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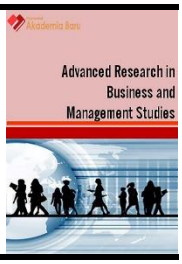

Analysing the Visible Pattern of Use on The Differences in Spatial Typology of Libyan Mosques with Space Syntax

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ABSTRACT

Changes are inevitable and fundamental phenomena. Indeed, the nations' disappearance and societal transformation relies on a range of variables directly linked to the time and the built environment. While the Space Syntax theory is becoming more popular and is being utilized worldwide, Libya has yet to use it. The purpose of this study is to determine the changes of the Libyan mosque layouts and its spatial typology in different periods of Libya using space syntax methods. The study's sample consists of four different historical mosques and a modern mosque chosen from various Libyan geographical regions. Each case has a specific prominence that is distinguished by their historical identity and spatial typology. Accordingly, the study also relies on the visible pattern analysing specifically represented in the Axial and visibility graph (VGA) analyses to reach the main benchmarks and indicators in measuring the differences in the spatial typology of the mosques using the DepthmapX software. The axial and VGA Graph analysis results demonstrate that the spatial typology of the mosques has been differed significantly and recognized clearly. The study concludes that it can distinguish the differences which is a potential to subsequently affect the changing pattern of use due to cultural.

Keywords:
Integrated reporting; institutional theory; legitimacy theory; agency theory; corporate disclosure

1. Introduction

Like any country, Libyan architecture faces the transformation that makes its typology and vernacular identity is changing through time [1]. Besides the built environment, spatial typology of the buildings are also the most affected by this change [2]. Although the characteristics of the Libyan typology, which form mainly its identity, are the most important cultural heritage that we should preserve for the next generations, it still faces the risk of change, disappearance and being replaced by an imported culture [3]. Some studies have advocated for a cultural heritage approach to maintaining and determined Libyan architecture [4-7]; Thus, there is still a gap in the perception of the transformation causes and finding the best solution using Space syntax method. Moreover, since there hasn't been single analytical research in Libya that dedicated the changing features of Libyan building layout using space syntax as a theory entirely, it is necessary to conduct academic research on Libyan architecture to demonstrate this transformation by using space syntax on the most influential buildings in the Libyan urbanization which is the Mosque. This paper aims to use the Axial

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and visibility graph (VGA) analyses to determine the essence of spatial typology of four different mosque in different periods and various regions to investigate the fundamental changes and the differences in spatial typology of libyan mosques and prove how they transformed.

2. Mosque Layouts and Space Syntax

The theory of Space Syntax includes a set of quantitative and descriptive analysis tools that can use for analysis the visible pattern of buildings layout, neighborhoods and landscapes in the space formations [8,9]. Space syntax studies point to enhance approaches for defining occupied space configurations in order to articulate underlying social meanings. By developing harmonious techniques to analyse visible patterns, Recent studies on Space syntax has attempted to recreate spatial ideas in mosque layout plans and predict how these designs will function [8],10]; The studies and applications of According to Space Syntax, the spatial typology in any building layout, including mosque design, has a perceptible and quantifiable impact on worshipper behavior. Given that these impacts can be tailored, anticipated and enhanced before architects should therefore comprehend the connection between design of layout and human behavior. Thus, it can easy to measure the differences through the results of the analyses [11]. The reason for choosing the mosque as a case study is that it is the building that embodies the Libyan identity and is the sturdiest among all other historical evidence. Furthermore, this space reflects Islam's identity. Its significance stems from its place atop the throne of worship [12]. Figure 1 (a), (b) show from left to right: An- Naqah mosque built in the old city of Tripoli; Al- Pasha Mosque in the city center of Al-Khums; Hadia Mosque in the Baraka area, Benghazi; Tobacco Factory Mosque in Tripoli.

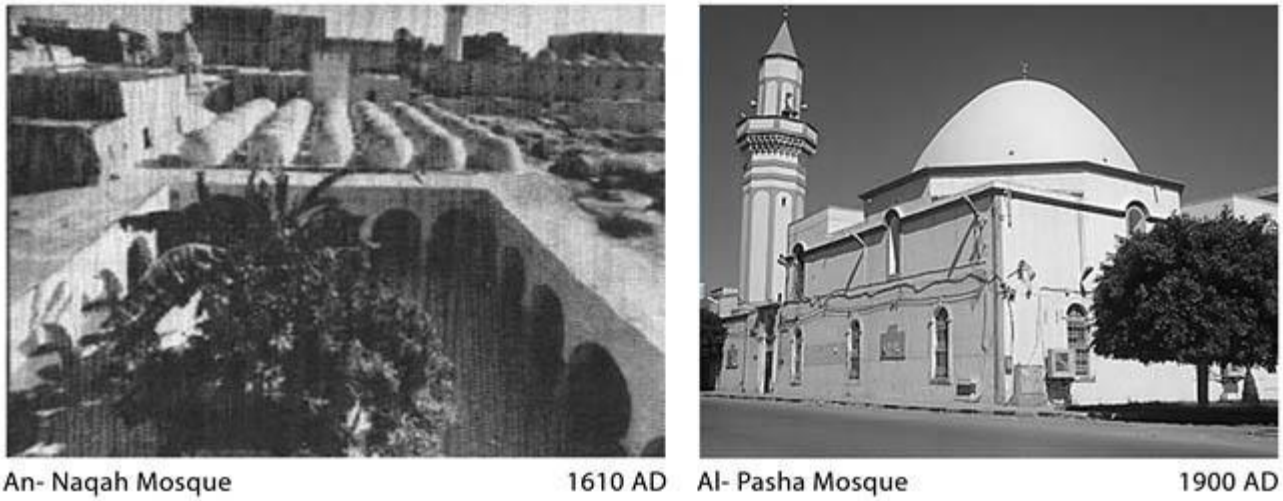

Fig. 1. (a) Images of the 4 mosques from various Libyan regions

2.1 Spatial Typology of Libyan Mosques

How human space is organised is one of the most successful techniques that exemplifies society's specific qualities; this strategy achieves the right spatial typology of building layouts [11]. As the saying goes: “A process is considered functional when the process used is suitable for its purpose.” Perez *et al*., [13] have referred that Buildings are a necessary part of the urban pattern. Buildings, according to urban morphologists, can be classed by typology; types, on the other hand, can be

defined by culturally specific characteristics [13]. Like any other architectural structure, mosques are typically categorized based on aspects such as their external appearance, internal architectural elements, how internal space in prayer halls is treated, and their roofing system. In this study, the mosque classification will be based on the book of *DR. Ali Mas'ud El Ballushi*, which he classified the Libyan mosques based on the roofing system: (1) Layout with a center dome on its roof; (2) Layout with multi domes on its roof; (3) Layout with multi barrel vault on its roof; (4) Layout with flat roof. By observing the mosque plans and their pictures, we can recognize the significant differences between the spatial typology of the four mosques. Consequently, this observation supports this study objective that the spatial classification of mosques has changed and distinguished from its predecessors.

Fig. 2. (b) Images of the 4 mosques from various Libyan regions

2.2 Architectural elements and Categories of space

The mosque's architecture is made up of numerous components that evolved over time and became the religious building's icon. None of these elements, however, have any sacred significance[14]. The masjid in Arabic, A "prostration location" defined as its orientation to the Kaaba in Makkah rather than by any architectural elements, sanitary conditions, a partition to keep the imam's space separate. as well as adequate area for worshippers to gather in rows and prostrate on a smooth surface[15]. Based on Aazam, Ziad, [15] the gates, the minaret, the mihrab (niche), water fountains, courtyards, and the Minbar (pulpit), are all non-essential components in the construction of the mosque concept. The ritual sequence of worshippers. To conduct an analysis of the mosque, it must be separated into several spatial groups that are found in almost all of the mosques studied. The existence with same categories on all the samples in this study demonstrates their importance in the social organisation of these types of buildings. According to typical architectural analysis, seven spatial categories have already been repeated in this type of building[15]. Respectively are the spatial categories description used in this analysis; the gate typically, in some cases one mosque has multiple gates which is indicated by the letter (G); the transition space, it indicated by the letter (T); the courtyard, indicated by the letter (C); the mosque's ablution and hygiene facilities; the ablution and hygienic facilities in the mosque, including water fountains and lavatories which is indicated by the

letter (W); the prayer area, which is the mosque's primary space it indicated by the letter (P); the sixth area contains the mihrab, where the worship is led by the imam in front of the Qibla and the Minbar., it indicated by the letter (M); The final space category categorizes the various uses found in the sample under the labelled functions, , it indicated by the letter (F).

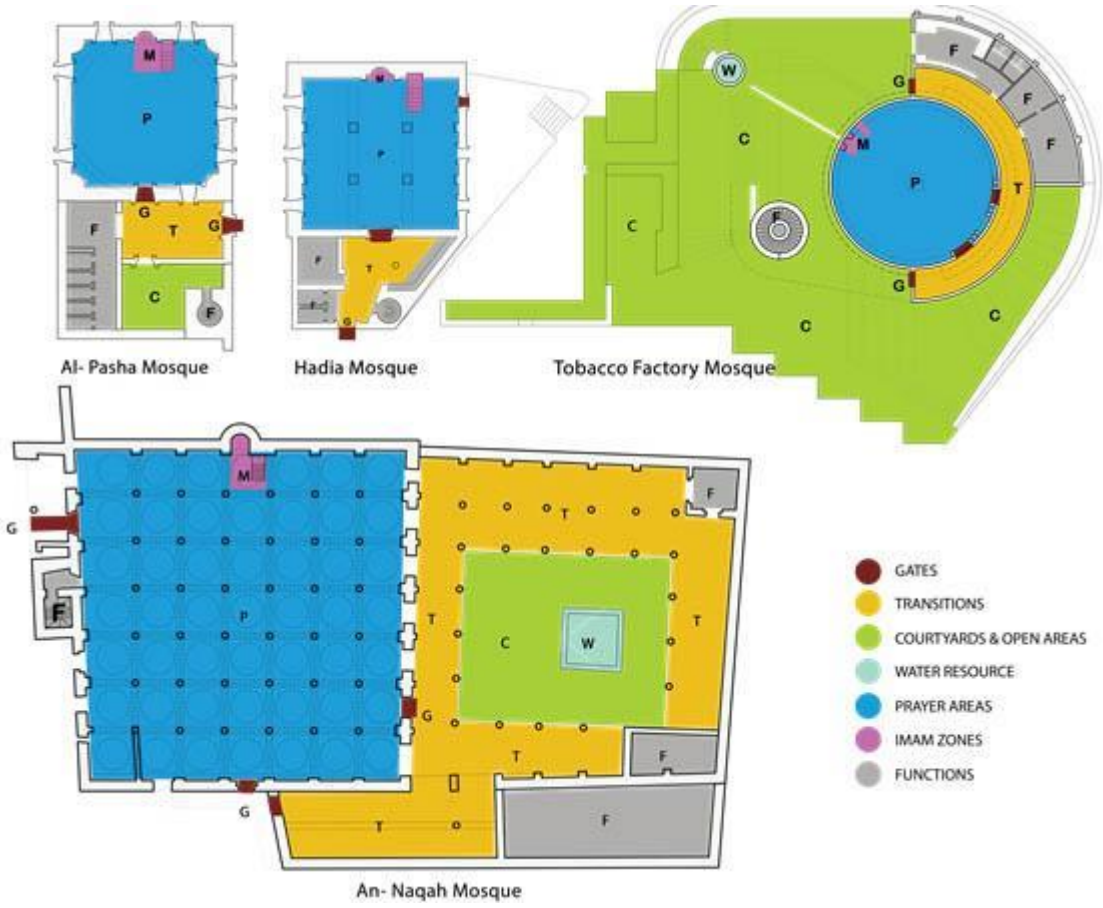

Fig. 3. Plans of the 4 mosques from various Libyan regions

2.3 Syntactic tools

To distinguish the differences, the axial map and visibility graph (VGA) analyses of a layout will be used as syntactic analysis tools in this paper [16]. The axial map is a collection of the shortest straight lines required to cover every space and complete every circulation ring in the layout while avoiding physical obstacles [17]. Which will be referred to in this paper as Lines of Movement and Lines of worshipping. In addition, the VGA is a method for identifying the visibility connections into spatial layouts and urban space. The visibility of strategic entry points can be demonstrated using VGA in all spatial layouts. Which will be referred to in this paper as visual and prostration points [18].

2.3.1 The Axial analysis

Based on the study of Aazam, the mosque has two kinds of lines, line of movement plus the individual's line formed for the purpose of praying because worshippers are required to stand behind and form rows parallel to the wall of the Qibla. This fundamental necessity transforms the

worshipping area of the mosque into a wall facing Qibla that is extended depends on the whole mosques area. Figure 3 show the Axial Analysis of the mosques [18]. Although the open space has been turned into a field of columns by structural requirements in some cases, there is a highly expectation of the movement between columns at any angle. In theory, this option generates a perfect grid just as close as a building can be. Accordingly, the axial lines pass through the mosque layouts in parallel and perpendicular directions to the wall of Qibla. Thus, this study excludes possible diagonal lines of movement in order to achieve an initial basic resolution [17].

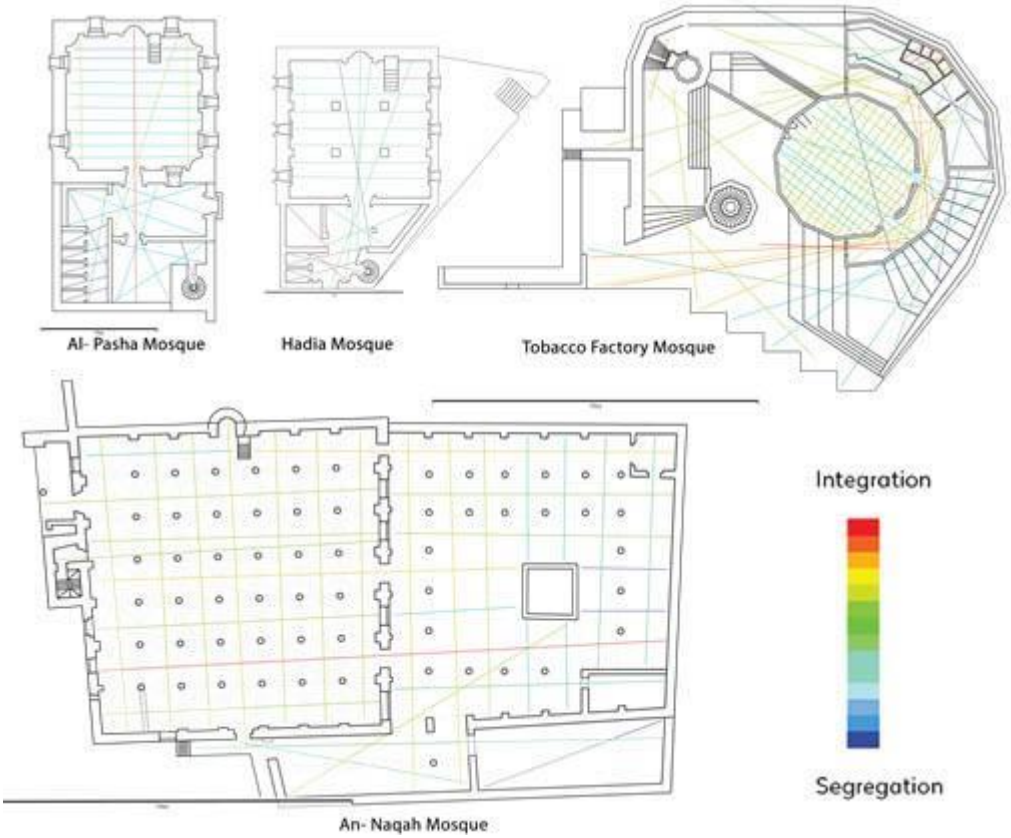

Fig. 4. Axial analysis of the mosques' spaces for the 4 cases.

2.3.2 The visibility graph (VGA) analysis

Yamu *et al*., [19] mentioned "visual graph "(VGA) analysis is a tool for analysing urban space intervisibility relationships"[19]. Turner, *et al*., [20] indicated that "Visibility graph analysis (VGA) analyses the properties of a visibility graph produced from a geographic context. The VGA may be applied on two different levels: eyes level for what people could see and knees level for how people could move, which is important for understanding spatial layouts. Take a look at the visibility graph." [20]

According to Turner *et al*., [20], visibility graph (VGA) analysis is a way of analysing the inter-visible linkages inside buildings or urban networks in design. In addition, visibility graph analysis emerged from the architectural idea of space syntax [16].

The high visibility on the spatial typology is the major characteristic of the mosque's space samples. Individuals (worshipers) anticipate a high level of visual command when they get into the mosque till they locate the way to their selected personal prostration space.

Other worshippers, racks, or small dividers on the ground may obstruct the routes of movement. Even though individuals have high visual integration at any point in time, this indicates that they have ordered to find a space for occupying.

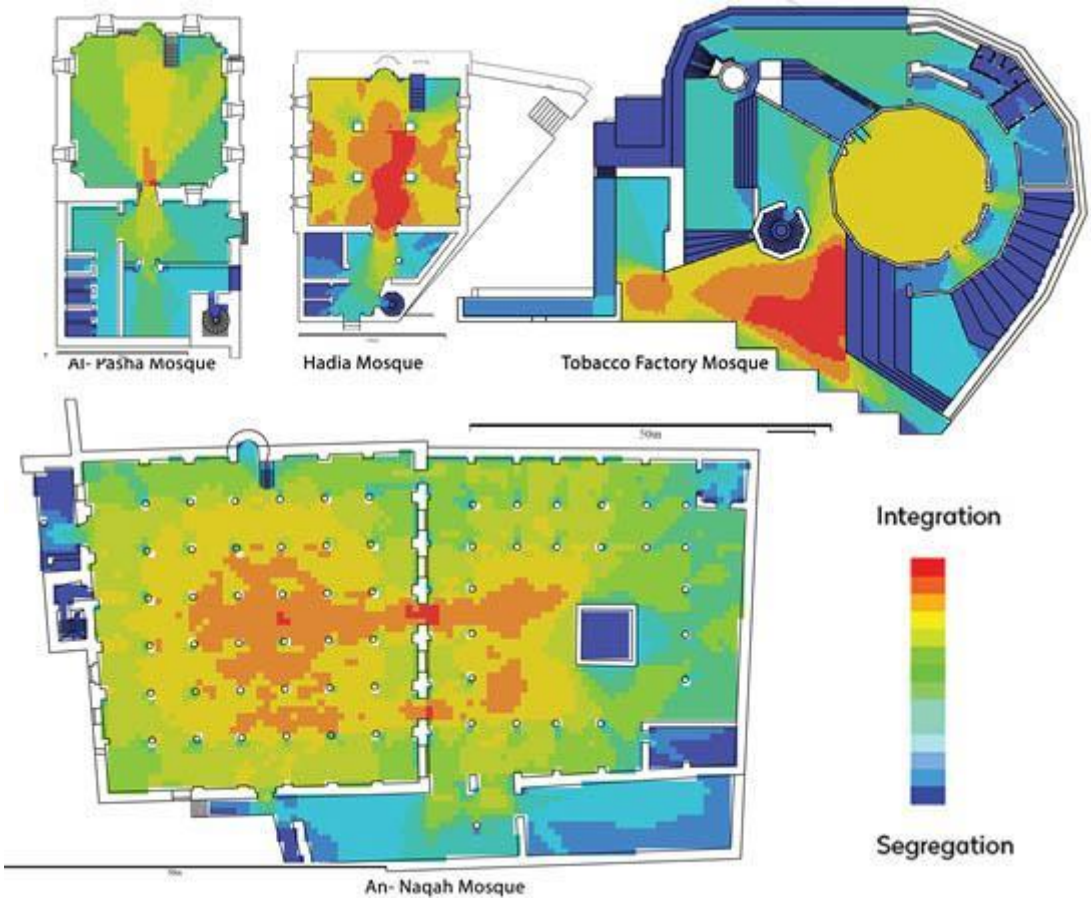

Fig. 5. Visibility graph analysis for the four mosques show high visual integration in the mosque layouts [18]

3. Results and Discussion

3.1 The Axial analysis

As shown in table 1, the results of the axial map analysis show that, while the grid is nearly flawless When comparing the integration values of the sample layouts, there are usually some commonalities. Which indicated and approved that there is a strong integration average between all spatial areas on all samples. “The greater an axial line's average integration value, the easier it is to get to the line from all other lines.” [21,22]

In addition, the study of Rashid, Kampschroer *et al*., [21] established that “Axial line connectivity is the number of axial lines that are directly connected to it’ [23]. “This axial line local property is attractive because it represents the degree of choice present on the line: The greater the connection of an axial line, the greater the number of movement possibilities from the line”[21] While comparing the average connectivity values of the sample layouts revealed a significant variation in the average values. Unlike other mosques, the average connectivity values of the Tobacco Factory mosque

showed the most significant connectivity value, which points that it has the greater number of choices of movement.

The results indicated and approved that the spatial typology of the mosques has been differed significantly and recognized clearly. That implies other impacts on axial lines, like direct connectivity to axial lines flowing through transition area and entrance halls. In some cases, the system's integrated lines appear to be integrated into prayer and transition spaces. Therefore, since there is differentiation in integration values, the space of worshipping, typically used for isolation and occupation, but can also be utilized for high movement.

3.2 The Visibility Graph (VGA) Analysis

As shown in both figure 4 and table 1, the results of the (VGA) analysis show several similarities, which showed high integration in the prayer space in most of the cases [16]. While some of the remaining spaces have less visual integration, the majority tend to have more visual integration. On the other hand, it is the intersection of interior spaces that possess the highest integration or least mean depth in all of them. Cases like Al Basha mosque, Tobacco Factory mosque and An-Naqah mosque has areas with less visual integration, indicating potential places for isolationIn comparison, the Hadia mosque appears to have high visibility across the prayer areas.

The Tobacco Factory mosque, in contrast to the rest of the cases show high connectivity value passing through its prayer spaces as well as lines passing through into all other spaces, which made the worship area more easily accessible. figure 3 and Table 1. Once again, the VGA analysis values revealed significant differences in most cases, demonstrating that using such techniques is highly beneficial.

Table 1
The average values of the Axial map and visibility graph analyses

Mosques' Name	The Axial Map		The VGA Analysis
	Connectivity	Integration	Visual Integration [HH]
Al Basha	5.16	3.06	8.7
Hadia	9.5	3.8	15.5
Tobacco Factory	10.76	3.8	14.75
An- Naqah	6.62	3.04	10.39

4. Conclusions

The space Syntax method powerfully helped identify common and interrelated characteristics of the study samples. It found out that spatial configuration differentiated between the periods when social and cultural differences occurred [24].

The paper concludes that these different layout forms prove the following: Although the similarities in the nature of the mosque layouts functions are conforming to the Islamic traditions, there is a clear difference made each sample unique and special, which confirms and proves that the change in the spatial typology of Libyan mosques have evolved over the years and different times.

This finding is believed to confirm the main purpose of the study. It has also been found that each sample has improved its spatial connections, but it has traces from the previous periods. This finding can help to explain why layout changes are a cultural phenomenon that is learned and then taught. Therefore, the space syntax method as a tool will efficiently help study and recognize the best design ways and develop them quickly. Furthermore, the using Space Syntax theory and the visible pattern analysing can be extremely instructive for professionals and researchers in systematic design processing field [24].

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