

Spatial Configuration and Urban Identity: Analysing Cultural Change in Mardin's Madrasas

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Abstract

Mardin is famous for its extensive historical and cultural heritage, which includes numerous madrasas that were important architectural and educational institutions in Islamic civilisation.. This study investigates the interior organisation of three madrasas in Mardin—Sehidiye, Zinciriye, and Kasımiye—using a spatial syntax approach. The innovative aspect of this study is that it approaches the madrasas in Mardin using both a comparative typological analysis and a quantitative spatial syntax method based on socio-cultural changes. Thus, going beyond traditional interpretations, the analysis was based on numerical data to examine how the space was organised in terms of user behaviour, accessibility, and privacy. The results reveal that the construction of religious environments with increasing spatial depth reflects dominant social traditions and ensures user accessibility. The circulation areas in the three madrasas, which reflect a clearly defined movement hierarchy that encourages organised access and interaction, have the best integration scores. The higher control scores, particularly in these areas, indicate an architectural aim to manage spatial experiences within the complex. This study underlines the importance of including spatial analysis methods in heritage conservation and architectural discussion, revealing previously unknown aspects of the relation between space, culture, and society.

Keywords

Cultural heritage; Historical buildings; Space syntax; Urban identity

1. Introduction

Space is a concept discussed in many different fields such as architecture, urban design, geography and sociology. By considering space as a network of relations, the unity and importance of social and spatial relations have emerged. Gregory and Urry (1985) emphasised the relationship between both titles and the need to consider them together. However, it is not a correct approach to reduce social relations to only spatial relations. According to Lefebvre (1991) gave the example of ancient cities and stated that these cities should not be defined as just a collection of structures and people from the past and that the social production logic

of space should be understood. Rapoport (1969) discussed the interaction of culture, human behaviour and space through spatial forms in the book *House, Form and Culture*. Similarly, Altman (1976) discussed the interaction of space and human behaviour in the context of architecture and stated that space is produced both physically and socially by its users. The existence of a relationship transition between spaces and the nature of the transition, on the one hand, organises spaces and, on the other hand, characterises the relationship between users.

This study comparatively analyses the spatial organisations of Mardin madrasas (Sehidiye, Zinciriye, Kasimiye) with the space syntax method. Madrasas were built not only as educational institutions but also as buildings reflecting the socio-political, cultural and architectural impacts of their time (Abdelsalam & Ibrahim, 2019; Aziz & Ismail, 2018). Reflecting the remains of multiculturalism in its architecture, Mardin has hosted many civilisations over history and owned a wide cultural variety (Alioglu, 2000). Mardin's madrasas stand out as tangible illustrations of the variety that Islamic architecture holds in this city where many religious and ethnic groups dwell together (Çaglayan, 2017). With the example of these madrasas, it is intended to evaluate the effects of social norms, privacy, and educational practices on the space. There is no analytical study specific to Mardin madrasas in the literature. This situation proves that the study makes a unique contribution in terms of interpreting the local architecture with both quantitative and cognitive tools.

2. Theoretical Background

Space syntax is one of the most important methods for analysing spatial organisations and is particularly important in architectural research to understand how cities and buildings are organised, how users move through spaces, and how spaces shape social interactions (Bekleyen, 2024). Hillier and Hanson (1989) developed this theory in 1970 and it determines the spatial organisation of connections between spaces. Hillier et al. (1984) developed this method analyses the spatial configurations of buildings to reveal spaces of accessibility, circulation, and interaction. Studies that comparatively examine urban form through temporal-space syntax have led to a range of possibilities for investigating the relations between spatial transformations and social activity. Using space syntax theory to measure the spatial connections of historical heritage sites and changing city environments has produced important findings (Has, 2022; Hegazi & Fouda, 2019; Lyu et al., 2023; Xu et al., 2020). Factors such as the visibility of a space, transitions to a space, and accessibility to a space are considered in space syntax analyses.

Space syntax analysis provides critical data for evaluating the arrangement of educational spaces, social hierarchies, and concepts such as privacy in madrasas (Psarra, 2010). Figure 1 indicates the increase in the number of studies using the keywords “space syntax AND architecture” in the Web of Science database. There are currently 1,446 studies with these keywords, with a notable increase starting around 2015. The most common fields of study are architecture and urban studies. The linear projection for 2030 suggests that this field will remain open to further research and development in the 21st century.

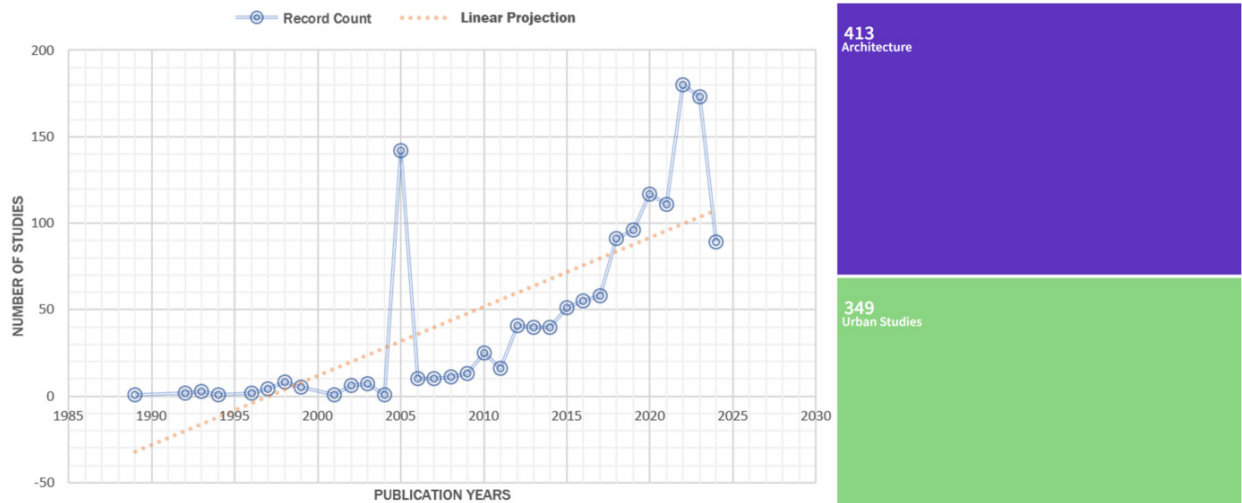


Figure 1. Distribution of publications indexed in the Web of Science database using the keywords “Space Syntax AND Architecture” over the years and a maximum of two study areas.

This analysis of Mardin’s madrasas could be a reference for local, regional, and thematic comparisons.

3. Study Context

The Muslim beyliks established in Anatolia did not only ensure the governance and protection of their regions; they also constructed buildings in line with shared principles and goals in the regions they controlled. Madrasa held an important place among these buildings (Semerci & Özkafa, 2020). Sciences such as medicine and astronomy, along with jurisprudence, religious studies, the Qur’an, Hadith, and related literary sciences, were taught in madrasa buildings (Çatakoglu, 2002). The construction of each madrasa differs in its structural elements and plan layout. Generally, madrasas have included basic spaces such as courtyards, iwans, prayer halls, tombs, student rooms, winter classrooms, pools, fountains, and teachers’ rooms (Göreci & Bilgiç, 2023; Ödekan, 1997).

The madrasas examined in this study—Sehidiye, Zinciriye, and Kasımiye—were built during the Artuqid dynasty (the completion year of Kasımiye corresponds to the Akkoyunlu period). Built in the 13th century, Sehidiye Madrasa was initially designed to provide social services along with religious functions and was planned to offer students suitable environments for social interaction. In addition, Sehidiye Madrasa provided areas such as a kitchen and a library to facilitate students’ educational activities. Zinciriye Madrasa, one of the first madrasas in the region, was built in the 14th century. Reflecting the architectural characteristics of the Artuqid period, the madrasa attracts attention with its ornaments and stone craftsmanship (Çaça, 2013). Zinciriye Madrasa was an important educational institution that offered courses in Islamic studies such as fiqh, hadith, and tafsir, and in scientific fields such as medicine and astronomy. Built in the 15. century, Kasımiye Madrasa is among the most famous architectural works of Mardin (Çaglayan, 2017). The madrasa was built around a large courtyard with classrooms, student halls, and prayer areas. It was also an important centre for socialisation and learning. Moreover, the madrasa integrated ancient Islamic sciences into education, including fields like philosophy and physics. The madrasa is open to guests today as the Kasımiye Islamic Science and Art Centre at Mardin Artuklu University (Figure 2).

This study focuses on the Sehidiye, Zinciriye, and Kasımiye madrasas, built between the 13th and 15th centuries in Mardin. These madrasas differ significantly from each other and from other examples in Anatolia in terms of stonework, courtyard layout, and building-area relationship (Çağlayan, 2017; Yesilbas, 2020). Although there are studies in the literature on the Sehidiye Madrasa (Çelik et al., 2023b; Demir, 2019), the Zinciriye Madrasa (Çaça, 2013; Çelik et al., 2023a; Dilek, 2015), and the Kasımiye Madrasa (Acat Akgül, 2022; Atalan, 2008; Buldaç & Eren, 2019; Çağlayan, 2016; Fırat, 2024; Halaç & Akdag, 2018; Semerci, 2017; Tetik, 2018), no study was determined that analyses their spatial organisations. The findings contribute to the spatial-architectural history of Mardin and provide a new perspective for understanding the cultural, social and spatial differences of other madrasas.

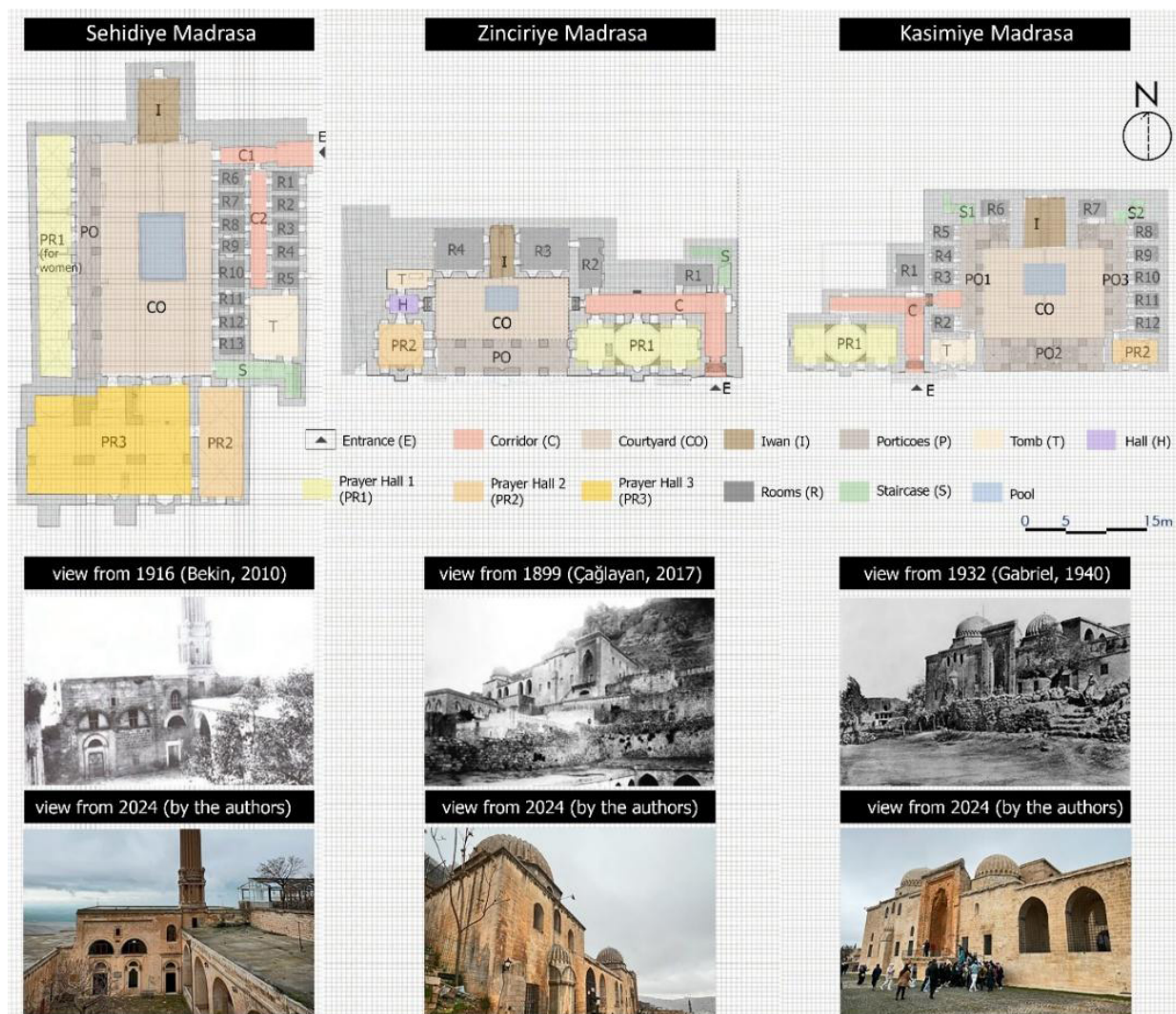


Figure 2. Plan characteristics of the madrasas along with images from the past and present.

This approach provides an in-depth perspective on Mardin's architectural heritage. In addition, it contributes to the theoretical understanding of how concepts such as spatial identity and social norms can be interpreted through spatial patterns in Islamic educational buildings. In this regard, the study answers the research question, "How do the spatial organisations of Mardin's madrasas reflect the transformations in religious practices, educational buildings, and social norms of the period?". The basic assumption is that the spatial organisation

of madrasas was shaped as a direct response to the changing religious, pedagogical, and social norms of the period. In this context, it is argued that the increasing spatial depth and control values observed in madrasas can be interpreted as a reflection of cultural variables such as religious privacy, educational hierarchy, and social gender roles in architecture, along with a functional distribution. This hypothesis is consistent with theoretical approaches that argue that space is produced not only physically but also as an area of social interaction.

4. Methodology

Examining the spatial organisation of the madrasas through the space syntax method has enabled a better understanding of how these structures promote social interaction and how they are influenced by the social fabric. This study includes a five-stage process (Figure 3).

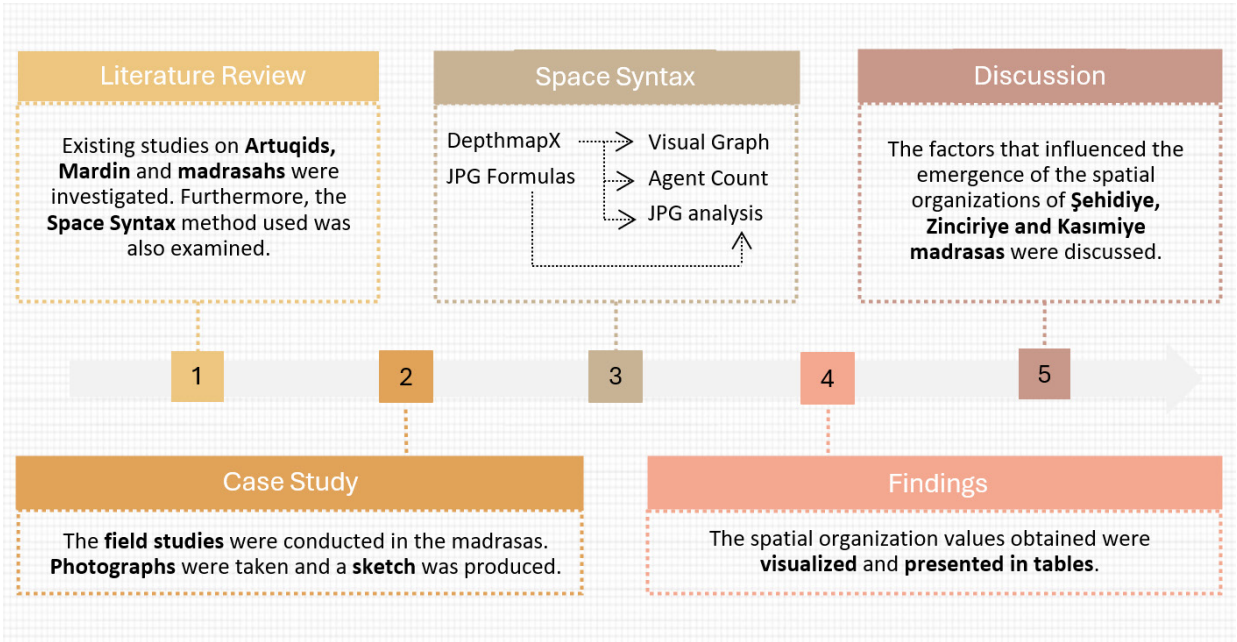


Figure 3. Representation illustrating the study process and its relationships.

The first stage involved conducting a literature review on the madrasas under study, which revealed a lack of existing studies on their spatial organisation. Additionally, works related to space syntax in the literature were examined, and a conceptual framework for the study was established. The second stage involved an observational field study conducted in the madrasas. As of 2024, fieldwork was carried out in the madrasa structures to determine their current conditions. Simple drawings and detailed photographs taken on-site provided the data necessary for the study's execution. The third stage involved the analysis of the acquired data within the framework of space syntax theory. The first step in space syntax theory is to create convex plan images based on layouts. The second step generates a Justified Plan Graph (JPG). In the third step, the analysis of JPG maps is conducted based on mathematical data. The definition of metrics and calculation methods are summarised in the table below (Table 1).

Table 1. Equations used in space syntax method (Adapted from Hillier & Hanson, 1984; Huang et al.,2019; Ostwald, 2011)

Metric	Description	Equations
Total depth (TD)	Total depth levels of all spaces	$TD = \sum (n_x \times x)$
Mean depth (MD)	TD divided by the total number of spaces less one	$MD=TD/(K-1)$
Relative asymmetry (RA)	Normalised version of the depth value	$RA= 2(MD-1)/(K-2)$
Integration value (i)	Degree of integration of the space	$i=1/RA$
Real Relative Asymmetry (RRA)	RA value corrected for the number of spaces	$RRA=RA/DK$
Normalised Intergration (I)	Integration criterion as the inverse of RRA	$I=1/RRA$
Number of connections (SV _n)	Control contribution of each neighbouring space	$SV_n = 1 / NC_n$
Control Value (CV _n)	The total control value an area gets from its neighbours	$CV_n = SV_{n1} + SV_{n2} + \dots + SV_{nx}$

Through these metrics, the social organisation, accessibility, and level of privacy of each madrasah could be analysed qualitatively and quantitatively. In particular, control values are important in visualising the control of instructor figures over space and the physical projection of social hierarchy.

In this study, the analysis of space syntax data was conducted using the DepthmapX software and the JPG (Justified Plan Graph) mathematical formulas. Within the This study employed the DepthmapX software and the JPG (Justified Plan Graph) mathematical formulas to analyse space syntax data. Within the DepthmapX program, Visual Graph Analysis and Agent Count graphs were generated. These visualisations are represented using a colour scale that progresses from dark blue to light blue, green, yellow, orange, red, and dark red, indicating values from lowest to highest (Turner, 2004). Additionally, Convex Map analyses were utilised to determine the numerical values of total depth, mean depth, RA, I, and connectivity. Corresponding formulas also supported the data obtained in this context. These formulas determined the RRA, I, and CV values.

The fourth stage involves the presentation of the obtained spatial organisation values. These values have been visualised and presented in table. The final stage of the study involves evaluating the visualised spatial organisation data. In this phase, the factors influencing the spatial organisation of the Sehidiye, Zinciriye, and Kasımiye medreses were discussed. Additionally, recommendations for future research endeavours are provided.

5. Results

The spaces with the highest depth levels in the Sehidiye Madrasa are ranked as follows: Prayer hall 1 (MD=3.913), Tomb (MD=3.826), and Prayer hall 2 (MD=3.739). The emergence of Prayer hall 1, which is utilised as a women's mosque, as the deepest space, is in alignment with the Islamic principle of female modesty. In the analysis of integration values, the spaces Corridor 1, Courtyard, and Corridor 2 stand out. The common feature of these spaces is their utilisation for circulation purposes. Notably, Corridor 1 serves as a connecting space to both the courtyard and Corridor 2, contributing to its high level of integration. The Visual Graph Analysis (VGA) graphs indicate that the courtyard exhibits intense interaction, further underscoring its status as a central space. The agent count graph also corroborates this observation, as users predominantly prefer the courtyard. Another noteworthy space in this graph is the Prayer hall 3, which can be characterised by its accessibility for users. In the analysis of control values, Corridor 2 (CV=10.33), which provides access to a total of ten rooms, emerges as significant. The result indicates a high level of control exerted by Corridor 2 over these rooms.

The spaces with the highest depth level in the Zinciriye Madrasa are the Tomb (MD=3.230), Prayer hall 2, and the rooms accessible from the Iwan, specifically Room 3 and Room 4. The integration analysis reveals the courtyard (i=2.312), corridor (i=1.891), and hall (i=1.224) as prominent spaces. The connectivity and integration graphs also reflect the high level of integration of the courtyard, hall, and corridor with other spaces. In this context, it can be concluded that the transition spaces possess high integration values. The connectivity and integration graphs illustrate that the courtyard and corridor serve as the main connection points among the spaces. Additionally, the Agent Count graph clearly demonstrates the strong inclination of users towards these two spaces. Another notable area in the Agent Count graph is Prayer hall 2. Despite being one of the spaces with a high depth level (MD=3.230), the significant user inclination suggests that this area is designed to facilitate easy access from the main functional spaces of the building. When examining the ranking of control levels among the spaces, Corridor (CV=5.330), Iwan (CV=2.250), and Hall (CV=2.250) stand out. Their shared characteristic is that they function as transition spaces.

The spaces with the highest depth levels in the Kasımiye Madrasa are as follows: entrance (MD=3.608), Prayer hall 1 (MD=3.608), and Room 1 (MD=3.608). These results suggest that the entrance and its associated spaces have significant depth levels. In this context, it can be stated that spaces close to the entrance are distinct from the primary areas. In the integration value analysis, Portico 1 (i=2.384), the courtyard (i=2.384), Portico 3 (i=1.864), and the corridor (i=1.367) emerge as significant spaces. The high integration value of the courtyard can be attributed to its role as a main distribution point, as it is directly connected to several spaces, including the two porticos with high integration values. Analysing the integration, connectivity, and user count graphs further supports the notion that the courtyard serves as a central space. The high integration value of the porticos can be directly linked to their relationship with the rooms. Moreover, the connection of Portico 1 to the entrance has further elevated this value. In the analysis of control values, Portico 1 (CV=7.250) and Portico 3 (CV=8.25), which are considered transition points to the educational rooms, exhibit significantly higher control levels compared to other spaces. The agent count graph indicates a notable preference for courtyard usage. Additionally, it is evident that there is a stronger inclination of users towards the mosque compared to other areas.

Although Şehidiye, Zinciriye and Kasımiye madrasas have a common tradition in terms of their functional constructions and spatial organisation, the comparative evaluation through Space Syntax analyses reveals how the spatial decisions specific to the context of each madrasa were constructed (Figure 4).

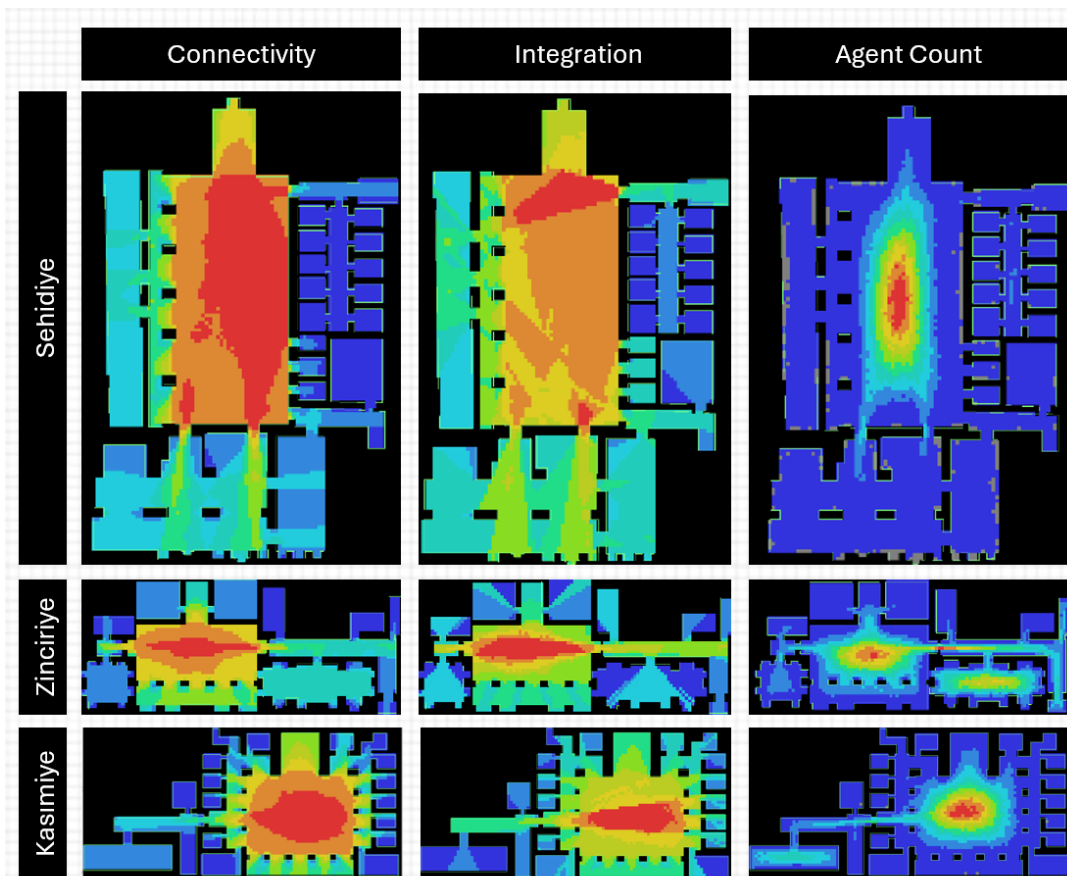


Figure 4. Visibility Graphs (VGA), Agent Graph, and JPG Analysis of Sehidiye, Zinciriyi and Kasımiye Madrasas.

6. Comparative Evaluation of Space Syntax Analyses

Analyses conducted using the space syntax method on madrasas in Mardin have yielded significant results in terms of spatial depth, integration, and control values.

- It is noteworthy that within all the madrasas, the Prayer hall is among the areas with the highest depth levels. Upon reviewing the Agent Count graphs, it is evident that the courtyard and the Prayer hall are among the most frequented spaces by users. This indicates that, despite their high depth levels, the design of Prayer halls allows for easy accessibility by users. The primary function of these madrasas being education may have led to an increase in the depth level of the religious spaces, such as Prayer halls. Nonetheless, the accessibility of the Prayer halls, despite their high depth values, reflects the significance attributed to religious spaces. Additionally, the fact that the women's Prayer hall in the Sehidiye Madrasa is one of the deepest areas underscores the importance placed on female privacy in Islam (Berkey, 2007). These findings reveal that the relationship between spatial depth and functional separation is clearly present in Mardin madrasas.
- Similarly, studies of madrasas in the Iranian region show that prayer halls are located in central but less visually accessible locations, while in Central Asian examples, worship spaces are often designed to be more inward-facing and separate from educational units (Karimi, 2012). In some urban madrasas of the Ottoman period (e.g., Suleymaniye Madrasa), the prayer halls are centrally located but directly connected to the courtyard and are more accessible. A similar structure is also observed in the Ottoman madrasas. For example, al-Madrasa al-'Uthmaniyya (Burak, 2013) and the 18th-century madrasas in Damascus (Tamari, 2001) demonstrate that worship spaces were designed in relation to both social and political hierarchy.

In some rural and provincial madrasas in the Ottoman Empire (Ihsanoglu, 2004), the distinction between classrooms and prayer spaces is more sharply defined. In the Mardin example, these two functions were organised in a more permeable and layered manner;

- A common feature among these three structures is that transitional spaces high integration values. This indicates that the transitional areas within the madrasas are frequently utilized by users and serve to provide spatial coherence. This coincides with the spatial configuration that supports institutional authority, which is explained by the concept of “internal organisation” in the Ottoman period (Has, 1988);
- In the analysis of control values, corridors and porticos are particularly prominent. These spaces enhance the control level over the educational rooms, thereby revealing the spatial hierarchy and functional organisation within the madrasas. At the same time, these areas of high control value increase the mobility and control of authority figures in madrasas, such as lecturers or mudarrises, thus making the educational hierarchy physically visible. Compared to Iranian madrasas, especially during the Safavid period (Green, 2011), it is observed that the prayer halls were more concealed within the inward-orientated and centralised planning schemes.

Generally, it can be said that the Mardin madrasas could be fully explored in at least four stages. In particular, the rooms in Zinciriye and Kasımiye madrasas appear to be located at two different depth levels. On the other hand, three buildings feature prayer hall spaces that span at least two different depth levels. Although the spatial design of the madrasas is similar, it can be said that they are levelled in a way to allow for unique uses (Figure 5).

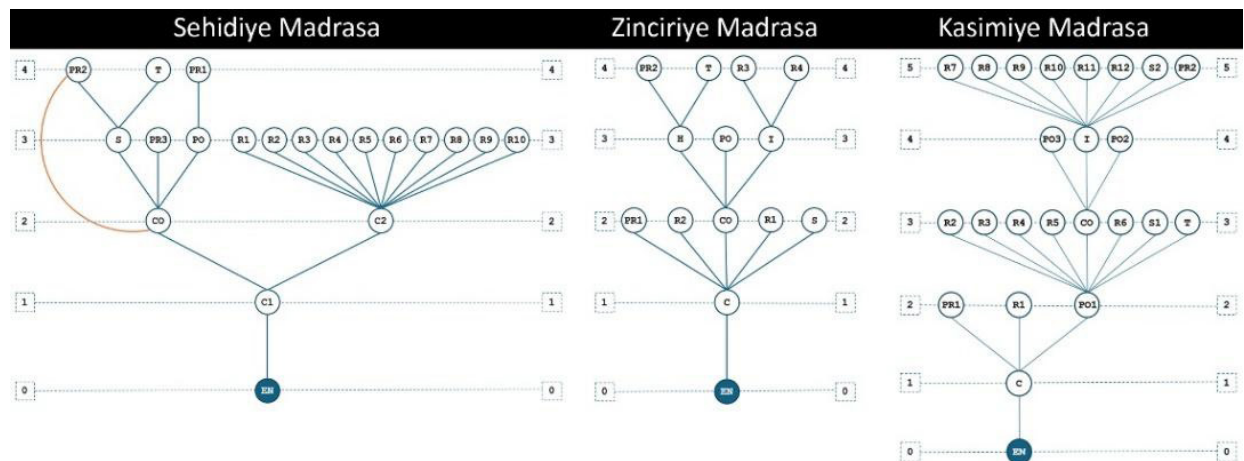


Figure 5. JPG of the madrasas

In historical Islamic geography, madrasas have provided significant indicators of religious privacy, social hierarchy, and user behaviour through spatial analysis. It is also observed that these patterns vary across different geographical and cultural contexts (Table 2). Iran’s geography, particularly during the Safavid period, typically positioned madrasas behind the central courtyard, restricting visual access. This situation is an example of the reflection of religious privacy in space (Karimi, 2012). In the Ottoman complex system, madrasas are located in a central and accessible position within the building complex. Thus, religious spaces establish a more direct relationship with community life. The madrasas of Mardin exhibit a hybrid approach that blends these two concepts seamlessly. Despite their depth, the madrasas do not restrict physical access. These comparisons should be examined not only through architectural plans but also through the ways in which cultural, social, and ideological production forms are reflected in space.

Table 2. Comparison of madrasa characteristics in different regions.

Feature/Region	Mardin Madrasas (13th-15th centuries)	Iranian Madrasas (Timurid/Safavid)	Ottoman Madrasas (16th century)
Prayer Hall	High depth, connected to the courtyard, accessible.	Highly deep, restricted access, introverted.	Central or courtyard-facing.
Courtyard	Social interaction and guidance	Circulation-oriented	At the centre, socio-religious core
Separate Area for Women	Exists (Sehidiye), high depth.	Exists and rarely emphasised.	Does not exist or is not specified.
Control values	High arches and corridors	Emphasised entry and exit points	Open-passage building design
Spatial Hierarchy	Middle level, functional	Strict hierarchical structure	Function-centred hierarchy
Sociocultural Impact	Privacy, dual social structure	Religious isolation	Community and public spaces

Mardin madrasas do not fully reflect either the Iranian type of introversion or the Ottomans's open-to-the-public külliye system in terms of their spatial organisation. Instead, they point to a hybrid formation in which local cultural values are embedded in the space.

7. Discussion

This study examines the spatial organisations, user interactions, and functional differences among Sehidiye, Zinciriye, and Kasımiye madrasas using space syntax.

Compared to other studies examining the spatial organisation of madrasas, the results of this study show both important similarities and differences. According to Hillier and Hanson (1989), the deeper and less accessible areas of religious buildings are associated with social hierarchy. The enormous depth of religious spaces in the Sehidiye, Zinciriye, and Kasımiye madrasas reflects this. These results are consistent with the results of studies on spatial differences in educational buildings by scholars such as Markus (2013) and Hanson (1998). The depth of prayer halls stems from the need for religious solitude. Similarly, Dovey and Fisher (2014) stated that courtyards and corridors in educational buildings can promote social contact. This idea is supported by the outstanding integration and control values of the courtyards and corridors of the madrasas examined in this study. The main function of courtyards, especially in Kasımiye and Zinciriye madrasas, emphasises the necessity of transition zones in social organisation, as emphasised by Hertzberger (2008) and Dudek (2007).

The agent count study reveals that users' strong tendency toward central locations further strengthens these results. Furthermore, the Sehidiye Madrasa's women's prayer area is very deep, which fits with research on privacy and gender (Al-Mohannadi & Furlan, 2022; Arjmand, 2016; Hanson, 2012). This demonstrates how historical changes in space have affected women's privacy in Islamic communities. Vaughan's (2007) observations on how interior spaces are organised in accordance with social customs support the placement of women in deeper areas of religious settings. Furthermore, the results of this study align with Hillier and Iida's (2005) conclusions on how geographic analysis can explain the difference between public and private spaces.

At this point, Lefebvre (1991)'s theory of the "social production of space" emphasises that the spatial patterns observed in madrasas are produced not only physically but also through social practices and representations. The integration and control values revealed in the spatial syntax analysis overlap with Lefebvre's conceptual categories of "perceived", "experienced" and "designed space" (Lefebvre, 1992) The spatial layout

of the madrasas offers both an organisation that directs user behaviour (designed space) and daily social interactions to specific flows (lived space). In particular, the high control values of transitional spaces such as porticoes and corridors reveal how space functions as a disciplinary and unifying tool at the same time.

The high integration and control values observed in the transitional spaces within each madrasa play a critical role in the functionality of these structures. These spatial patterns are considered important insights for architectural conservation and repurposing efforts today. Especially the high integration and control values of the transitional spaces show that these buildings are flexible in terms of both user orientation and programmatic transformation. With the help of space syntax analyses, educational and cultural heritage exhibitions or public use scenarios suitable for today's conditions can be developed by preserving the original function distribution in historical madrasas. In this context, the study provides a historical analysis and serves as an architectural guide for strategies to sustainably maintain these buildings.

Mardin's multi-layered cultural structure has also shaped organic spatial forms and the patterns of use of these forms. In this context, the results of spatial syntax provide clues not only about physical configurations but also about the continuity of social interactions. This study addressed the intersections between the local architectural tradition and contemporary spatial experiences as fundamental units of analysis. The main point of the study is the hypothesis that the space syntax approach can be used not only as an analytical tool but also as a framework for discussing the spatial projections of socio-cultural structures. Therefore, the analyses are not only confirmatory in nature but also provide a basis for interpretations of how space mediates privacy, social rituals and cultural continuity. This study fundamentally transforms our approach to the spatial organisation of educational buildings in Islamic architecture, viewing it not merely as a historical reflection but as a dynamic and multi-layered design practice in which social norms, understandings of privacy, and functional needs are reproduced over time.

8. Conclusions

Madrasas, which were built as historical spaces for prayer and learning, are important centres for social and cultural activities. The study conducted among the Sehidiye, Zinciriye, and Kasimiye madrasas reveals that religious environments of significant depth are produced in accordance with social traditions and at the same time provide user accessibility. In this context, religious privacy is represented in the space, and how this representation is balanced with the access configuration is also supported by numerical data. Furthermore, the exceptional integration and control values of the transitional spaces indicate the importance of these buildings for social and educational activities.

This study examines the traces of cultural transformation by analysing three different madrasas using a comparative spatial syntax method, focusing on the different spatial preferences between buildings constructed under similar historical, climatic, and geographical conditions. Thus, the study offers a methodological contribution that not only provides a typological comparison but also reveals how sociocultural variables influence spatial design through numerical analyses. In this regard, an innovative framework combining comparative typology and a spatial analysis-focused methodological approach was proposed.

This article presents a new approach for the geographical study of madrasas and therefore provides a useful platform for further research. The findings have the potential to shed light on the internal organisation of historical madrasas and their architectural, social and cultural contexts today. In particular, gendered privacy patterns revealed through spatial depth analyses demonstrate how the public/private distinction is reproduced

through space. Similarly, the fact that transition areas increase social interaction with high integration values is in line with the importance of ‘common space’ design in new educational buildings and public facilities. In addition, the results of these analyses reveal the spatial parameters that should be considered not only in terms of physical integrity but also in terms of functional continuity in the reuse processes of historical buildings. The relationships established with the social memory and original use of the space allow for a more participatory and contextualised approach to restoration and reuse projects.

Future research could delve deeper into how the spatial organisation of these structures has evolved within social and cultural contexts, examining how madrasa buildings can contribute to contemporary architectural and urban planning processes. In particular, the application of digital analysis methods and technologies could facilitate more precise and detailed spatial analyses. In this context, digital twin technologies and AI-assisted analytics can provide data-driven solutions to conservation policies by modelling spatial behaviour patterns in a more dynamic and collaborative way. Such an approach would allow for the digital documentation and preservation of the spatial characteristics of these structures, potentially leading to more sustainable solutions in cultural heritage management. Madrasas should be considered both the architectural heritage of the past and a living, tangible source of information that can be referred to in the development of layered, socially sensitive, and functional design models for the future. Therefore, multidisciplinary approaches to the analysis of such structures will not only contribute to the understanding of the past but also inform future architectural design and conservation projects.

Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, I.K., R.E., A.N.; methodology, I.K., A.N.; software, R.E.; formal analysis, R.E., A.N.; writing-original draft preparation, I.K.; writing-review and editing, I.K., R.E.; visualization, I.K., R.E.

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