses a historic significance in the Islamic world, and in Egypt. Designed back in 1903 by Alfonso Manescalo and was constructed in Neo-Mamluk style. This Museum also shares the same characteristics with the EMC as it was built during the colonization and was influenced heavily by the European interpretation of the Islamic culture. This museum went through a series of issues and conflicts but it always managed to re-open, the most prominent of which the attack on a nearby polis station in 2014 that caused huge damage to the building and the inside collection but the museum and its curators were able to restore it to its original state and same curatorial arrangement that was done by Adrian Gardere back in 2010, but the museum chooses to re-adapt it again, as it was stated by the museum administration that the arrangement done by Gardere despite some of the concerns and critiques that were raised against it, as it was adequate for the budget that was assigned for the restoration of the building (Berger, 2017). In this study, the focus has been only done on analyzing the ground floor plan in Figure 5.21, and specifically the gallery part as well, as there is another facility that are connected to it, however it hasn't been of a significance to this study.
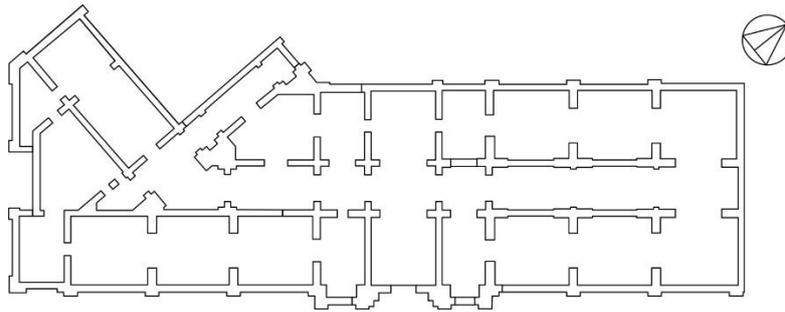
Figure 5.21: Ground Floor plan of the Museum of Islamic Art (MIA) (Author).

5.4.1 Exploring Spatial Configuration

The Museum of Islamic Art was designed following the Neo-Mamluk style, which is a revived Islamic style of the original Mamluk style, this style became more prominent in the 19th century mostly due to the increased western influence that wanted to fulfill the needs of this century with the ornamental style of the Mamluk architecture, this style was heavenly influenced also by the European style and how their interpretation of the Mamluk style, that reflected a rich and powerful Egypt. This building design and façade also followed the same approach that is clearly visible in the modular, and grid organization of the spaces, and the arches that frame all the exhibitions and the corridors across the gallery. Those properties had some implications on how the design is perceived and how it generates movement patterns within it. The spatial composition for the space, showing a grid-like arrangement of modular spaces divided across the whole layout, the layout represents a kind of asymmetry where one side is organized in equal spaces and sizes across the horizontal axis, and the other side is the exact opposite where one side of the axis is orientated differently and contains differently sized spaces. The layout also shows a long axial corridor that traverses the whole layout from one side to the other that is expected to have a great influence on the syntactic properties of the space as shown in the former case of the Egyptian Museum.

Convex and Axial analysis

Starting with identifying the spatial configurational of the space, first by applying the convex map analysis that reflects on the relation of the spaces with each other and the whole, by analyzing the links between them. In this plan, the convex spaces were mapped based on the grid layout, and the spaces that are enclosed with the columns and the walls, as a different way of mapping the spaces, whether bigger or smaller would alter the results as the analysis

74

relies on the size of convex spaces and the number of them available to correctly show the level of integration and depth of each space with the context. The graph shown in Figure 5.22, reflects the number of convex spaces in the layout which is (30), and this layout is shown to have the integration core in the center next adjacent to the entrance space which shows that this space is connected to all the other spaces in the layout and that the integration decreases as it gets further away from the core and starts getting deeper in the layout, where it gets more segregated, that changes the visitor's reliance on cues from the global level to the local, showing a good link between both of them. When linking the convex spaces together the analysis followed the existing layout that blocked some of the links with their neighboring spaces in order to create spaces that would house narrative arrangement, and avoid the maze layout that would have been experienced. And this was set up by Gardere in 2010 to facilitate his narrative structure (Berger, 2017).
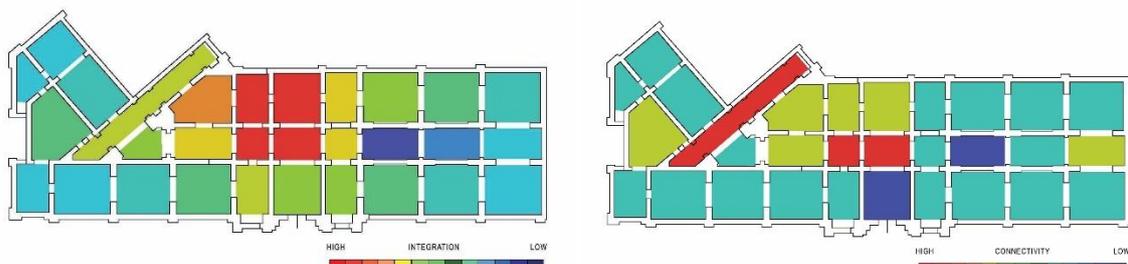
(a) Integration   (b) Connectivity

Figure 5.22: Convex map of the MIA (Author).

From an axial map perspective, the plan has a very strong axiality that holds an essential character of this museum. one that presents the whole museum from one side to the other framed by the beautiful arches as shown in Figure, 5.23, that as mentioned before was adapted from the Neo-Mamluk style designs. Moreover, based on the axial map very few direction changes are needed to get a conceptual idea of the general arrangement and layout of the space, to traverse the whole 30 convex spaces of the layout one has to follow 14 axial lines, that frames visual field and determines next step movement. Noticing that major axes are a common characteristic in this design as it is shown in multiple other parts in the layout parallel to each other on the eastern side, and diagonal on the western side due to the

orientation, that was influenced by the direction of the Kaaba, which was a traditional characteristic of the Neo-Mamluk style, along with the alignment of the main façade on the main street, to show off the ornamentations and decorations. By analyzing the perspectives that are produced by the central axis, it can deduced that the focus and more traction will be on the eastern part of the gallery and this is due to the perspective that guides all the way to a dead-end, identifying the limitations of going right in the space and aiding in the understanding of the layout, while on the other end, it doesn't show where you will go, giving a sense of curiosity but also a sense of uncertainty that will result in people favoring the eastern hallways more.

Figure 5.23: The Neo-mamluk style arches used to frame the main axis of the Museum of Islamic Art. Reprint of Museum of Islamic 3D virtual tour, in NAV3D, n.d., Retrieved March 19, 2021, from https://mpembed.com/show/?m=GLcinPBnEet&mpu=497.

Next by applying the convaxial map one can deduce the relation between the axial lines resembling visual field, and choices of movement as terms of connectivity, by layering both maps on each other a more clearer idea is obtained of how many spaces are crossed by one axial line, and how many other spaces this specific axial line is connected to (explained in chapter 3). The map shown below in Figure 5.24, focuses the eye on the central axis, by also identifying the color gradience that reflects the intensity based on the number of convex spaces that it crosses, ranging from red to blue, with red being the highest in our case

recording a value of 8 convex spaces, and connecting to 4 other spaces, which resembles the highest level of integration, and an average of 3 to 4 spaces traversed by one axial line. This shows that as one stands in one point, they have a linear visibility range of three to eight spaces from any point in the layout, and whilst movement gives also some glimpses on what other spaces hold within them.


(a) Axial integration   (b) Convaxial integration
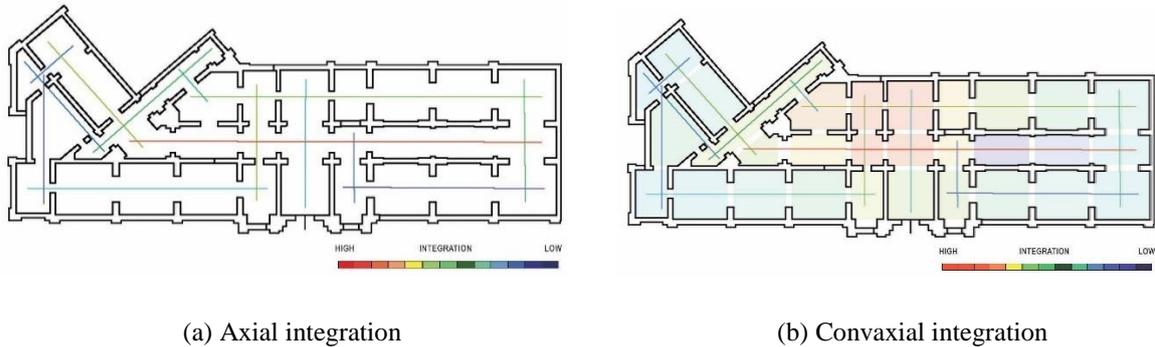
Figure 5.24: Showing axial and convaxial maps of the MIA (author).

Space Depth and Typology

For further analysis on the structure of the space and the type of movement choice that this space creates, a set of j-graphs was generated (explained in chapter 3), that categorizes the spaces into 4 different types of spaces, defined by their relation to each other and the type of movement they induce. By first reading of the justified graph, in Figure 5.25, the results found that the layout has two distinctive space types on both sides of the layout, one side that is deep and sequential representing what is referred to as a 'deep tree' form, as it has so many sequential spaces and creates a deep space at the end, and the other side, shows a balance between the two, where some areas encourage exploration and other spaces or directions when choosing the visitor will be forced to complete the route till connecting back to a *d-space* that will give the visitor the freedom to choose where to go next, but eventually, it leads back to the center, to the spaces (2 or 3) acting as a gathering point of the whole space.
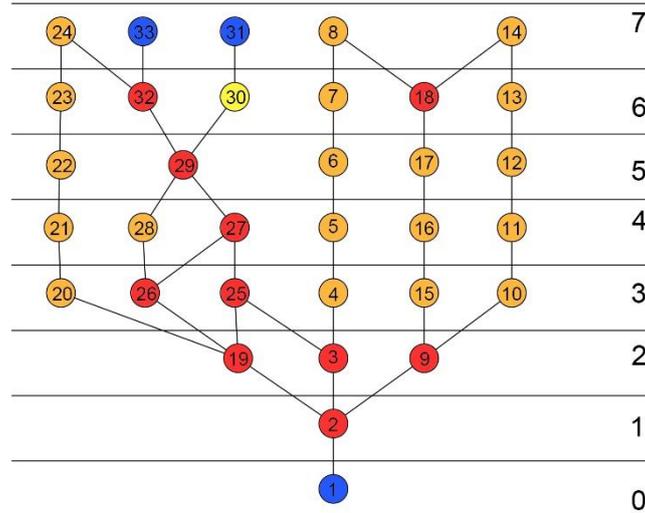
Figure 5.25: The j-graph of the MIA. a-spaces in blue, b- in yellow, c- in orange, d- in red (Author).

Moreover, the space structure implements in the major spaces a unidirectional pattern of movement, owing to the high number of *c- spaces*, which means that the visitors are offered to keep moving forward or backtrack to the main linking point, however, all those c-spaces, are placed on a circular ring, where it can be shown that the eastern wing, constitutes of two bigger circle routes, giving some chances for choice, while on the western wing, there lies more choices and more rings as more *d-spaces* are present, and those spaces are mostly present on one or two circular rings, this provides the western wing with more flexibility in visitors exploration route, while applying some rigidity within the same wing by applying a minor level of control over the movement (as shown between the spaces 20 to 24), and then releasing this tension by providing more freedom of movement and exploration, compared to the eastern wing that looks more rigid. In the Islamic Art Museum, there is around three *a-space* which is 9% of the total number of spaces, which reflects on very little hierarchy in the arrangement of spaces, where all the gallery is set up for a global audience where not many elements are deemed to be for specialized viewing or for deeply interested individuals, and in a movement pattern perspective, the visitors doesn't have enough spaces, where they concentrate on the exhibition elements in front of them, in an area where vision is limited, and contemplation is encouraged. Moreover, there is 1 *b-space* within this layout, meaning that there is more sequencing routes and circular rings in the site, as b-spaces tend to end up with a dead-end, so as b-spaces reduce the other space types are evidently increasing. With

regards to the *c-spaces*, which is 20 spaces, marking around 73.3% that reflects the heavy sequencing of the deterministic approach in movement on the global scale, where people are given two choices of either backtracking or continue the sequence to the next room, those spaces usually lie on a once circular ring. And lastly, 10 d-spaces, around 30% of the total space, showing that along with the building layout the visitor is always presented with a set of choices that they chose to proceed with their exploration. Overall, the layout constitutes of around 2 times the *c-spaces* than *d-spaces* in the layout which means that almost half of the whole itinerary is sequential and controlled, and very little parts of the layout offer choice and exploration, which will affect the social encounters whether on the global or local scale.

5.4.2 Exploring Visual Structure

After analyzing the spatial configuration properties, it is important to analyze the visitor's spatial experience to get an idea of how the spatial layout controls the visual field and its effect on movement. First, the study will analyze various point isovist from separate locations in the layout, to examine the types of views presented to the visitor when in a stationary position. As shown in Figure 5.26, the center of the gallery presents views that are mostly shaped by the arches framing the two distant ends of the corridor and presenting powerful and guided views and perspectives. Moreover, most of the linear galleries including the central axis are presenting a series of visions that spans across the gallery from west to east, the central one spanning over 11 spaces. Other points in the gallery present the viewer with other long distant views as well as shorter views on the local axis linking the local network together visually, while in deeper spaces, the vision is narrowed down to a unidirectional and shorter views that aim to slow down the visitor to focus on the exhibits they are encountering. In this museum layout, the isovist was done on two levels, the knee level to show the spaces that are accessible from a certain point, and from eye level to show the spaces that are only visible (Ostwald & Dawes, 2018), and this would explain the different levels of analysis that will be applied here.
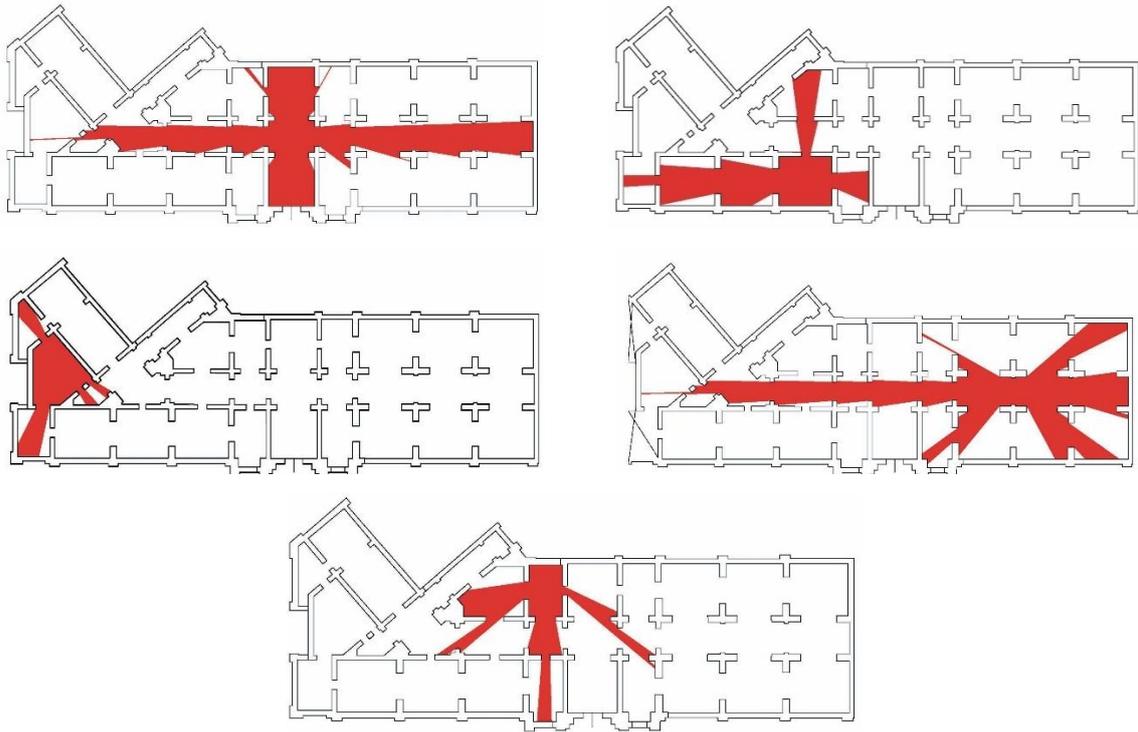
FIGURE 5.26: Point Isovist applied within different locations with the MIA, showing the different type of visual fields presented within the layout.

After doing the point isovist the study has expanded the analysis by deploying multiple isovists in the map to identify the overall visual structure of the layout and analyze the visual relation of each point with its surrounding and the whole. By applying VGA (visual graph analysis), on the two layers of visibility first and then accessibility, the visibility analysis includes the connections done between the rooms over low displays, or transparent glass exhibitions, which allows vision but cannot be traversed [See example in figure 5.30 below], the layout that is being analyzed at first isn't including the spatial layout arrangement, but it includes the boundaries that were set by the designer, to create a setting that enables a narrative structure as discussed earlier on the justified graph. At the first glance the visibility analysis in Figure 5.27a, b, confirmed the previously mentioned expectations, due to the geometric and grid nature of the layout, the central corridor constituted of the main visual integration core, as along this axial line the visitor is met with uninterrupted views of all the surrounding galleries whether axially or at an angle. From an accessibility point of view, the integration core shifts from the whole axial line to being right in the center or at the eastern end, where more spaces are accessible from this single point, and it links to more spaces on

the global integration network, showing much weaker integration links compared to the visibility which means that the visitor will be encountered with many objects within their vicinity that are visible, but they will only be able to get to them after doing some direction changes, going deeper within the layout. This results in a much less varying movement patterns due to the reduced choices, as evident in the j-graph, and this, in turn, reduces the complexity of the graph, as the general outline of movement is more or less set up to control the movement.


(a) Accessibility   (b) Visibility
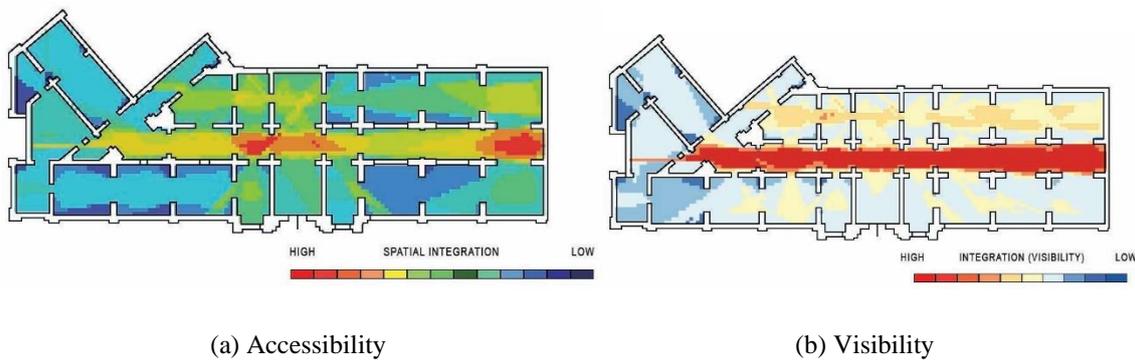
FIGURE 5.27: Visual Integration analysis map of the MIA.

On the local level, however, in Figure 5.28a, b, the visibility analysis, showed a high level of connectivity between the spaces, especially on the eastern wing, as most of the spaces are visible from each other, and the central axis as shown in the graph is the most visible point or axis within the whole layout, meaning can be seen from multiple spaces, in the other parts of the gallery the intensity reduces as the spaces get deeper and more segregated from the global network and from each other as the visual accessibility between them are reduced. On the other hand, accessibility matched the integration core, being in the center and the far end of the eastern wing being the most connected global and locally, and that the link between the spaces became predominantly unidirectional, owing to the sequential spaces within the layout. When plotting the intelligibility map shown in Figure 5.29a, b, the study tested the two levels of intelligibility from an accessibility and visibility point of view, and the results were (R^2=0.63, and R^2=0.67) respectively showing a very close link between both graphs, which is mostly linked to the central integration axis as a core in the visibility map, compared to the smaller center point integration core in the accessibility map. Meaning that the layout

is easily legible from the local scale of the layout and that even when what is visible is not directly accessible, the visitors can figure out the number of direction changes needed and how to get there easily.


(a) Accessibility   (b) Visibility
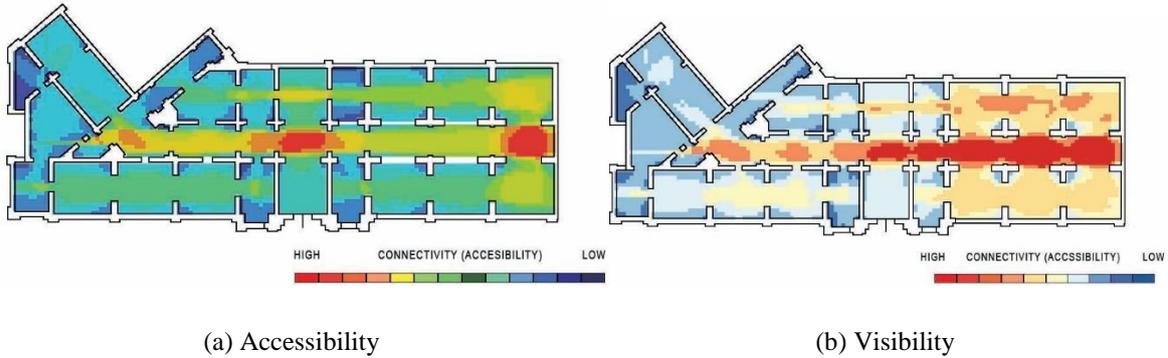
FIGURE 5.28: Visual connectivity analysis map of MIA (Author).

(a) Accessibility (0.63)   (b) Visibility (0.67)
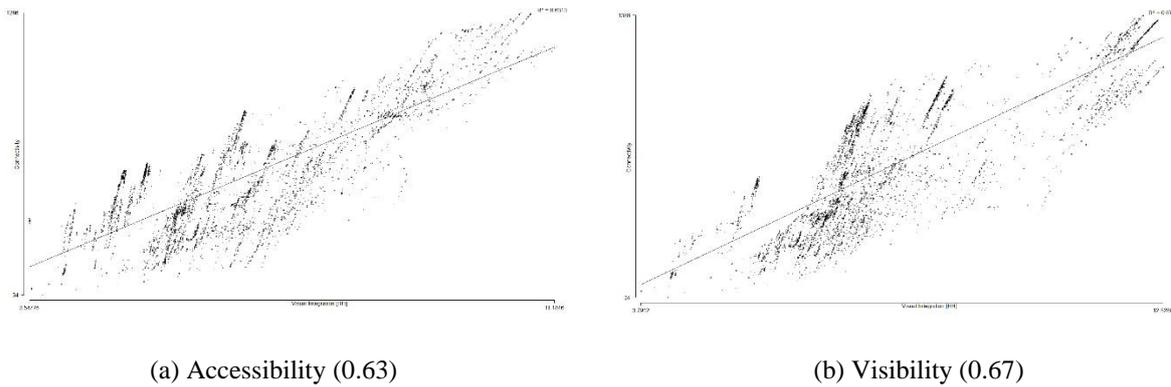
FIGURE 5.29: Intelligibility maps showing the correlation between the connectivity and the integration analysis within the MIA for (a) Accessibility, (b) Visibility.

5.4.3 Visitor's Movement, Exploration and Encounter

Based on the integration core, and the values and results obtained in the previous section, specifically related to the intelligibility, that helps predict the visitor's movement, making it possible to develop an expectation about the movement pattern within the layout, as with the prior cases the agent simulation model was used, deploying 10,000 agents. The results of the simulation in Figure 5.31e, shows that most of the movement is present within the integration core that was previously visible in the movement integration map. Moreover, the results show that most of the people are spotted in the center as it links the left wing to the rightwing

acting as the main axis for circulation, moreover, the other galleries that exist along the central axis constrict movement to linear/sequential movement, that ensures that most of the spaces are to be visited, and so even visitation of all the space is achieved. However also as shown, the more they go deeper within the network, the less intensity is read especially in the western wing galleries, as the deeper they go the number of space that the visitors omit increase (Tzortzi, 2007). In terms of social encounter, the spaces created to limit the encounter of people within the same itinerary as the movement is limited to sequential spaces in the majority of the layout and especially in the local network, however, an informal social setting is developed when the people get to see other visitors between the two scales where people in the local network can see the visitors in the global network due to the high visual permeability of the layout. Moreover, the scattergram shows that the local network shows a very low correlation (R^2=0.34) with the visitor count, owing to the linearity of the layout discussed in the previous section.

5.4.4 Exploring Spatial Object Arrangement

The articulation of the spatial objects is another layer that has been analyzed in order to measure the difference it has, in improving the overall spatial configurations and the museum experience, and how does it affect the visitor's movement and visibility of their surroundings. By referring back to the design intent that was referenced earlier, it was acknowledged that Gardere wanted to create the exhibition spaces that supports and enforces his narrative structure, and his organization and curatorial intent, whether chronological, regional, geographical or thematic, which will be discussed further in the next section. The spatial objects that were mapped first were measured in terms of visibility integration between the spaces, not major differences have taken place as not all the exhibits were mapped especially the ones that won't block the visual field, like the fountain in the eastern wing, and some other displays that are placed on a low height, that wouldn't also hinder visibility as shown in Figure 5.30. Thus by applying the integration analysis not so many differences were expected, and as shown in the results below in Figure 5.31a, b, shows that the integration core has been dissipated to focus along the whole axis corridor, but with a lower intensity, as shown based on the color intensity, this is caused there are elements that block the linear perspective of the central axis, as well as in the local network, where the strong axial vision has been reduced, to visibility within the local scale only. Besides, the layout reduced some of the segregation of the western wing, caused by the breakdown of the

long axial line, which would cause visitors to stop and survey their surroundings and choose the next destination. Moreover, a change in movement pattern is expected, and this will be deduced after the analysis of the syntactic variable of the configuration.
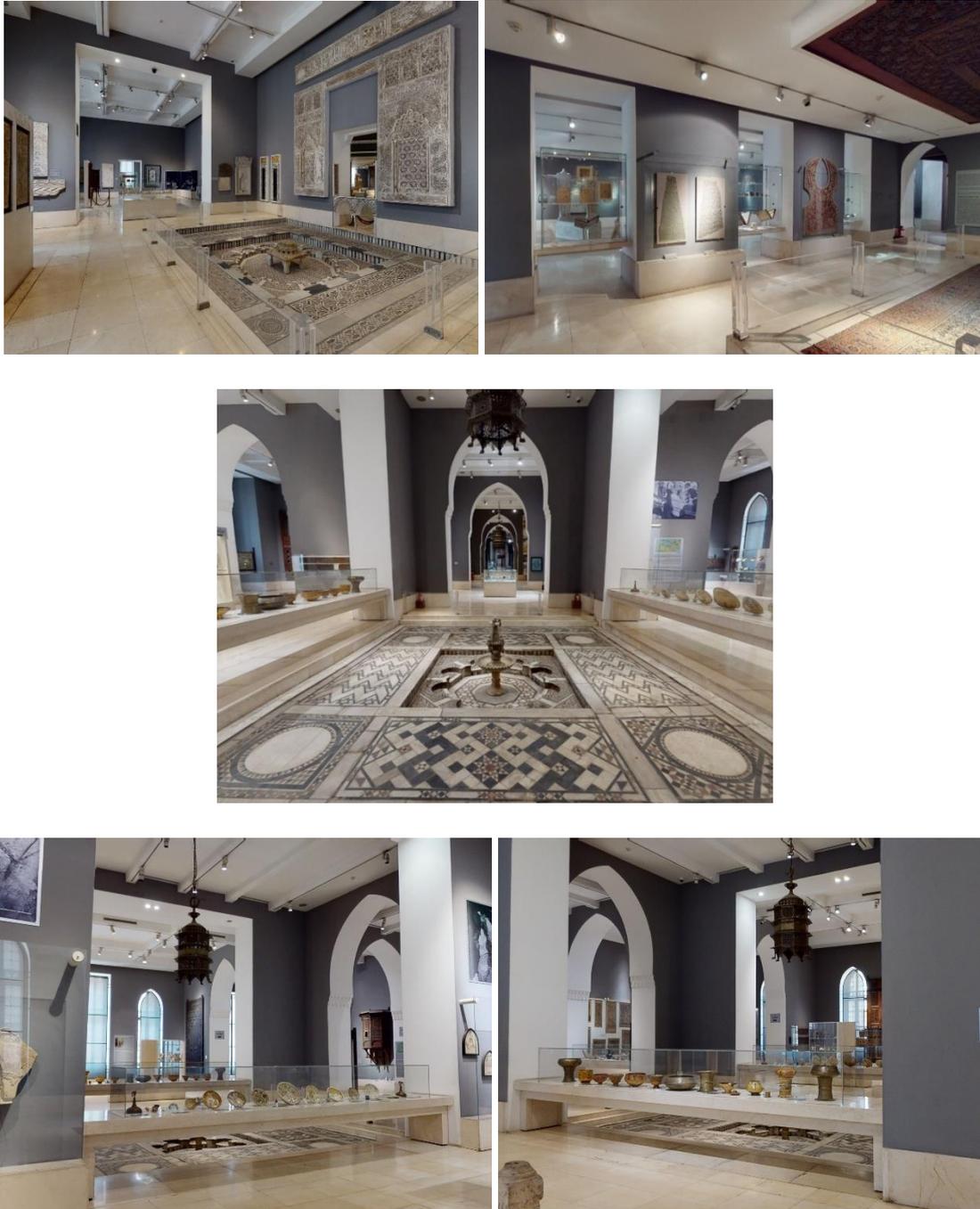

Figure 5.30: Showing some of the ground placed exhibits, like the Ayyubid civilization's water fountain, and showing some of the low display objects that only limits movement but not vision. Reprint of Museum of Islamic 3D virtual tour, in NAV3D, n.d., Retrieved March 19, 2021, from https://mpembed.com/show/?m=GLcinPBnEet&mpu=497.

Upon mapping and analyzing and producing the maps, the results showed in Figure 5.31c, d] that the integration core, is now divided across the layout, two of which was already identified before, and another one that was developed due to the mapping of the objects causing another integration core and increasing the level of integration within the deeper parts of the segment. However, within the inner and sequential layouts, the integration dropped significantly, which shows that the global layout is getting disconnected from the local scale layout. Moreover, it can be noticed that the object arrangements are blocking various sections of the exhibition movement pattern, especially the eastern wing where the main axis is blocked. While on the other side, some of the objects hinder the quick movement of the visitors within the axis, which will give them a more chance for comparison and contemplation. Albeit those blockings caused a major changes in the layout intelligibility on the visibility and accessibility layers, where it produced ($R^2= 0.50$ and $R^2= 0.14$) respectively meaning that in terms of visibility the layout is legible owing to the linearity of the layout, and the permeability between the spaces, however when it comes to movement the correlation dropped significantly resembling and enforcing the idea of a detachment between moving in the global network compared to the local ones, which plays an underlying role in structure of the social character of the space, where it sustains visual encounter but not as much as physical encounter, as movement-wise the groups that join together have a very little chance of deviating to different routes and if so very little chances of re-encounter, however throughout the itinerary due to the visibility and the low display arrangement, co-visibility can be structured which develops an virtual community, highlighting that active interaction isn't developed or necessary to develop to create the social element within the museum experience (Choi, 1999). Moreover what can be shown from the movement simulation shown in Figure 5.31e, f, that the movement isn't concentrated along the central axis any more, instead on the eastern wing, a more deterministic movement pattern can be seen in a network of a circular ring, where people will enter from one side, and exit from the other site, gathering at the central point of the gallery as shown by the high intensity reading, and then the visitors continue their itinerary in a more exploratory manner, showing some meandering in some parts of the western wing, as they are more locally connected, showing that more tracking movement are now switched to areas of the museum layout that encourages exploration, over sequential routes, as clearly reflected on the maps in Figure 5.32a, b. in terms of correlation between the movement pattern and visitor frequency of

people within the layout, the results were almost the same, showing low relation as mostly the co-visibility and presence is established visually, and based on that next step destination is determined, and also because the layout comprises of mostly a main axial skeleton, where all the movement converges and diverges around.

(a) Integration (visibility) w/o display

(b) Integration (visibility) w/ display

(c) Connectivity (accessibility) w/o display

(d) Connectivity (accessibility) w/ display

(e) Agent simulation w/o display

(f) Agent simulation w/ display
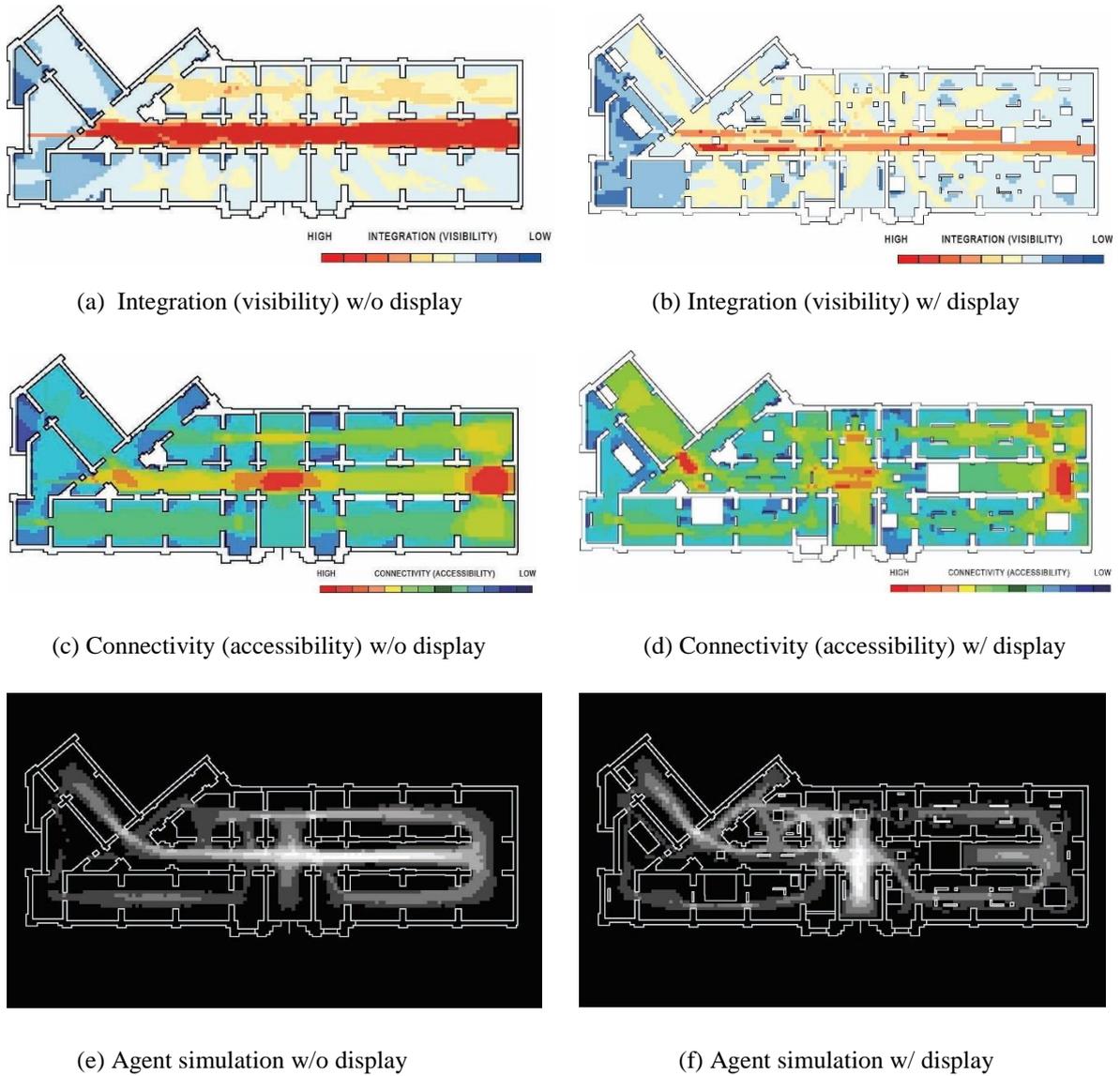
FIGURE 5.31: Maps showing the comparison between the spatial configurations, and the object placement for different variables (Author).

<div align="center">(a) existing layout   (b) w/ display arrangement</div>
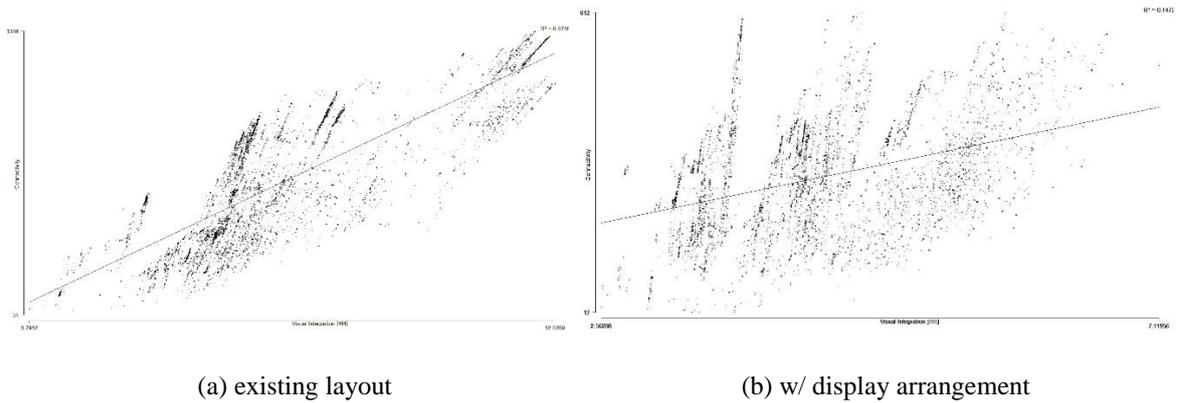
FIGURE 5.32: Scattergram showing the correlation graph between the connectivity and visitor count in the (a) layout on its own, and (b) the layer of the spatial arrangement.

5.4.5 Museological Intent

After understanding and measuring the impact that the object placement will have on the syntactical features of the space, the study adds another layer to try to deduce the curatorial intent in organizing the spaces and predict its strength and its influence on the visitor's itinerary. Before the analysis is done, it is important to recall some of the design objectives that Gardere implemented in the 2010 restoration and innovation plan, where he utilized the eastern wing for a narrative structure that presented a chronological order of the history of Islamic civilizations starting from Omayyad's till the Ottomans, in a circular ring motion, exhibiting the key art pieces from each civilization, and on the western wing, the organization is done based on a mix between the geographical and thematical arrangement of the spaces, the question lies on the different approaches that the spaces are organized in to facilitate a different kind of organizations, and how the classification of spaces and knowledge structure that is implemented in the visitor itinerary, and whether it would work as planned. To test these features, an application of Pradinuk's (1986) approach on the concept created by Bernistein of classification and framing that measures whether the existing spaces facilitate the delivery of the curator, by categorizing the knowledge within conceptual or physical boundaries and this is referred to as classification, and whether the spatial property of the space, being sequenced or open, create a circulation pattern that also aids in the delivery of the curator's intent. Starting with the framing of the layout spaces as calculated by the mean convex integration of space where the results are between 0 and 1, in our case, the value is (0.65) showing a strong framing, and the classification strength of the layout is calculated by finding the convaxial integration. However, in this case as the

value increases the classification strength decreases and vice versa, the results came out to be around (0.73) which means low classification, what this means on the overall layout is that the layout has a strong framing, that shows a lot of movement restrictions across the layout, containing a lot of sequential space organizations which support a more controlled narrative arrangement, and works best with chronological arrangement plans. And on the other hand, the low classification shows that the narrative isn't linking all the parts of the layout and that there is no existence of too many physical boundaries that would isolate the galleries instead, the low classification reflects that when visitors are within a specific point in the network, they can compare and contemplate two exhibits from different rooms, or different chronological timeline that enhances the museum experience.

5.5 Comparing the Quality of Experience

After analyzing all the museum's spatial layout and layering the arrangement of objects and exhibits on top of it to compare the differences. What is left is to compare the overall museum experience of the museums across each other, and find out which museum layout offered a better experience? and which layout was affected the most by the spatial object arrangement? did the movement and exploration patterns differ? In an effort to determine the character of the experience.

5.5.1 The Egyptian Museum of Cairo

Starting with the Egyptian Museum, that was primarily designed with the Neo-Classical approach that used to follow the concept of "large museums require simple plans" (Serota, 1998, p.14): with the axial corridors, modular enfilades, central hall/atrium, symmetry in the layout and a general design arrangement that isn't confined to a specific narrative, mostly organized in a categorized manner by the act of grouping. This kind of configuration gives equal value to all the gallery spaces that don't make one space stand out over the others, and presents a layout that was shaped by the needs of time. Thus, resulting in a layout that dealt with the spaces and their display separately, where neither are participating in the delivery or the conveying of any message, and their relationship is conceived as mere exhibits within a building envelope or as said by Serota, (1998) "a machine for showing art". However, this organization allows the visitors to determine what is for them is important, and they get to

see all the spaces categorized properly within their enclosed enfilade that controls the visitors distant visual field and allows the visitor a bigger chance for contemplation.

Moreover, as analyzed most of the galleries aren't linked together visually except the central hall and the central exhibition room in the center, all the rest connected together, instead they are linked to the long axial halls on the periphery of the building that encourages movement on the global level, and concentration on the local level, as shown the spatial arrangement also participated in slowing down the movement which increased the presence of people in the corridors/halls as well, which integrates the halls from being just a circulation ring into a mixed-function were people traverse, see exhibits and be seen, that bridged the gap between the static and dynamic approach of the space. Based on the analysis, it was clear that the layout is easily legible and that it reveals itself to the visitor upon entry giving them the idea of the spatial layout of the who layout, which gives the visitor more time and energy and the confidence to choose their own route and easily locate their area of interest within the museum. Visitors in the Egyptian museum despite not being designed in a fully sequential pattern or progression of spaces, still imposes a sequential one-way movement within the circular ring of motion that narrows down the visitors' choices to handful decisions that provide more control over to the curator.

Nonetheless, there exist some other elements that constitute the museum experience, which is the social function, that in our case is very limited due to the overly exposed halls, and the adjacent enfilade galleries that don't provide different patterns of encounter, and this is due to the fact that people within this layout are most likely going to start their itinerary together, and follow the same uniform movement pattern which means that co-presence that happens by changing views and patterns are not existing, as shown the set of spaces that are accounted as gathering spaces are all on the peripheries with limited movement options, and the central hall, that is jam-packed with exhibits that slow down movement and merges between exploration and social interaction, contrary to the other sections within the layout. Overall, the Egyptian Museum gives more attention towards helping the visitor understand and contemplate the exhibited artifacts by making it easier to traverse the spatial layout.

5.5.2 The Nubia Museum

The Nubia Museum exemplifies the opposite properties of the Egyptian Museum, with different design setting, site, and aim, this museum broke away from the traditional typology of museum designs, shaped by the new museology movement; reducing the curatorial control over movement, making it more related to the people and the community, giving the power for the visitor to self-interpret and develop their own understanding, and breaking away from the object-centric approach that discards architecture as an envelope for the artifact and not a contributor to the experience, and with also the integration of education and knowledge transmission as an essential part of the museum (Hooper-Greenhill, 2000). The most noticeable feature and property of the Nubia Museum are that there is coaction between the space and the objects displayed to shape the experience of the visitor. Based on the brief this harmony will be utilized to construct a narrative that will help convey meaning and helping with the understanding of the exhibits and their significance, in a specific hierarchy that leads up to the centerpiece being in the northern part, housing the statue of Rameses II (1304-1237BC). Moreover, they help develop a relationship between different categories by providing direct visual access to them from different points within the space.

The syntactical analysis also revealed the synergy between the space and the added layer of exhibits that helped enhance the overall use of the space, improving intelligibility within the layout, and channeling visitors through them, and providing a permeable field of vision that limits the view to a determined set of spaces that assures the continuity of the narrative and also increases the probability of visitor count in other spaces that may be missed. This indicates that the experience is exploratory and constructive that promotes individualized exploration as enforced in the recent results, with an unsubstantial curator control that offers the information in a visibly accessible manner attracts the visitors and provides a changing view from this each point in the gallery that entices exploration, and curiosity, this constant position change and attraction caused by the object arrangement indicate a dynamic exploration pattern.

The other underlying function of the museum experience is the social aspect of it, and how it is shaped. As is shown in the previous section, the design intent and the level of

classification within the layout capitalizes on the nature of space, and encourages social encounter, most the encounters happen on a local level, between the exhibit spaces that are framed by the objects, which increases co awareness and social interaction, yet it is mostly between individuals with the layout compared to the Egyptian that established social encounter between groups. Overall the Nubia Museum exploits the spatial configuration of the layout, along with the curatorial object arrangement to create a museum experience that entices curiosity by unexpectedness and surprise, and the cross-visibility of the exhibits that creates a rich social experience, that develops along the line of the narrative structure that sets up the information in the open space layout and allows the visitor to construct their own understanding and compare and interpret the difference between the exhibits, allowing for a visual field that crosses culture and time, while developing the chronological sequence of the narrative.

5.5.3 The Museum of Islamic Art

The Islamic Museum which was designed following the Neo-Mamluk style, showed a different approach and results compared to its predecessors, especially with the way the object arrangement has been placed and how the narrative was constructed. The syntactic analysis showed that the simple arrangement of the layout played a major role in constructing the curatorial message that was intended, with great importance being given to the grid-like arrangement of the space that structured a sequential itinerary through most of the spaces, where a chronological arrangement was needed. Moreover, the whole layout is structured around the central hall, that lies next to the entrance, as it links the eastern and western wings together where each wing presents a different kind of movement pattern, that in turn differs in terms of experience as well, where on the eastern side there is a more deterministic approach that dictates the visitor's next destination, and the western wing allows for a more exploratory type of movement where the accessibility is high and no chronological arrangement is established.

while installing some exhibit elements along the axis line to slow down the movement of people through the hallway and increase the reading and contemplation time of the exhibits, reflecting an overall spatial configuration that doesn't function to frame or value more works

from the others, instead the grid layout and the modular spaces gives the same significance to all of them, creating a coherent spatial experience.

Although some of the areas within the layout would limit movement to a specific route including the eastern wing, they offer a visual permeability, not restricting or dictating how exhibits should be viewed, in fact, it gives the visitor the ability at most parts of the gallery to experience and compare different civilizations from one point, or even different types of art from one point within the space, that reflects on a spatial configuration, and a spatial object arrangement that doesn't highlight one piece of art, or artifact as in the Nubia museum and the Ramses statue, instead the equal value is placed on all art elements and more appreciation is given to each art piece as it is compared with surrounding object far being it or close.

The Spatial layout and the curatorial decisions played a major role in structuring a strong social pattern within the layout by shaping movement and vision. This is due to the high visual permeability that exists within spaces and the gathering spaces that were formed on the local scale where people would co-existence especially when traversing the central enfilade that globally links all the two wings together. However, the MIA possess a stronger element of co-visibility than the co-presence factor, being a major factor in shaping the social function of space, as it provides the visitors with constant views of other people within the layout while traversing in more limited movement patterns this helps to maximize the co-awareness within the visitors, rendering a more socially exciting experience.

Moreover, the syntactic analysis reflected that the layout is structured in a way that eliminates surprise within the visitor's itineraries, which reduces the self-exploration feels from the visitors. For example, in the eastern wing, all the exhibits are easily visible from any point within the grid, and throughout the sequence, moreover the central enfilade and the arches produced, frame objects placed along the way, and reveals all elements in the hallway, and anything visible from it, and as it is not a very deep layout, the central hall exposes most of the surrounding spaces, which would provide a rush of information for the

visitors who go through it, as there is always a new thing to look at as shown in the isovist figures produced earlier [see above figure 5.26].

5.5.4 Final Observations

Through this chapter, the analysis revealed how each museum utilized the characteristics of the spatial layout, and how the spatial object arrangement either enhanced or hindered the spatial experience of the space. In case of the EMC the symmetrical and modular design layout optimizes a proper categorization of the display, that would make it easy to navigate to specific points within the gallery, however, it restricts movement and especially exploration to a set of circular rings that lie on a shallow configurational structure that would limit the curatorial options. In the case of the Nubia Museum, the open plan and symmetry in the exhibition space created a layout that enables the full exploitation of the space by the organization of the objects to articulate spaces that creates a more exploratory nature of movement in the museum. while in the case of the MIA, the grid layout, along with axiality and asymmetry helps divides the layout into two types of movement patterns: one that encourages a sequential movement pattern the other that sustains a more exploratory culture. All the Museums share in common a set of syntactical properties either across all of them or one with the other, such as the axiality in the EMC and the MIA, as well as the presence of modular gallery spaces, and a core line that traverses the gallery from one side to the other, Moreover, the Nubia Museum and MIA layout allow for a different spatial organization, due to the low number of physical boundaries, allowing for a more flexible organization of exhibits compared to the EMC. Moreover, all museums showed a great effect after the implementation of the objects, and how it changed the overall syntactic configuration of spaces and its effect on movement patterns. Other commonalities that are found amongst all of them are distant visibility, as owing to the low number of direction changes need to cover all the layout, more powerfully experienced in the EMC and MIA, not to mention that within all the cases presented they all possess a shallow depth when measured from the main entrance hall.

However they also have distinguishing features such as the difference in space articulation to convey meaning or the use of space as a narrative device, in the EMC there is a conceptual

narrative that is applied, but with very little control on how you would intake or traverse through the set of spaces, as all the galleries lie on a circular ring, not a sequential route, meaning that some places can be missed, in the Nubia Museum, the objects are the elements used to categorize and classify different objects from each other, structuring a more probabilistic type of exploration meaning that some spaces can be seen but not visited, as the visibility levels are higher compared to the EMC that has hard physical boundaries between different categories making it harder to link the narrative together, while in the Nubia museum the distant visibility of other exhibits gives the visitor the power to construct their own understanding, in the case of the MIA, the spatial layout and the object arrangement are used to create a narrative on one side of the gallery where a sequential, and restrictive nature are produced by the help of the spatial object arrangement, that offers a much less controlled visual field, that enables comparison of different artifacts from different times, that highlights a locally guided itinerary that is either encouraged by the high permeability of the spaces, and the restriction of movement, on the other hand, the western wing didn't structure a narrative instead the curator created a simple autonomous set of spaces that would make it easier to compare different forms of the Islamic art with each other and compare different geographical or regional art with each other by separating them into two layout arrangement, one that is sequential, and the other that is more exploratory and open, the sequential part of the western wing is aimed at minimizing the effort applied by the visitor to comprehend the space, while allowing a full direct line of sight to the end of the corridor, retaining them more energy to concentrate and focus on the displayed content, this also ensures equal accessibility for those galleries which have other implications that will be compared later on, however when it comes to the regional categorization section of the layout more exploratory, and accessible spaces are created that encourages self-discovery, as information is laid out in a visual open layout that presents an overflow of information, that in turn diversifies impressions.

This deference in movement pattern and exploration brings about any key part of the experience, which is the social encounter. The study showed that the EMC capitalizes on the shallow layout of the spaces, and the movement pattern it generates to create multiple shallow encounter zones that happen primarily on the long axial routes, whether the vertical or the horizontal ones, both create a diffusion between movement, contemplation of the

artifacts and social interaction or co-presence. However these shallow encounters highlights and uncovers the spatial influence of space that organizes encounters between groups as most of the gathering spaces are circular and provide very few choices to deviate from the chosen route, therefore group encounters take place, and high co-presence is all enforced by the axiality of the layout, which reduces the intensity of the encounter, as most people start together and end together, in other words, co-present, which reduces the natural encounters that are induced by the spatial configuration. In the case of the Nubia Museum, the open layout as mentioned earlier provides for a series of distant visibility across distant parts of the layout that is achieved by the change in height as well as the existing nature of the open plan arrangement, the spatial object arrangement is an essential factor in classifying and shaping movement in the layout, however in this layout most of the encounters would happen visually as the difference in high and the spatial configuration, created one gathering space which is near the entrance, which reflects on a stronger pattern of co-visibility where people are being aware of each other at varying depth and in our case at varying heights as well, compared to the physical co-presence, which reflects a layout that generates individualized exploratory routes that develops in the local scale, where the exhibits blocking the visitor route shape the movement and therefore lead to more individualized encounters as well, which is the total opposite of the EMC that structured encounter on the global scale, and mostly on the moving routes, compared to within the gallery spaces as in the Nubia museum.

In the case of the MIA, the opposite of both layouts are found here, the spatial configuration and the exhibition setup had a major consequence on the social encounter within the space, the highly permeable characteristics of the layout as well as the long axiality that traverses across long parts within the layout reflect on a high co-visibility rate between the visitors, supported by the arches framing the end of the axis, and the low displays that permit distant visibility into other spaces, within different distances, this increases the sense of co-awareness and co-visibility creating a strong visual community, however due to the high ratio of sequential spaces most of the visitors will be more or less following the same exploration of the pattern which means they will also explore in groups due to the overly sequential spaces which mean they are co-present, and the chances of individualized explorations and deep encounters are reduced as the deepest spaces in the layout are also connected to a sequential route, showing a layout that created a didactic arrangement that

restricts movement and exploration yet tries to sustain the social encounter by maintaining a level of co-awareness within the visitors at different parts of the gallery.

The other element within the museums' layout that played a major role in shaping the overall experience lies in the spatial object arrangement and the placement decisions that were employed, despite the first assumption that the display layout in the EMC was poor and the analysis showed that the display arrangement and how it was articulated favored a more explorative approach, as it slowed the visitors down, allowing them to contemplate the exhibits and explore there surrounding, increasing the level of connectivity with the spaces, and increasing tracking counts within the overall layout, and increasing the overall intelligibility and enhance the whole experience within the layout. In the case of the Nubia Museum, the object organization constituted an essential part of the gallery as it is an open plan arrangement, therefore the object placement is what constitutes the overall spatial experience, without the spatial object arrangement as expected the intelligibility of the space is quite high as shown earlier, indicating that visually the visitor can determine and understand the global structure from the local structure, however after the spatial object placement the layout is integrated into becoming an integral part of the spatial experience, as it reorganized the core structure in terms of accessibility, and visibility, in terms of visual field, the display arrangements block some of the visual fields, causing a reduction in the overall integration and intelligibility of the layout, however it still remains quite legible in terms of visibility, However in terms of access integration the structure exposes the polarity between the structures as the object arrangement breaks down creates a form of movement with very few axial or linear traversing lines showing a more local and exploratory type of connection between the spaces, resulting in a space that visually invites the visitor to the center atrium where the center piece lies, and exposing even more distant points within the complex, while accessibility wise the object arrangement dictates a more localized motion that is experienced once the itinerary starts, as the movement becomes more individualized and with limited vision, guided around the exhibition setup, from one space to the other following the global circular ring route, take would eventually take the visitors back to the entrance hall.

And Finally in the case of EMC, the spatial objects contributed to articulating the vision of the curator that aimed at categorizing and creating a narrative that is didactic in the eastern wing, in the sense that the curator tried to create a space with the help of the spatial object arrangement that ensured the correct intake of information by done by the visitors while allowing them the ability to compare and contemplate different timelines that adds on a different layer compared to any sequential spaces formerly observed in the recent cases, and a more discursive or dynamic experience that relies on the visitor to create a link and convey the meaning of the arrangement while traversing freely through parts of the western wing, overall the object placement affect the MIA on two scales as in the case of the Nubia Museum, however, the effect of the objects in the MIA was more intense than in the Nubia Museum as before the object placement the visibility was very high, as measured by the visual graph analysis, showing the long axial vision through the end of the hallways, and the diagonal field of vision that penetrated the surrounding rooms as one travels through the central axis, creating an easily legible, as well as equally accessible, however upon the implementation of the objects a noticeable difference becomes apparent in terms of visibility that took into account low display elements and ground-based exhibits mentioned earlier, the long visual axial lines are reduced drastically into smaller linear vision across the main central hall, while the diagonal or oblique lines that traverses through the surrounding spaces thus resulting in a reduction in the overall intelligibility as the visibility within the global scale has been reduced, giving more attention and focus to the surrounding spaces, while on the accessibility integration showed the dissipation of the integration core, highlighting that the central axis is no longer a global link within the whole layout, instead of the object placement, was employed to shorten the long axial views in the center but not throughout the whole layout, while limiting and restricting movement in various parts in the complex, thus creating tension in places where the visitors can see for longer strands but are only limited to follow a specific route showing a more controlled framing, and more loosely managed classification, compared to the Nubia and the EMC which is the strictest amongst both cases analyzed.

Table 5. 1: Spatial Typology variables (Author)

Museum	Total Display Area (m²)	No. of Spaces	a-spaces	b-spaces	c-spaces	d-spaces	c-/d-spaces ratio	a-/d-spaces ratio
EMC	1998	24	14	1	3	4	0.75	3.5
Nubia	1086	25	8	1	5	11	0.45	0.72
MIA	1874	32	3	1	19	10	1.9	0.3

Table 5. 2: Syntactic properties of the case studies (Author)

Museum	Number of Convex spaces	Mean global integration (convaxial)	Mean local integration (Convex)	Mean depth	Mean connectivity (convex)	Mean connectivity (convaxial)	Mean Intelligibility
EMC	24	1.95	0.93	2.91	0.93	2.28	0.76
Nubia	25	0.92	0.83	3.96	2.38	2.6	0.43
MIA	32	1.18	0.65	5.08	2.33	2.71	0.29

Table 5. 3: Comparative comparison between convex map analysis of the three cases. (The color scheme for the total depth map is inverted where red is the deepest and blue is the shallowest) (Author)

| Museum	Egyptian Museum of Cairo (EMC)	Nubia Museum	Museum of Islamic Art (MIA)
Integration			
Connectivity			
Depth			
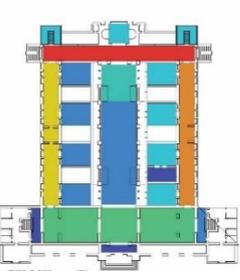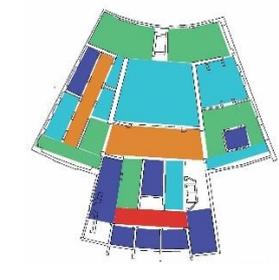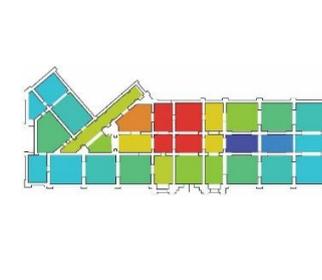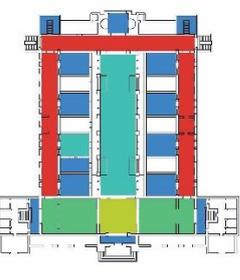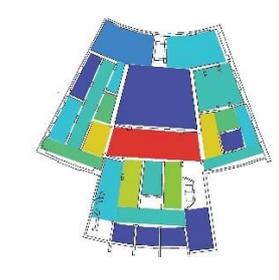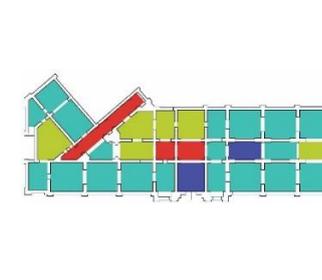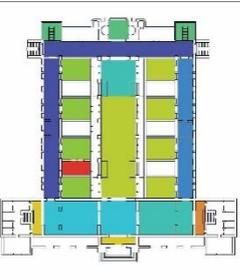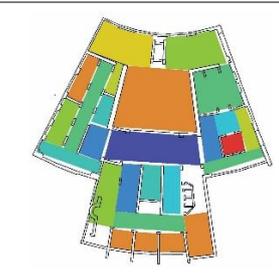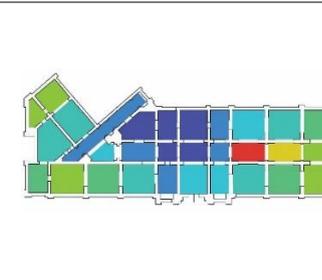
**Table 5. 4:** Comparative comparison between Axial map analysis of the three cases (Author)
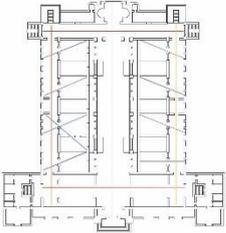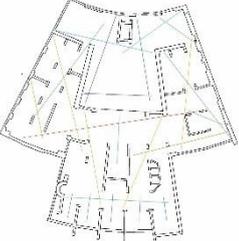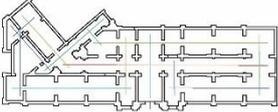
	Egyptian Museum of Cairo (EMC)	Nubia Museum	Museum of Islamic Art (MIA)
Integration			
Connectivity			
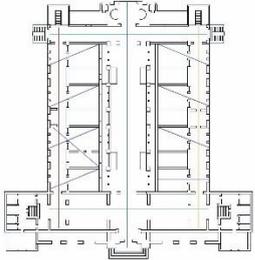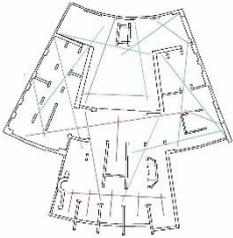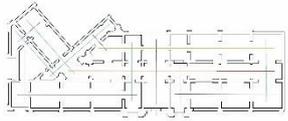
Table 5. 5: Summary of all the major comparative criteria within the analysis (Author)

Museums	EMC	Nubia Museum	MIA
Design Layout			
Configurational Structure			
VGA (Integration)			
VGA (Connectivity)			
Movement Pattern			
Connectivity/ Movement correlation (W/Display)	0.36 (0.42)	0.20 (0.41)	0.34 (0.36)
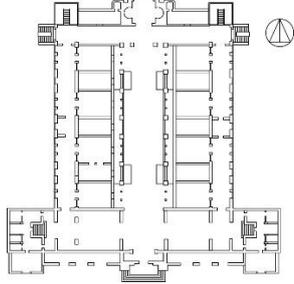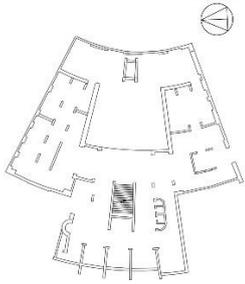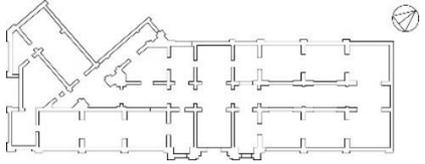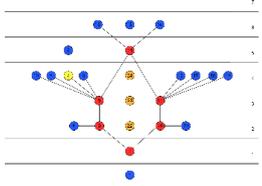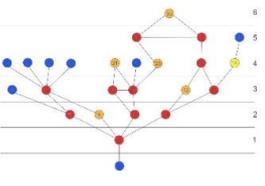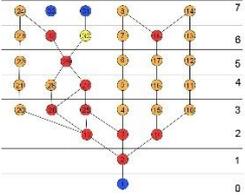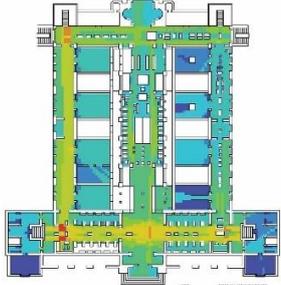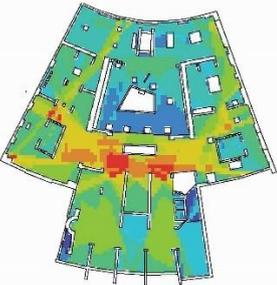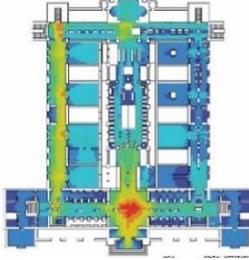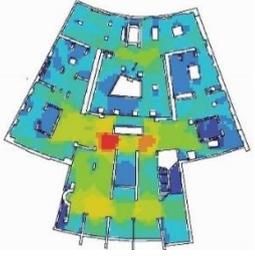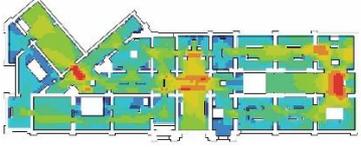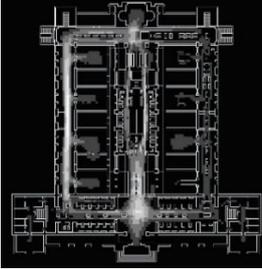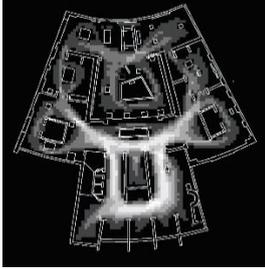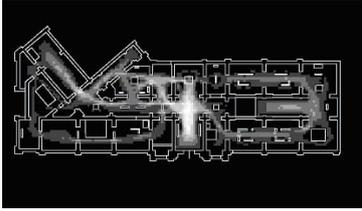
Intelligibility (W/ Display)	0.64 (0.57)	0.93 (0.78)	0.67 (0.50)
Display Arrangement Strategy	Autonomous	Objects enhanced space	Space enhanced objects
Co-visibility	Weak	Average	High
Co-presence	High	Low	Average
Classification (Narrative Structure)	0.58 (Average)	0.88 (weak)	0.73 (relatively weak)
Physical or Conceptual boundary structure (Framing)	0.90 (Strong)	0.83 (Strong)	0.65 (Average)
Quality of Experience	Didactic	Asynchronous	Relaxed and informal

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study has set out to investigate and answer a set of questions that was inspired by the recent rise of interest in museum development in the country and aimed to set a groundwork for future projects by providing an in-depth analysis of key museums in the country, and by identifying and characterizing, as well as highlighting the spatial components of each museum and its effect on movement pattern and the overall experience of the space. By first reviewing and summarizing key points in previous works of literature, that presented the history of museum development and museology, and the emergence of a new kind of museum designs that is revolutionizing the traditional style of museums as a container that harbors art or history. Likewise, in the case of Egyptian museums which was mostly used as a storage space, with no clear intent of presentation, into a more open space that encourages exploration and contemplation. These new approaches shed light on the spatial layout of space and the different ways people interacted and used the built layout, as well as the number of researches that documented the effect of the spatial configuration on the movement and exploration pattern within the museum. Besides that, the existence of vast amount of literature that examined and analyzed various museum layouts in different settings with the help of space syntax as the main methodological approach, which is a quantitative and descriptive method that breaks down the components of space into smaller elements that enable the separate evaluation of each component and its overall effect on the spatial configuration of the layout and translate its effects on the social and cultural function of the space, all of which presented a good body of literature that the author has relied on for the comparison of the case studies addressed in this thesis.

The study then has undergone deep exploration in the history of Egypt, in order to understand which factors especially the socio-political factors that lead to the construction of those museums in their current form and the different museological approaches employed to

organize their permanent exhibition elements in order to develop a good understanding of the cases and build a coherent evaluation of those decisions and their consequent effect on the overall experience of the visitor.

Findings in this study have revealed some interesting results, starting with some of the commonalities and differences of the physical and spatial qualities of the cases, some of the most apparent being the linearity and axiality of the EMC and the MIA, compared to the open layout of the Nubia Museum. This linearity reflects on a more exhaustive circulation patterns that can be associated with the predominant unidirectional views and long hallways as shown in the initial movement simulation noticing high density of movement in the central axis [Figure 5.9e, 5.28e] that is also equivalent to the type of movement experienced in the Tate modern and the National Archeological Museum that both had an exhaustive circulation pattern that limited motion and choices. Wherein, the Nubia museum it possessed a more selective pattern, showing a much more scattered density, owing to the open layout that provided wide visibility that resulted in a variation in the movement pattern as shown in the New Acropolis, as they shared some common elements where the open layout as well as elevation difference helped shape different types of movement patterns for each individual even enabling distant vision across different levels, However in the Nubia, the intensity is shown to be the highest in the center of the space, or near the entrance [Figure, 5.19e]. Another key finding is shown upon the creation of the justified graph that showed equal depth [7] from the entrance, in the case of EMC and MIA, and the Nubia Museum came in with just one less step depth of [6]. However, the difference lies within the types of spaces or space typology that constitutes the spatial configuration network, and the ratio of each space within the layout [Table 5.1]. What can be noticed is that across the cases, the c-spaces accounts to one fourth of the space in both the EMC and Nubia Museum, with the exception of the MIA accounting for half the spaces within the layout, and d-spaces accounting for approximately half the spaces in the Nubia and MIA, and around one-fourth of the spaces in the EMC, and b-spaces was practically insignificant within all the layouts, and based on the known correlation between the d-spaces and a-spaces, when d-spaces are low, dead-end spaces are high and vice versa. Besides that, as shown in the EMC where a-spaces makes up half of the spaces within the layout, while the Nubia and MIA show a very little ratio of a-spaces, where an increase in a-spaces reflects a shallower depth and an overall more

integrated layout between the dead-end and the global circulation ring. Furthermore, the high ratio of d-spaces reflects on a more exploratory path, that eventually shows the effect of spatial typology on the movement and exploration pattern, as well as their effect in assisting in the narrative structure of the layout, which will be discussed later on in this section. In order to properly compare and evaluate the overall experience of all the cases, which is a byproduct of the syntactic and semantic feature of the layout, starting first with applying the spatial analysis and discussing its results.

The Egyptian Museum in Cairo is the biggest and oldest museum within the cases, that the findings revealed that it has the highest level of integration between the spaces, and the lowest level in transparency, as the layout doesn't permit distant vision beyond what is accessible compared to other cases, which renders the layout static, as a result of the axiality and the lack of deeper spaces within the configuration that blurs the line between global and local navigation and exploration. Yet the EMC layout is very legible to the visitor, as it is clear and easy to understand and navigate through owing to its symmetric structure, the EMC presented relatively similar results to those of the National Archeological Museum and the Tate Britain, owing to their neo-classical building style that revolved around symmetry and long enfilades, that made the layouts easily legible for the visitors. In addition, the results also showed that the EMC encourages movement on the global scale, shaped and enhanced by the long corridors that frame the distant perspective, while on the local dead-end spaces more concentration and interpretation is achieved. Besides that, the convaxial analysis performed showed that the spatial structure permits equal accessibility link between the global circular ring network and the dead-end gallery spaces that permit equal visitation to all the gallery spaces but also ensures that not all gallery spaces will be traversed or visited by all the visitors, which equalizes the significance of the galleries amongst each other, not providing the curator a set of spaces that can structure a hierarchy of importance. Despite the layout not being extremely sequential like in the case of Tate modern where the visitors are forced to go through one route and meet in the same point where they started their itinerary. However, the EMC lies on the closer spectrum of linear movement patterns, with very little choices, and a high level of uniformity that causes an underlying effect on the social level, as the low level of movement variation and choices and the very low transparency, results into a very little social encounter between the visitors as most of the

visitors will take one of two circulation rings, and will meet at the gathering spaces that are located on the intersection point of each end of the corridor. That is clearly shown and represented in the graphs as the integration core of the layout indicating the function of those spaces as a reference point and a space where global and local network meet, that highlights the shallow core of the layout, as well as induce movement around the complex. Not to mention, that those gathering space permit long visual fields which present other spaces in the layout. Overall, the layout provides a low probability of social encounter and high co-presence within the layout, which produces an overall a weak social function of space, or a layout that is not socially exciting.

In the case of the Nubia Museum which is half the size of the EMC and MIA, and is one of the modern museums implemented in Egypt, the analysis revealed a relatively high level of integration, where the core is focused primarily next to the entrance, as well as a high level of visibility and a good level of transparency where the incoming visitor will have a direct view of the deepest part of the layout from the entrance, as shown by the isovist maps [figure 5.15]. Moreover, the layout showed a high level of intelligibility of around (R^2=0.92) reflecting the high level of visibility that makes it easier to understand the whole layout of the space, as in the case of the New Acropolis Museum and its open plan layout. Thus, encouraging a more selective movement pattern, as proof that the visitors tend to explore and choose different routes when the spaces is more legible (Choi, 1999), as shown in the movement simulation graph [Figure 5.19e]. Moreover, based on the J-graph, the Nubia Museum was shown to have a more complex layout than the EMC, despite also having a symmetrical physical structure, where hierarchical difference is present between the entrance and the deeper parts, especially in the space typology where there is a higher ratio of d-spaces over c- spaces, that reflects on a more exploratory pattern, that would induce several circulation rings whether on the global scale or the local scale. Moreover, the a-spaces constituting the second-highest number of spaces reflects the difference in a hierarchy within the layout and the different types of movement induced, based on the relationship between the spaces and their surroundings. With these results, a less homogenous and uniform type of movement was expected, instead of a more selective on the global and local scale, and a more dispersed density within the layout with the focus being on the integration core, and areas next to the entrance, as shown in the graph [figure 5.19f]. Moreover, by analyzing the

movement and the integration core, it will facilitate the ability to deduce the underlying social experience of the space, which showed that the circular ring, that dictates the peoples' movement from the start to finish in a circular motion within two global circular rings, structures a strong center were most of the social encounters will take place. Besides that, it will also act as the gathering space alongside another space which is at the other end of the gallery, where the main piece of Ramses II statue is placed, creating a space where people can be co-present that structures an informal social structure, and strengthens the social experience of the visitors. What differentiates the function of the gathering space here compared with the EMC is that the latter induces and guides movement, while the former provides choices to empower the visitor to choose their next destination while creating a sense of co-awareness within the space.

And now for the final case study, the Museum of Islamic Art, that notably identifies with an asymmetrical arrangement of spaces opposite both former cases, which already reflects on a different hierarchical arrangement of spaces, and a predominantly grid structure that reflects the Neo-Mamluk style inside and out, in the façade design, and the inner arches of each enfilade. The MIA isn't highly integrated being the least integrated museum amongst the cases, as it has a deeper structure compared to other cases, and has its sole integration core in the main central axis matching some of the characteristics of the Pompidou which had a deep layout and a single axis where all local circulation branched from it. This axis spans two-thirds of the layout, connecting the eastern end the western end of the museum. Not to mention that, the low integration is caused by the high number of segregated spaces that are available in the layout, most of these spaces are aligned on both sides of the main axis, and the western end is the most segregated part as it has the weakest links with the global structure and each other. From a transparency perspective, the MIA has a very high ratio of accessibility and visibility, owing to its grid layout, the central axis would permit views to the surrounding rooms upon traversing it, give the visitor a good understanding of the space, showing high intelligibility as well (second highest after the Nubia), which makes it easier for the visitor to easily read the space and navigate through it, however, this layout structure was vitally changed by the display structure, that altered some of the existing characteristics to serve in the curator's narrative structure. Aside from that, the MIA contains the biggest ratio of c-spaces in terms of space typology, where the high c-spaces reflect on the sequential

movement pattern within the spaces, and very few d-spaces that is mostly around the central hallway where the central spaces organize a movement to the east and western part of the museum. This type of spaces permits a mostly linear and uniform type of movement as shown in the movement analysis graph [Figure 5.31e] that shows the strong effect of the central core, having the highest density of movement, and the peripheries that also contain a linear type of motion. Identifying the central axis as the integration core, has helped in the classification of the gathering space, which in this case functions as a key element within the layout that connects between the entrance of the buildings and more deeper parts of the layout on the east and west, and so functions as a movement inducing space that guides visitors along the whole layout. Moreover, it connects with the sub-cycle of each side along the layout, while still functioning as a social gathering space that has a high level of co-visibility, exposing people present in different rooms from the central axis, or within different locations, and develops an eminent sort of encounter with all the visitors, providing equal spatial experience as in the Pompidou as all the local spaces permit vision to one or multiple rooms at a time which exposes exhibits and people that improves the social character of the museum. Besides that, in the MIA a visitor selects a path within any of the sub-cycles in the local structure they are bound to return back to the central axis, that ensures the social encounter to take place within the visitors, as well as enhance the co-presence effect caused within the sub-cycles that permit sequential movement, resulting in a rich social experience within the space.

After analyzing the spatial layout of each space individually, the study will now turn its attention towards the second critical part of this thesis that is, analyzing the added layer of display arrangement and evaluating its effect on the spatial characteristics of each museum. To recap, the author has mapped only the elements that are present either at the center of any hallway or spaces that were believed to make a significant difference to the analysis excluding all wall side artifacts due to its ineffectiveness. Starting with the case of the EMC, the results of mapping the objects had little effect on the overall intelligibility as a starter. However, other factors have witnessed more fluctuations of data compared to before, first of which the integration core of the layout is no longer present, perhaps in very small areas around the layout, but what it shows is that the object arrangement blocked some of the recently developed direct visibility and accessibility spaces within the layout. It is important

to note that when analyzing the visual graph analysis, in this case, the accessibility graph and the visibility graph are presented together, as it was mentioned earlier that the layout is not transparent. The results also showed that when the visual field of the visitors are reduced, an inverse effect takes place where the connectivity amongst the local scale increases, as the presence of blocking and occluding elements increases, more and more spaces are being visible within the local sub-cycles, which would benefit the deep galleries a great deal in increasing the visitors' density within them. Besides that, this result is further supported after the implementation of the agent-based that showed a more spread-out intensity of visitors within the deeper parts of the layout, that correlates with the connectivity values. This was previously discovered by Alan Penn and Turner (2001) that observed people behave differently when faced with obstacle along their itinerary or a junction, as they explore the surrounding for a possible next step destination. Based on the results achieved when analyzing the curatorial intent behind the object arrangement strategy, the findings suggest that the current arrangement doesn't function to add any symbolic meaning to the experience or partake in the organization of the space, instead the spaces are organized to functionally be presented independently from the surroundings or the intended narrative, instead, be organized based on the theme required as mentioned earlier [see chapter 4], the layout is organized in a chronological manner. However, the findings suggest and prove that the spatial structure of the layout could be restricting any better display arrangement strategy due to its strong framing of spaces that have been identified in the layout, perhaps further analysis should be applied to measure the flexibility of the spatial object arrangement of the space.

The Nubia Museum on the other hand showed significant results, starting first by the noticeable decrease in the overall intelligibility as proven in all cases as well, resulting in lower integration values, while the integration core hasn't shifted, its intensity was reduced as some of the implemented displays are intended to create occlusions that would encourage local exploration and concentration instead of longer visual fields that induce movement. In addition, the object arrangement was used to create a three-dimensional visually permeable space that can be accessed only from one side, forcing the visitor to turn around and access it from a specific location that attracts visitors towards deeper parts in the layout enhancing local exploration and increasing the number of visitors traversing in the sub-cycles within

the layout. The curator of the Nubia Museum organized the spaces following a chronological arrangement same as the EMC, however as the results show the organizational structure follows a weak narrative structure that follows a strong conceptual boundary at times and physical at others as explained recently, which reflects the sequential movement created by the display arrangement on the local structure. However, in this case, it functions in a way that empowers the visitor to make his own decision, while slowing down their movement to increase contemplation along with providing various visual views that encourages interpretation and exploration. The central statue of Ramses II that spatially lies at the other end of the layout, can show an object-driven layout where visitors traverse through some spaces to get to the key artifact, instead the difference here is that this statue presents itself to the visitor upon arrival, which in turn eliminates the element of surprise, yet it would always maintain intrigue for the visitor to see it up close. Overall, the layout here seems to be organized in a way that aimed at creating a good spatial experience for the visitor, more than developing a proper structure for it that assists in meaning-making.

And finally, in the case of the MIA, this museum instantly shows a decrease in the intelligibility of the whole layout due to the decrease in the integration intensity and the reduction of the integration core strength, that is caused by the centrally placed objects that aim to narrow down vision in the main axis, resulting in a slower movement pattern. Due to the low display objects the layout still retains its distant visibility characteristics but witnesses accessibility restriction that is caused by the curator in order to serve the narrative structure implemented, which would help maintain the high level of co-visibility and co-awareness in the layout, sustaining the overall social experience of the visit. In addition to this, the analysis reveals that the current narrative structure among the layout is relatively weak, meaning that the spaces can be presented to the visitor, but doesn't have to follow a specific order, instead, there exists three different circulation rings each conveying their part of the narrative. However, no rigid arrangement has been made to control the full itinerary of the visitors, instead, the control is applied in the sub-cycle circulation rings only, as proven also by the strength of physical boundaries, that is very little in this layout, permitting further views between two different categories, encouraging interpretation and cross-comparison between two different categories, thus enriching the visual experience for the visitor. What can be noticed as well, is that the curator utilized the existing spatial qualities to structure

and privilege some parts of the layout compared to others, creating a good sense of hierarchy within the layout in relation to the entrance or the center of the layout, and by providing direct accessibility to it, or permitting distant views that attract visitors and encourage movement towards it, either deeper within the layout, or to increase the chance of seeing and visiting other galleries. Overall, this added layer revealed a different effect on each museum layout, whether it slowed down movement to enhance local scale movement and density, or was used to encourage individualized and curious exploration, while modulating views and movement patterns, or utilizing the space to further enhance the object impact, by employing distant views, frames and cross-visibility within spaces, which gives a better understanding of the relation between the syntactic and semantic elements of the layout and sets the scene for the upcoming researchers, designers, and curators to build on this findings to develop a different alternative for the display arrangement, with a different curatorial intent or to create an extension for any of the spatial structure of the space, and how it would affect the overall layout.

This brings the study to the last point of this thesis which is the comparative analysis for the overall quality and type of experience. As shown above, in recent sections, a full breakdown and analysis of the spatial layout has been done, analyzing different variables and components within the layout (syntactic, semantic, and social variables), that all contribute to the quality of experience throughout the museums, the study revealed fundamental differences between all the cases. The first been the EMC, revealed a didactic type of experience, which resembles the museum experience to that of a class, where the information are characterized and categorized in a proper way, which makes it easier to intake information. In the case of the EMC, this is primarily due to the physical structure of the layout, and its subsequent spaces that was created by it, where the symmetrical layout and modular spaces eliminate any element of surprise that usually enhances the experience, or provide choices and power for the visitor to choose his itinerary, instead they identify the global circulation ring that starts from pre-dynastic era to the Greco-Roman period, and the only difference would be done by traversing the gallery all the way from the center which would even make it hard to get a full sense of the meaning and the narrative structure of the place. Moreover, the other element that also contributed to this experience is the object arrangement that was shown to autonomously interact with the surrounding without adding

or removing any extra meaning or spatial properties for the layout, which reflects the functional aim of this museum that utilizes the simplicity of the layout to convey specific information in a pre-determined pattern. However, in the case of the Nubia Museum quite the opposite is experienced, the results revealed to have a synchronous type of experience, which means that every step within the layout presents different views and a different set of choices, whether globally or locally, this is affected primarily due to the open layout structure of the complex that facilitated a high visibility structure. However, the object placement layer added an element of surprise and unexpectedness to the visit, that is created by the short line of sight, that is a result of the objects' visual occlusion that motivates discovery in deeper parts of the layout, as well as individualized discovery and encounter, thus enriching the overall experience of the space. Not to mention, this layout as mentioned above doesn't rigidly structure a narrative, instead, it organizes categories in clusters across space, creating conceptual and physical boundaries that empower the visitor to explore, and interpret the idea and link between one space with the other adjacent objects that would also permit co-visibility and cross-comparison between different displays, compared to EMC that only presents galleries in a secluded and individualized manner. Coming to the last case, the MIA provides a more informal and relaxed type of experience as evident in the grid structure of the layout, and its asymmetrical structure that proved to break linear movement and enhance more opposite types of movement pattern across the layout, as shown by the weak framing structure of spaces, that results in a circular ring of movement at one end, and a more exploratory pattern at another and a sequential movement in deeper parts. Thus showing that the designer didn't structure a specific way of traversing the space, instead focusing on enhancing the visibility between the spaces, objects, and people, where it will be highly intelligible for the visitor to explore the space from whatever point, while having direct visibility of distant displays that can increase cross-comparison at times, and also enhances co-awareness over co-presence due to high visibility over accessibility ratio. Overall, creating a space that encourages movement by distant vision even when in deeper parts within the layout, and enhances cross-references between artworks that results into a highly aesthetical and visual experience within the space, that doesn't follow a rigid narrative or physical structure and maintains an informal social structure in the layout.

Results in this study showed the various differences between the cases, amongst themselves in the spatial level and display arrangement level, where the extra layer caused a different movement and exploratory movement in all museums, and in some museums like in the Nubia Museum played a role in structuring a narrative while in others as in the EMC it remained autonomous. Moreover, the results also showed that amongst each other the spatial configuration of the layout can determine the level of spatial flexibility of the layout as shown in the EMC and its shallow core, however, more research is needed to prove this hypothesis and that each of the museum layouts, despite having the same aim of creating a narrative structure, decided to handle it in a different matter based on what the spatial layout offered, raising the question of what would be the optimum arrangement of spaces that enhances the spatial experience and strengthens the narrative structure intended by the curator?

6.2 Recommendations

This thesis has resulted in some important findings that would set up the groundwork for the upcoming researchers and the government to utilize and improve upon for the implementation and testing on upcoming renovation, development, or museum design projects. However, it is also important to note that due to the pandemic limitations those results haven't been tested on the field, or underwent the traditional observational tracking, instead, a computer-generated simulation has been employed, therefore the author advises future researchers to test the results of this thesis in the field before implementing any design based on it. Moreover, this study has discovered some important dimensions that would be further analyzed in the future which would enhance our understanding of Egyptian museums, mainly the socio-economic impact on museum design and development, analyzing the different aims and intents of foreign and local designers and curators, which lies more on the museological end of the discipline which would explain why it hasn't been covered in this study.

Finally the author hopes that this analysis can help the designers get a better understanding of the spatial characteristics of the spaces, especially those that are going to be renovated or re-functioned, or perhaps reorganized in the near future like the Egyptian Museum in Cairo and the Museum of Islamic art, the former will lose some of its collection to the newer

National Museum of Islamic art and the Grand Egyptian Museum, leaving more space for the re-organization of the spaces, therefore the author encourages the reliance of this study and its methodology to come up with the optimum results, the same case applies for the latter where the curators refused to change the current layout due to budgetary issues and because of claims that this presents the optimum result. Thus the author encourages the testing of optimum arrangement perhaps with merging of artificial intelligence, where the base analysis and layout will be based on this study and its results, in effort to further expand the understanding of spatial object arrangement and its effects. And finally, the author proposes an inclusion and comparison with the newly opened museums, the National Museum of Egyptian Civilization and the GEM to compare the spatial, semantic, and social structure of the museums and compare between the colonial, and modern Egyptian museums.

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APPENDICES

Appendix 1
Originality Report

	AUTHOR	TITLE	SIMILARITY	GRADE	RESPONSE	FILE	PAPER ID	DATE
☐	Mustafa Ahmed Gaber ...	Full MSc Thesis: COMPARATIVE MUSEOLOGICA...	4%	--	--		1614861687	02-Jul-2021
☐	Mustafa Ahmed Gaber ...	ABSTRACT	0%	--	--		1615862723	05-Jul-2021
☐	Mustafa Ahmed Gaber ...	CHAPTER 1	0%	--	--		1615863056	05-Jul-2021
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☐	Mustafa Ahmed Gaber ...	CHAPTER 4	4%	--	--		1615864052	05-Jul-2021
☐	Mustafa Ahmed Gaber ...	CHAPTER 5	0%	--	--		1615864550	05-Jul-2021
☐	Mustafa Ahmed Gaber ...	CHAPTER 6: Conclusion	0%	--	--		1615865694	05-Jul-2021

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Assist.Prof. Dr. Aminreza Iranmanesh
05/07/2022

Appendix 2
Ethical Approval Paper

YAKIN DOĞU ÜNİVERSİTESİ

Appendix 2: Ethical Approval Document

ETHICAL APPROVAL DOCUMENT

Date: 24/04/2021

To the **Graduate School of Applied Sciences**

The thesis titled "Comparative Museological Analysis of The Spatial and Semantic Characteristics of Egyptian Museums" has been evaluated. Since the researcher will not collect primary data from humans, animals, plants or earth, this project does not need to go through the ethics committee.

Name Surname: Assist. Prof. Dr. Aminreza Iranmanesh
Signature:

Role in the Thesis: Supervisor

126