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Narratives in Mamluk architecture: Spatial and perceptual analyses of the madrassas and their mausoleums



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Abstract

Mamluk sultans were known for their patronage of the arts and architecture. Their educational institutions were among the wide array of architectural projects that linked them as ruling elites to the religious scholars of their times. Their tombs were placed in a mausoleum attached to their educational-religious complexes to attest to their legacy. The evolution of their buildings such that both educational and memorial functions are integrated with the dense surroundings is scrutinized through chronological-spatial analysis. The configuration of the built form, the disposition of its boundaries, its patterns of accessibility, and its visual properties are the features that present the buildings to one's experience and bring certain perceptions into play. In this study, various spatial descriptor tools of space syntax are employed to analyze the data of 14 Mamluk examples (1260-1517A.D.) and capture the differences in the experience where the expression is preserved. Analyses of the configurational characteristics, axial attributes, visibility structures, and isovists highlight how the spatial and formal properties of the layouts were used to express certain representational relationships. The advantages of combining different spatial investigations allows for understanding historical design principles and how the geometry of forms could hide in its abstract rules, conceptual and perceptual qualities.

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1. Introduction

In this study, the dynamics of the spatial experience of a *Mamluk madrassa* and its *mausoleum* are investigated, and the nature of the configuration rules underlying their annexation over time is examined. Furthermore, answering

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the questions of whether the madrasa and the mausoleum remain as two independent functions within one context or their adjacency developed into one homogeneous functional whole is attempted. This paper provides a look into their spatial physical attributes and attempts to capture the narrative behind their formations. The investigation focuses on extracting the meaning of the architecture and learning how architecture becomes meaningful as a functional and perceptual space. Analyzing Mamluk forms produced through time is the key to understanding the spatial-perceptual phenomena and the mechanisms through which such phenomena unfold. To this end, this paper starts with a historical review of the Mamluk period with emphasis on the two architectural types under investigation. It then provides an exposition of the spatial investigations, showing their tools, theoretical conceptions, analysis, findings, and interpretations.

The Mamluk sultanate (1250-1517) emerged during the decline of the *Ayyubid* realm when Turkic Mamluks (originally slave-mercenary soldiers in the Ayyubid military organization) eventually overthrew the last Ayyubid sultan in Cairo and established their own rule. Mamluk history is divided into two periods based on the origins of their different dynastic lines: the Bahri Mamluks (1250-1382) of Turkic origin from Russia, and Burji Mamluks (1382-1517) of Caucasian Circassian origin. In the context by which they ascended to the throne, Mamluks used architecture among their tools to reestablish their authority as sultans. Their choices as to what status to cultivate were affected by their need to reaffirm their legitimacy and power. They exploited every avenue to associate themselves with the actions of the distinguished past rulers and worked “to create the trappings of an empire” (Newhall, 1987). Although the range of their work was outpouring at every social, geographic, and topological scale, the most eternal testimony to the Mamluk reign remains to be its architecture. Their buildings exemplify one of the most distinguished medieval architectural civilizations and their spectacular manifestations are keys to the political and social history of the epoch.

1.1. Madrasa

As an institution, the madrasa is centuries old, first built in the eleventh century in Baghdad and spread later to varied locations. *Madrassas* attracted the patronage of rulers throughout the Mamluk history, and are to this day a mosaic of parts dating back to different periods and building campaigns. Mamluk sultans showed great interest in improving education, concentrating on religious, theological, and practical aspects, such as the Quran, Sharia, and prayers (Brentjes, 1997; Makdisi, 1981). Although a full picture of life within the Madrasa’s religious institution is unavailable, this life is illustrated by several accounts clarifying that there “was not a madrasa where students did not focus on their studies day and night” (Tamari, 2001). Ulama played a vital role in the political and social life of the era; they were “employed as teachers of religion, and were seen as religious elites” (Lev, 2009). The rule system, which madrasa division encapsulates, suggests three categories of users: passer-by visitors (strangers), long-term users (students), and caretakers including sheikh and live-in students (inhabitants).

A madrasa usually has a cruciform arrangement with four iwans where the four Sunni rites were usually taught (Fig. 1). On the main axis of the *Qibla-iwan* lies the mosque. The court is an integral part of the four-iwan formation (Creswell, 1922); its creation employed distinguished decorative capacities and revealed the sophistication in the use of geometric patterns and motifs (Al-Harithy, 2007). In addition to these major components, a madrasa included cells for the students, quarters for the sheikh, and sometimes a free water fountain (Parker, 1985; Rabbat, 2010). In the last quarter of the fourteenth century, Khutbah and prayers were allowed on Fridays; thus, minbars and minarets were added in some institutions (Behrens-Abouseif, 2011; Mahamid, 2013).

1.2. Mausoleum

A typical Muslim grave usually consists of a simple tomb and a headstone occasionally decorated with inscriptions of the

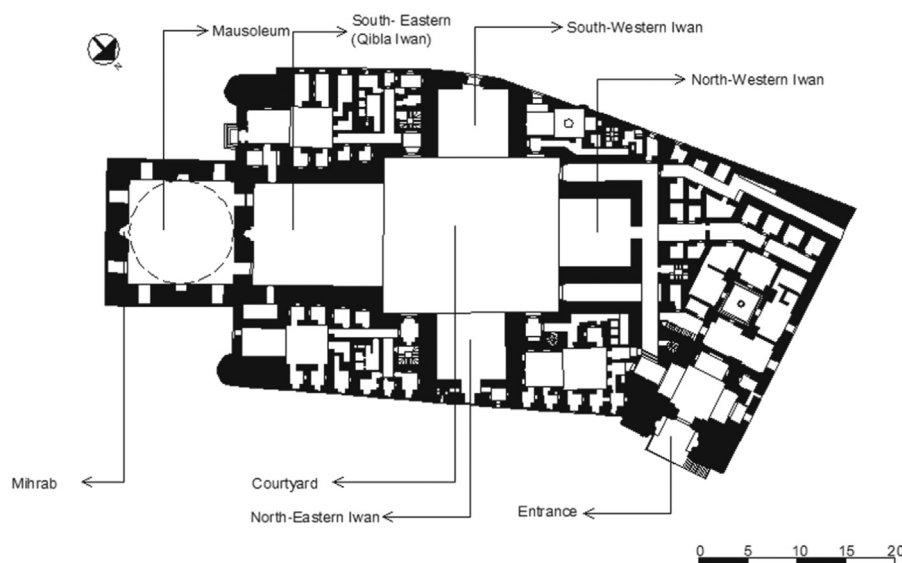


Fig. 1 Sultan Hassan’s madrasa complex plan—C7—with its spatial categories.

Quran. It lays flat on the ground and is usually located in cemeteries outside the dynamic areas of the cities. Despite the beliefs of Islam, which denies the glorification of the dead and building graves over tombs, many mausoleums are found in Islamic lands. Vincent traces the development of mausoleums and argues that “the proliferation of princely mausoleums ... coincides historically with the coming of the power of Seljuks [Turko-Persian Empire 1037-1194] who perhaps, retained and transposed the funeral customs of their Central Asian ancestors” (Cornell, 2007).

Although building mausoleums for notable figures predates Mamluks to previous eras, Ayyubids who preceded Mamluks adopted this practice to promote their religious and political agendas. In 1187-1191, Salah al-Din (Saladin) ordered the construction of a college (madrasa) dedicated to Shafi'i—a great Sunni scholar. Influenced by Persian and Syrian practices, the Ayyubids later on linked this madrasa to a mausoleum, thus infusing a new programmatic association. About a half century later, another chronological and architectural urban twist was recorded. The first funerary structure ever to be introduced into the fabric of the city along its main spine was the mausoleum of Sultan al-Salih Najm al-Din. His widow Shajarat-al-Durr erected the mausoleum in 1250 and attached it to his madrasa, thus establishing a precedent for the inner-city sultan mausoleum. Although it insignificantly contributed to urban adaptation, this new practice became the custom during the Mamluk period (Mesut, 2010). Despite the importance of these two additions at the chronological level, the mausoleums in both cases were not part of the original design of the madrasas. Later on, the mausoleum became a major architectural type that played an essential part in the establishment of the Mamluk madrasa complexes. Mamluks built burial domed chambers in prominent sites and associated them with public institutions by “connecting the memorial for the patron with the functional program of a socioreligious institution, the orthodox practice of Islam that prohibited the building of mausoleums was to some extent circumvented” (Al-Harithy, 2001).

2. Background

The literature provides a considerable number of articles that examine Mamluk madrasas and mausoleums. Although the theoretical considerations underlying these studies vary as much as their scopes, aims, and approaches, all draw on art and architecture to reflect the cultural attitudes of the Mamluk era. These publications are classified into four main thematic approaches: (1) evolutionary, which documents Mamluk buildings along specified descriptive arrays of elements and forms; (2) narrative-descriptive, which deals with Mamluk elites and their patronage; (3) semiotic and epigraphic, which indulges in the connotative meanings of the iconographic and textual content of the monuments; (4) socio-political, which informs the relationship between the city, its makers, and its architectural forms.

The first approach deals with the evolutionary content of Mamluk monuments and aims at documenting their artifacts in a graphical-pictorial typological format or in a chronological regional format (Creswell, 1959; El-Banasi, 2001; Grabar, 1987; Parker, 1985). Of particular significance is

the contribution of the leading scholar Doris Behrens-Abouseif who authored numerous publications on Mamluk buildings and whose work aimed at recording Cairo's significant examples (Behrens-Abouseif, 1992, 2011). In a profusely illustrated manner, she cataloged numerous distinctive buildings with their plans, architectural features, photographs, and descriptive supplementary historical writings that support the catalog sections. In describing the madrasa-mausoleum of Sultan Hasan, she recalled its geometric and ornamental detail to be “free standing on three sides ... the chamber, the largest domed mausoleum in Cairo, thirty meters to the top of the rectangle, is twenty-one meters wide. Its wooden inscription band, whose high relief is painted white ... [is easily read]” (Behrens-Abouseif, 1992). The incorporation of such descriptions with the visual and detailed documents uniquely enables the formulation of a better cognizant and more balanced understanding of Mamluk architecture.

The second type of research treats the monuments in the context of the patronage of Mamluk elites. It is concerned with how Mamluks worked architecturally to impress upon the groups the image of their association with earlier caliphs (Alhamzah, 2009; Brentjes, 2012; Holt, 1975; Ibrahim, 1984; Lawson and Petry, 1995; Nimrod, 2014; Rabbat, 2010). As their titles suggest, a handful of these focus on a single sultan's reign rather than a large number of monuments and rely on examining the historical literary sources and studying their architectural and archeological bearings. This type of research investigates the ways by which written historical sources represent Mamluk elites and attempts to reveal their ideological attitudes and manifestations. To combine esthetic-architectural association with sultan's personal agenda, the authors interpret the power of the reign as implanted in the architectural and urban splendor of their produced forms. In analyzing the monuments, they regularly refer to extracts from historical documents and use their narratives as tools to revisualize the monuments and to restore their original older cultural and architectural formats. In her research on the patronage of Sultan Qaitbay, Newell highlighted how Qaitbay sought affiliation with the past by embracing titles and protocols of earlier great leaders and concluded that many of Qaitbay's “constructions and restorations were specifically designed to proclaim the message of Mamluk superiority” (Newhall, 1987).

The third approach is conceived to be more epigraphic. The authors using such approach focus on the iconographic content of the monuments and provide detailed information about the foundation of inscriptions, graphics, Quran verses, and texts. It tries to clarify their cultural meanings (Abdullahi and Embi, 2013; Ramzy, 2013). In her attempt to capture this symbolic dimension in the funerary complex of Sultan Qaitbay, Ramzy employed a group of semiotic tools, including signs, codes, connotations, and paradigms, and provided a detailed semiotic reading of the formal expression of the funerary complex. She elucidated several layers of esthetic and spiritual meanings embedded in the richness of the inscriptions, whether verbal or pictorial. According to Ramzy, the semiotic readings “reveal that the building was perhaps meant to depict the two eternal upper domains of the cosmos, which include the heavens, the gardens, and the Throne” and that “the dome above the mausoleum, with its six transitional steps included in the imaginary lines

defining the Footstool, most likely connotes the domical seven heavens” (Ramzy, 2013).

The fourth approach finds its way in the works of the scholars who weaved Mamluk architectural manifestations with the political and social intrigues of the sultans who created them. The culmination of this focused approach is found in the numerous publications of Alsayyad, the pioneering scholar of Islamic architecture at Berkeley. He portrayed Mamluk monuments as “a sharp reminder that real political events, personal ambitions, and mere whim often determine urban forms” (Alsayyad, 2011). While describing the harmony of a building, Alsayyad insisted on figuring out the intentions behind its erection and judging its impact on the city. Alsayyad visualized and described the monuments from the maker’s point of view and within the values of the city itself. This focused approach is voiced in several other academic studies that discuss the urban particularities faced in producing perfectly integrated stylistic and urban complexes (Al-Harithy, 2001; Ghaly, 2004). Al-Harithy’s approach in describing the compositional attributes of a building stems from her interest in the production of space. She stated that if “buildings were to gain prominence, it would be through their participation in forming the image of the city, as measured by their impact on the urban quality of their immediate context. The complex of Qalawun represented a moment in the production of a space that was urban in quality, social in function, and dynamic in nature” (Al-Harithy, 2001). In a similar approach, Ghaly shifted the focus from the interior of the building to its elevation, toward the street and its urban city. According to Ghaly, “the monuments in the street confirm an ever present characteristic of Mamluk architecture”, that is, the importance of the facade, and thus the importance of the street in building design. All monuments invariably have their mausoleums located on the street facade, and have their minarets located next to their portals for emphasis and as a landmark.... The side and back facades or portals were not as lavishly decorated as were main facades and portals were (Ghaly, 2004).

Although the first two approaches are important as these provide the basic data to allow for retracing the artifacts of the past and highlight the change of taste and the progressive transformations of Mamluk Bahri and Burji esthetic appreciations, the studies of these two approaches remain descriptive and not ideal for an analytical description of the mere shape. Despite the analytical and interpretive nature of the research of the third and fourth groups, the focus of both approaches shift either to the surfaces of the buildings where the text resides or to their outer edges where the external space is produced. Notwithstanding the fundamental importance of these studies, the challenge remains in the richness and multiplicity of the layers of readings on Mamluk architecture. Despite the abundance of studies, the dynamics of the spatial morphology of this dual educational-memorial complex and how the different factors, whether temporal or spatial, affected the formation of its perceived experience over time is scarce, if not silent.

Given that the mausoleum as a building type is controversial in its presence and signification, the questions of what meanings are associated with its inclusion and how was it treated to elucidate such paradox need to be answered. This research discusses this issue in four sections.

The first introduces the two building types of madrasa and mausoleum and explores their evolution over time. The second identifies the scope of this research and raises relevant questions regarding the relationship between the two building types with the use of the available literature. The third explains the theoretical framework of the methodology of this research and sets its tools. The fourth subjects the sample to four levels of in-depth analysis and discusses the findings. The paper ends by outlining the way by which both institutions coexist.

3. Methodology

Given the Mamluk case of mausoleum annexation to the madrasa and the notion that space “is in itself lawful” as it emerges through the ways people place physical objects in it, the use of the spatial analytical tools is a valid proposition (Hillier, 2014). The overriding concept of *space syntax*, which relates to this line of investigation, is its ability to “interpret the spatial phenomena in social terms” (Hillier, 2014). Space syntax refers to a group of theories and tools that investigate the relationship between space and society and the ways by which the resulting pattern of space affects its users (Dalton and Holschor, 2006; Hillier, 1996; Hillier and Penn, 2004; Holschor et al., 2006; Karimi, 2012; Penn, 2003). It characterizes the spatial system in terms of how its spaces are related to one another rather than how it is geometrically or metrically composed. Any set of complex spaces can be represented as a configuration of spatial hierarchy in which some spaces are more strategic and more accessible than others. Space syntax methods quantify the spatial patterns with the use of a set of measures that allow them to be compared mathematically and perceptually. In its beginnings in the 1970s at University College London, space syntax focused on the society as the maker of the form and tried to understand its typological (genotypical) formations. Recent space syntax research, however, has shifted its emphasis to a line of inquiry that tries to comprehend the relationship between space and the individual subject, rather than space and the society at large. Thus, it engages in more perceptual and narrative cognitive aspects and develops a wider array of analytical tools.

The main idea behind space syntax spatial elements is “that people experience their environment in certain geometries: they move in lines [axial lines], interact in convex spaces [convex spaces], and sees changeable panoptical views when moving around [isovists]” (Akkelies, 2011). By investigating the ways by which the spaces are put together, one can relate to how people have used, moved through, and perceived their spatial systems (Penn, 2003; Peponis et al., 2004). The methodology of this research rests on this premise. By investigating the characteristics of the samples along layered levels of compositional and syntactical analysis, the embedded experiential rules of Mamluk architecture together with their associations could be revealed. The syntactical means for understanding the spatial form can convert Mamluk architectural plans into series of defined spaces, lines of sight, and visual locations. Such syntactical means form, along with other tools, the methodological basis of this research and include

configurational, axial, and visual graph analyses (Hillier, 2014; Hillier and Hanson, 1984; Pinelo and Turner, 2013; Turner, 2003).

Configuration can be simply defined as “simultaneously existing relations, [it] is about the composition of the built form from the parts that are in a unique relationship with each other” (Karimi, 2012). The configuration of the layouts can be represented as spatial systems composed of either a group of smaller units of convex spaces (convex map) or a system of axial lines of sight (axial map). The former demonstrates the static state of being, whereas the latter deals with movement. The connections between these spaces are studied in terms of the relationship between a convex space/line and its immediate neighbors or its relationship to the entire set of convex spaces/lines that compose the system at large (Fig. 2a-c).

The condition to the convex space in the convex map is that all pairs of points within that convex are intervisible (Karimi, 2012). A discrete convex map is created by reducing the spatial complexity of the layout of a building to the fewest and fattest convex spaces. A space in this map is deeper than other spaces if “it is necessary to pass through intervening spaces to arrive at them” (Hillier and Hanson, 1984). Using a certain mathematical formula to compare how shallow or deep a space in a layout is and to account for comparisons across several layouts that might significantly differ in their syntactic size, space syntax features the measure of “real relative asymmetry” (RRA) and its inverse, which is the widely used measure of “integration” (Hillier and Hanson, 1984; Hillier et al., 1987; Mustafa and Hassan, 2013). Lower RRA values or alternatively higher integration values usually indicate higher levels of integration. The integration value of each convex space in the convex map thus reflects the cognitive complexity of reaching that space. The easier a space can be reached, the higher its mathematical value and the

more integrated it would be. The spatial cognitive pattern formed by these values usually range from the most integrated to the highly segregated (Hillier, 2014). Integration can be measured at two levels, global (to every other part of the complex) or local (within the surroundings). A spatial meaning begins to form when spaces are discussed in terms of how they relate to each other. The ranking and the values of the integration of the spaces of the major functions of each studied layout across an investigated sample reflect how a specific culture structures the forms of its inhabitants. Although consistent ranks embed clear functional typologies, inconsistent ranks of very similar integration value “may be said to homogenize functions and render them spatially interchangeable with one another” (Orhun et al., 1995). The “degree of difference [BDF] between the integration values of any three spaces or functions ... can range between 0 or very strong or close to 1 or very weak,” indicating the strengths/weaknesses of the social relations with regard to the spatial ordering of the examined functions (Hillier et al., 1987).

Axial lines demonstrate the way by which people move on foot in lines through space (Turner et al., 2005). In syntactical terms, an axial map is drawn by identifying the longest line (line of sight/movement) that can be drawn through a random point in the studied spatial configuration and then the shortest ones until all permeable spaces in the layout are covered (Fig. 2c). The resulting pattern of the intersecting lines and their relationships are then analyzed, and the spatial values of integration are assigned to these lines. Depthmap software can automatically generate an axial map, calculate several indicative measures to each line, and graphically represent the variations in their axial analysis with the use of different colors. Integration, which represents the potential destinations in the layout, is

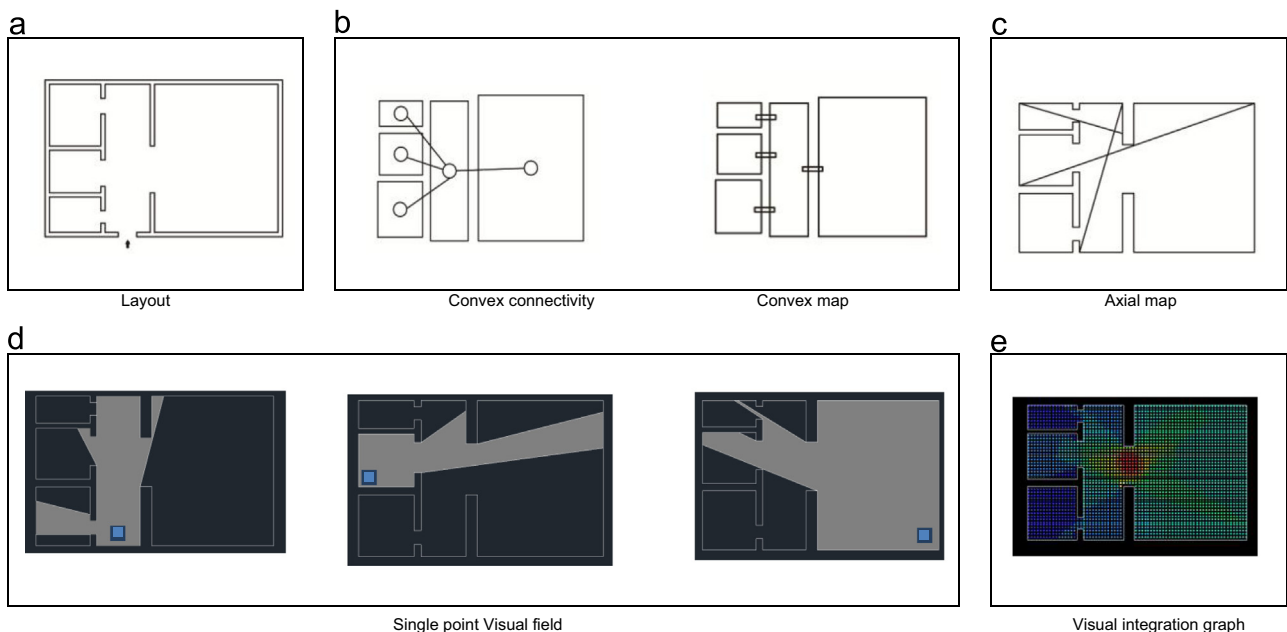


Fig. 2 Spatial representations of space syntax.

highlighted in red for the shallowest locations in the graph and blue for the most segregated spaces. Integrated lines usually represent the active locations in the system. The society's cultural message could be recalled by focusing on how the resultant permeability patterns of the axial map can motivate varied spatial navigational experiences.

Visual graph analysis is also important in developing an understanding of the visual properties of spaces, where movement is exploratory (Lu and Peponis, 2014; Peponis and Bellal, 2010; Psarra, 2009). A single-point visual field (an isovist) represents the panoptical view from a given vantage point in a space and captures the spatial visible property from that point, whereas the visibility structure considers the whole composition (Fig. 2d and e). The visibility structure differs from isovists in its ability to describe each position in the layout not only with respect to its own visibility polygon but also according to how it relates to the visibility polygons of all the positions of the layout as a whole (Wineman et al., 2006). It is based on creating a uniform grid that can be as fine as points. By drawing the visual fields from each point within the grid and then carrying out certain syntactical analysis, the visibility patterns of the studied areas become clear. Depthmap automatically constructs the overlapping isovists from every space to every other space in a connected, spatially linked layout and calculates several indicative measures. Visual integration analysis, in particular, shows how much one can see from each point (Fig. 2e). The integration value of a certain space is given a mathematical value and consequently one can make "the pattern formed by these mathematical values intuitively clear by assigning colors to numbers, usually from red for most integrated to blue for least [integrated or highly segregated]" (Hillier, 2014; Zhang et al., 2013). Intelligibility is another measure that invokes aspects of spatial cognition that relate to navigation and indicates "the degree to which what we can see from the spaces that make up the system" (Hillier, 1996). According to Hillier, the high correlation between connectivity and global integration guarantees an understandable spatial configuration. These tools can help in investigating the visibility characteristics of Mamluk buildings and consequently in understanding how the spatial properties of these buildings were utilized at the experiential visual levels.

Before being subjected to these syntactical analyses, the qualities of the buildings undergoes a first level of formal geometric investigations to facilitate the comprehension of the context of the studied buildings and form the baseline for their further detailed spatial investigations. These combined tools are particularly important in revealing any hidden rules because the madrasa had a role in strengthening the sultan's symbolic role as the religion's protector during his life and his mausoleum was constructed to perpetuate his legacy even after his death. This duality of madrasa-mausoleum is investigated in four stages: (1) creating a descriptive geometric and compositional account that clarifies how the two buildings of the madrasa and mausoleum were regulated in response to one another and within the urban settings of their surroundings, (2) recalling the configurational readings to identify the nature of the spatial differentiation between the functions,

(3) visiting the axial analysis results to identify the motivated spatial sequences, and (4) focusing on the results of the visual graph analysis to comprehend their visibility structures and their isovist forms. Madrassas are analyzed both individually and collectively, and comparisons among all examples are presented in a chronological order. Finally, an interpretation is created to highlight the compositional commonalities among the examples and clarify the impact of this annexation on the morphologies and the meanings of the buildings.

4. Historical framework of the sample

As the historical framework of the Mamluk sultanate is fairly established and its chronological unfolding is well documented, the sample consists of few representative examples that can describe and examine the morphological development of madrassas within the sultanate. The literature has shown that Mamluk sultanate was marked by great political changes, which led the philosopher Ibn Khaldun to say, "When the universe is being turned upside-down, we must ask ourselves whether it is changing its nature, whether there is to be a new creation and a new order in the world" (Alsayyad, 2011). His words in fact guided the research framework and sampling. Thus, this research aimed at documenting the critical points that can capture the nature of the historical-architectural production, whether in its stabilities or its divergences and included examples of distinguished political leaders whose reigns ushered in either stability or an end, as well as those of regular and regional representative reigns.

Among the most distinguished examples was the complex of Sultan Qalawun, who succeeded the founder of the Bahri dynasty and whose reign ushered in a century of stability (C1 in Fig. 3). The Qalawun complex was unparalleled both in its magnitude and in the novelty of its functions; it "introduced an entirely new architectural typology to the city" (Alsayyad, 2011). The last Bahri example of Sultan Hasan's complex was also included. The complex is one of the most preserved and documented medieval Cairo monument (Alsayyad, 2011). It covered an area of almost 10,000 m², with walls standing 40 m high and four minarets rising to 85 m (C7 in Figs. 3 and 4). The complex of Sultan Barquq, the first Circassian sultan of Egypt and the founder of Burji Mamluk (1382 A.D.), came to document the beginnings of this era (C8 in Fig. 3). Built in a manner similar to the prevailing Bahri Mamluk style both in the composition of the prayer hall, which replicates Qalawun madrasa and the formation of its iwans' stone vaulting, which is similar to Sultan Hasan's madrasa, the Barquq complex served as an important transitional example (Al-Maqrizi, 1854; Alsayyad, 2011).

Sultan Barsbay (142 A.D.), who established Egypt's control of the East-West spice trade and whose schemes ensured Cairo's prosperity until the end of the Mamluk period, was also included in the sample (C9 in Fig. 3). The complexes of Sultan Inal and Sultan Ashraf Qaitbay were also included (C11 and C12 in Fig. 3). Inal is the sultan who ordered the widening of Cairo's main corridors, and Qaitbay is known for his outstanding contributions to the established heritage of Cairo (1468-1496 A.D.). Owing to the

Bahri Period (1260 - 1382 A.D.)				Burji Period (1382 - 1517 A.D.)			
	A	b	c		a	b	C
C1: Qalawan				C8: Z. Barquq			
d	ES CRT ISN INW 1.28 1.23 1.23 0.98	ES ISN IQ M 0.98 0.95 0.89 0.65		d	ISN ISN CRT INW 1.08 1.08 1.06 0.88	IQ M ES S 0.86 0.71 0.48 0.47	
C2: UmShban				C9: A. Barsbay			
D	CRT IQ INW ISN 1.14 0.95 0.94 0.87	ISN M ES E 0.87 0.71 0.67 0.65		d	CRT IQ ISN ISN 0.93 0.92 0.75 0.75	ES E INW M 0.75 0.74 0.67 0.66	
C3: Al-Tashtamar				C10: Z.D. Yahya			
d	INW CRT IQ ISN 1.02 0.95 0.80 0.76	ISN ES E M 0.76 0.75 0.73 0.65		d	CRT INW IQ M 0.99 0.84 0.81 0.78	ISN ISN ES E 0.78 0.78 0.67 0.65	
C4: Al-Saffaheya				C11: Sultan Inal			
d	CRT ISN INW IQ 1.96 1.69 1.41 1.23	ISN E M 1.18 0.90 0.89		d	CRT IQ ISN INW 1.27 1.25 0.94 0.85	M ES E ISN 0.76 0.76 0.75 0.59	
C5: Mezhar				C12: Qait Bay			
d	CRT INW ISN ISN 0.89 0.75 0.73 0.73	IQ ES E 0.72 0.45 0.44		d	CRT IQ M ISN 1.28 1.22 1.06 1.01	ES E ISN INW 0.97 0.96 0.95 0.85	
C6: Al-Baldiya				C13: Al - Guri			
d	CRT ISN IQ M 1.59 1.28 0.90 0.85	INW ISN ES E 0.81 0.80 0.45 0.44		d	INW IQ CRT ISN 1.30 1.10 0.99 0.81	M ISN ES E 0.80 0.76 0.47 0.45	
C7: Sultan Hasan				C14: A. Karkamas			
d	CRT IQ INW ISN 1.19 1.04 0.96 0.95	ISN M ES E 0.95 0.72 0.52 0.51		d	CRT ISN ISN INW 1.54 1.08 1.05 1.03	IQ ES E M 0.92 0.83 0.80 0.73	

Key: ES – Entrance transitional spaces CRT – Courtyard M – Mausoleum E – Average sum of entrance spaces or portal
 IQ – Qibla (South eastern) Iwan INW – North western Iwan ISN – South western and North eastern Iwans

Fig. 3 Bahri and Burji sample layouts with illustrations of the compositional characteristics of each example in the first row and the integration values of the configurational readings in the second row.

exceptional fine decorative finishes of Qaitbay's funerary complex, it is described as one of the most elegant buildings of its era. Its plan reflects the "inventiveness and flexibility of Mamluk religious architecture and its capacity to incorporate multiple uses in a single structure" (Alsayyad, 2011). To document the wide and varied spectrum of Mamluk reigns, the complex of the last effective Burji ruler, Sultan Al-Ghuri (1501 A.D.) was also included (C13 in Fig. 3). In addition to those architecturally and chronologically documented significant examples, the sample was extended by adding examples of diverse sizes, locations, and alignments. In their totality, these examples formulate a strong baseline against which the compositions of the diversified sample could be comparatively tested.

5. Analyses

In this section, the analyses of the compositional, configurational, axial, and visual attributes of the sample are presented.

5.1. Compositional characteristics

Given that the focus of this research is the duality of the madrasa and mausoleum and the experiential aspect of their agglomerations, the particularities of this dual spatial relationship are scrutinized. The intrinsic geometric and extrinsic narrative characteristics of the layouts of Mamluk monuments are examined to clarify their apparent intricacies and detect their abstracted semiotic relationships, if any. The preliminary reading of the compositional qualities of Mamluk monuments shows that their layouts can be read using the following descriptors:

Geometry: As shown in Fig. 3, the layouts grew out of the juxtaposition of two main elements: the cross form with its four iwans to facilitate the educational function and the rectilinear shape of the mausoleum to preserve the legacy of the sultan (Fig. 3). Although the mausoleum maintained its clear geometry, the cross form had no controlled proportional relationships. When the geometry of the site of the complex was added as a third element, which is essential in understanding the morphology of the complex, it became clear that most examples were implanted in extremely awkward and non-Euclidian plots. Rababat clarified that "of the fourteen major Madress and mosques built in time of Bahri Mamluks inside Cairo, twelve had staggered exterior facades, usually with one side aligned to the street. In contrast, those located outside the city proper had very uniform plans and plain exterior facades" (Rabbat, 2010).

Alignment of forms: The layouts show that the cross forms consistently occupied the central part of the madrasa with the Qibla-iwan marked by a mihrab and oriented toward Mecca. Furthermore, the mihrab in the mausoleum is consistently aligned on the same axis as the eastern mihrab of the southeastern Qibla-iwan (Kahil, 2002). Examination of the adjacency showed that the mausoleum is adjacent to the educational cruciform and in parallel direction in most cases. However, its position with respect to Qibla-iwan does not follow a clear standard or assume a constant contextual position.

Amalgamation: In general, the way by which the buildings evolved to amalgamate their two major functions with the whole complex may be ascribed to two different concepts. First, the spatial composition relies on the great corridor as the spatial organizing element, as shown in C1 of Fig. 3. Second, the various architectural components are merged into a more homogeneous plan. The sample shows that several examples succeed in producing perfectly integrated layouts, whereas others display several awkwardly shaped functions, resulting in a considerable loss of functional spaces. The private functions are either rectilinear placed within perfectly aligned layouts or irregularly squeezed between the wasted spaces around the courts, iwans, mausoleum, and transitional corridors of the madrasa.

Connection to street facade: With regard to how entry spaces connect to the street facade (Fig. 3), the sample shows that the recessed entrance in most cases acts as an intermediary space that generates a dynamic movement, sequentially opening into the components of the madrasa and its mausoleum. Although few madrassas have entrances orthogonally aligned adjacent to the mausoleum, many entrances were placed at the edge of the facade of the plot; they open into transitional spaces that eventually lead to the courtyard and the mausoleum. The concept of space is understood as fluid, activated by the movement of users and marked by orientation locations.

Spatial continuity: In most examples, the complex maintained the spatial continuity between the interior and the exterior through a series of long, bent, and dark spaces that seem to control the route of visitors and sustain the element of surprise in the experience of the building (Fig. 3). Madrassas offer a spatial experience, concealing the interior of the building from the outside. The geometric cruciform of a madrasa is only revealed after one reaches its center. Regardless of the directional location of the entrance at the main street and the internal positioning of the cruciform, the visitor is always navigated to the central court, establishing an experiential rule that governed most of the examples. The literature shows that this practice highlights "the tradition of labyrinthine passages current from the later fourteenth century onwards" (Newhall, 1987). According to Alsayyad, builders did not follow any prescribed rules and would have carefully "examined every possible location and chosen the one that would create the most attractive configuration from various angles" (Alsayyad, 2011). In contrast to the cruciform, the mausoleum does not abide by such clear experiential rule, upon the geometric examination of the sample. Some mausoleums have gained visual dominance by projecting their mass into public urban space, whereas others have no particular exposure. Locating the mausoleum, as in the case of C7 (Fig. 3), on the "central axis of the complex behind the Qibla wall of the mosque has been considered as unusual" (Max, 1919). The variability of the positions of the mausoleum did not allow, at this stage, the development of any clear geometric logic of how to confront the mausoleum. This contradictory location of the mausoleum is discussed even in the literature. Some researchers argued that tradition dictated that mausoleums were to be situated in a humble corner with a prominent dome viewed from the street, whereas others argued that the founder of the mausoleum was usually located at one corner of the building on the main facade.

We consulted contemporary written accounts to provide us with a better understanding of the aforementioned geometric characteristics; however, further abstracted and compositional rules surfaced (Mayer, 1956; Michel, 1995). According to Kessler, several traditional features or “unwritten laws” characterized this category of architecture (Kessler, 1973). For instance, religious and funerary buildings should be oriented to Mecca, funerary structures should have openings on the facade that follows the alignment of the street “for seating Qur’an readers who were to read day and night” (Fernandes, 1987), and the internal arrangement of the mausoleum should be symmetrical. Bloom and Blair (1994) claimed that designers had a preference for locating madrassas on the west side of the street. The west side enabled, as the sample shows, the designers to construct the mausoleum on the street side next to Qibla-iwan as in C1, C8, C9, and C11 (Fig. 3). By contrast, the east side dictated a specific plan of organization, as in C3 (Fig. 3), where the “entrance had to be on the street side along with mausoleum, while Qibla-iwans had to be on the opposite side” (Ghaly, 2004). Arguably, several unwritten rules should be obeyed; nevertheless, other moves remain within the circle of preference.

Fernandes (1987) discussed the challenges in such instances and clarified that, in some examples, the mausoleum was hardly squeezed between and against existing structures; thus, light was secured only marginally by articulating through the remaining exposed sides. Unlike Fernandes, who focused on the difficulty of locating the mausoleum, Kessler detailed the particularities of the adjustments. He clarified that the orientation of the mausoleum at the Baybers complex to Mecca, for example, required subtle adjustments in the manipulation of “the walls so that their inner and outer faces, instead of being parallel, were allowed to diverge, one following the line of the street, the other that of the interior” (Fernandes, 1987). Other researchers explored the issue of context and clarified that although Mamluks located their buildings close to the existing agglomerations of the earlier structures of the city and along its major arteries, they were concerned with providing fine architectural additions without disturbing the identity and the character of the existing buildings. When the plans were viewed in the context of the narrative description of their locations, as provided by contemporary and historical interpretations (Al-Harithy, 2001; Alsayyad, 2011; Kahil, 2008), the detected irregularities clearly reflected the architectural and urban aspects of the Mamluk history.

Initial readings of the Mamluk complexes showed that their architectural plans could be read as complex mediators between different sets of categories and forms. Mamluk designers succeeded in using these constraints to make a case for architectural design that consistently harmonized the varied demands of the sophisticated patrons of interior decor. The qualities of madrassa and mausoleum architectures were governed by complex sets of architectural, urban, and political factors (Kahil, 2008). They were more “responsive to their context than they were initiators or dictators of new ones” (Al-Harithy, 2001). Within a two-century span, the architecture of the madrassas and their mausoleums moved from their modest beginnings of form and style to an extraordinary complex expression, in which a dynamic balance between the different elements that contrasted with each other in both form and treatment was

evident. Mamluks located their structures with respect to older architecture and helped balance the composition of the seemingly competing elements (Alsayyad, 2011). Despite the clear geometry of the governed mausoleum, cruciform, and religious orientations, the irregularities in how the rest of the components of the madrassa are connected with the mausoleum overshadowed such clarity. Whether these detected irregularities resulted in monuments of diversified spatial experiences remains unclear and warrants further investigations.

5.2. Configurational readings

Previous examination showed that the examples had certain dissimilarities in terms of the response of the spatial attributes of madrassa and mausoleum to one another. These spaces and their relations and alignments reflected considerable variations. To provide a better understanding of how these attributes acted at syntactic levels, we examined the spatial configuration of the 14 examples that could capture sets of relationships central to the nature of spatial structure. As the focus was the contextual relationship of the mausoleum with its educational surroundings, the intention was limited to examining and interpreting the configurational attributes essential in comprehending this relationship without expanding into genotypical investigations. Eight space labels that could capture the full spectrum of the activities were selected, including mausoleum, court, and its four iwans (southeastern/Qibla, northwestern, southwestern, and northeastern iwans), entrance, and entry transitional spaces.

Results in Fig. 3 show a clearer picture of the integration values of the entrance, entry transitional spaces, and mausoleum, in which thirteen cases were consistently and significantly lower. In contrast, the court and in most instances, Qibla-iwan had the highest integration values. The rank order showed that the iwans, in most instances, occupied the middle tier of ranks. The high values of the court confirmed its central and integrating role in the madrassa. Though relatively deep in most of the instances, it connected to the different study locations of the iwans and to a group of transitional corridors. The Qibla-iwan was at the far end of the court, and was the last iwan to be discussed. The Qibla-iwan was the space that alternated between occupation and movement and study and prayer; its spatial and structural composition catered to such an interface. Although students occupied this space for performing their educational activities, they shared it with other worshippers at prayer times. The double purpose space augmented the court during the overflow of worshippers during congregation. The ranking shows enough variations for it not to be exclusively secondary; clearly, the ranks of the Qibla-iwan fluctuated. The reason for this fluctuation as the layouts show was the Qibla-iwan had direct connections with other spaces, particularly with the mausoleum. The only madrassa that deviated from the low values of the entry transitional spaces was Qalawun C1; the integration value of this space was the highest, followed by the court. The intermediate values and ranks of the three other iwans in most of the cases conformed to expectation. Having a certain amount of formality as

locations of study sessions and their intermediate rank was an indication of the need to negotiate the layout to approach them; yet, their sense of being public was still maintained.

However, the results of the mausoleum had numerous variations; its values showed discernable levels of irregularity. In some examples, the mausoleum occupied the lowest band, suggesting a high sense of formality. In other examples, the mausoleum moved into intermediate levels, giving an impression of not being too far or entirely removed from the rest of the building. As a private shrine with function unrelated to educational activities, the mausoleum required a higher degree of privacy and sense of detachment. The variations in the integration and in the relative ranking values of this space, were signs of a changing social pattern, particularly given that designers were engaged in responding to the particularities and patronage requirements of each site.

The other set of results that required notice was those of the lower levels of integration, that is, the entrance and the entry transitional spaces in most of the instances, except for C1. The low values would imply that relatively more steps were needed to go from the entrance and its transition spaces to any other location. On behavioral terms, this layout meant that entering and leaving the madrassa was more difficult than moving within it. This property indicated the overall formality of the madrassa, and the relative independence of the various groups constituting it.

An examination of the Qalawun's madrassa C1 integration values would reveal that although its entrance space remained relatively segregated, its long corridor transitional spaces acted in a contrasting manner to the whole sample. The integration values of the long corridor were higher than any other space. It was the strategic, unavoidable, and controlling space that must be passed through to move from the two main parts of the complex, i.e., the

educational cruciform and the memorial mausoleum. Despite this configurational change, the court maintained its role as the controlling space of the educational part and conformed to the general trend of the sample. The transitional corridor thus controlled the interior-exterior relationships and separated the educational and the memorial parts. Despite the similar long entry transitional corridor of C2, the difference between those two examples that chronologically followed one another was clear in the geometric dimension. The left-right spatial property of the transitional corridor of C1 was a primarily syntactic property in a geometric form. However, the corridor of C2 existed only as a geometric form that did not separate the two major functions of the mausoleum and the court, and thus C2 remained syntactically similar to the other examples of the sample where the court controlled the interior relationships and united the educational and memorial parts.

Variations in the integration values of the different spaces in the one madrassa could also be informative in this regard. To quantify the extent of variability, we examined in Table 1 the values of the most integrated and most segregated spaces with the mean integration value for each complex. In most cases, the court that was the center of the educational part (the most integrated) was over twice more integrated than the mean of the complex when the carrier/outside was excluded. The integration value of the mausoleum remained more than the mean integration (mausoleum of C2 for example=0.71, mean=0.62; mausoleum of C10=0.78, mean=0.61) or very close except for C1 (mausoleum=0.65, mean=0.76).

The sheikh, caretakers, and students living in the residential quarters constituted the few constant inhabitants of the madrassa, whereas the students who spent all day in particular study sessions and prayers constituted a larger percentage. The madrassa was an institution characterized by the absence of clear or overarching control as

Table 1 Integration values of the different spaces in one madrassa with the carrier included.

Periods	Madrassa	Maximum	Court	Mausoleum	Minimum	Mean	BDF	
Bahri	(1260-1382 A.D.)							
	C1	Qalawan	1.28	1.23	0.65	0.50	0.76	0.811
	C2	Um Shaban	1.14	1.14	0.71	0.38	0.62	0.741
	C3	AlTashtamar	1.02	0.95	0.65	0.42	0.61	0.833
	C4	Al-Saffaheya	1.96	1.96	0.89	0.57	0.90	0.660
	C5	A. Mezhar	0.89	0.89		0.30	0.56	0.759
	C6	AL-Baladya	1.59	1.59	0.85	0.40	0.77	0.596
C7	Sultan Hasan	1.19	1.19	0.72	0.38	0.63	0.726	
Burji	(1382-1517 A.D.)							
	C8	Z. Barquq	1.11	1.06	0.71	0.37	0.64	0.749
	C9	A. Barsbay	1.18	0.93	0.66	0.41	0.68	0.764
	C10	Z. D. Yahya	1	0.99	0.78	0.37	0.61	0.799
	C11	Sultan Inal	1.27	1.27	0.76	0.42	0.74	0.746
	C12	Qait Bay	1.28	1.28	1.06	0.50	0.78	0.817
	C13	Al - Guri	1.45	0.99	0.80	0.44	0.72	0.691
C14	A. Karkamas	1.54	1.54	0.73	0.48	0.76	0.697	

seen by the weak differentiation of its spaces. The madrasa with its mosque was a “School of God” (Azam, 2007); all users and visitors abided by the codes of conduct established by the Islamic traditions rather than by a particular group of people. This explanation showed the dynamics of the madrasa and the different filters and corridors that separated the highly integrated inner part of the inhabited madrasa from the outer environment. By contrast, the mausoleum seemed to have different adaptations. Initially, the configurational findings have clarified the emergence of two distinct patterns: in one, the educational court integrated the whole. Its emergence was characterized by a tendency for giving the mausoleum a sensation of being removed from the main educational part, but still belonging to its weakly differentiated educational space. Its spatial pattern was structured to foster relations within the student area and encourage their formal interaction with mausoleum visitors; in the second, the great transitional corridor appeared to be the most integrating space followed by the educational court. The first spatial structure seemed to have integrated their mausoleums within the educational part, whereas those two distinct functions appeared strongly separated in Qalawun.

Although the preceding analysis managed to cluster the sample into more clear configurational groupings than those which resulted from the compositional investigations, the effect of these findings on the perceived madrasa-mausoleum spatial experience remains unclear. The present research examines the individualities of how each space is navigated and focuses on the visual information through axial and visibility analysis.

5.3. Axial analysis

To describe the visual lines of sight and to reflect the potential lines of movement that each system offered, the spaces were mapped using Depthmap software to a system of lines of access and sight that constituted an “axial map” (Fig. 4). An examination of the resultant axial maps revealed the existence of different permeability patterns. The axial lines with the highest integration and connectivity values across the whole sample were along two main varied versions of sequences. The first longitudinal axial-diagonal line stretched from the southeastern end of the court at the Qibla-iwan, across the court toward the northwestern or southwestern iwan, followed by another line that stretched from one of the iwans towards the entry transitional zones. For example, C1 showed a line that stretched from the southwestern iwan through the court towards the north-eastern side, and then extended to overlap with the entry zone transitional corridors; C3 showed a longitudinal axial diagonal line that stretched from the northeastern side through the court to the entry zone. These patterns indicated that the potential movements of visitors, at the global and local levels, were most likely to be attracted along this sequence. Movement at first would be attracted to the central part of the court core where a global comprehension to the organization of the space was gained, and then the attention was likely to be attracted towards the entry exist points and portals. In these cases, the

mausoleum could be seen once those transitional spaces were reached.

The second detected version was interesting. The sequences of its axial lines with the highest integration and connectivity values read as follows: a longitudinal axial diagonal line(s) that stretched from the southeastern end of the court at Qibla-iwan across the court towards one of the iwans, followed by a diagonal line(s) that stretched from an iwan through the court and Qibla-iwan, and then to the center or periphery of mausoleum C8 and C12. In one case, the highest axial integration line stretched across the lower end of the court towards the transitional area of C14 mausoleum and ablution space. These results showed an interesting spatial axial development both at the direction of the axial line and at its integration and connectivity value. The lines stretching towards the entry transitional spaces - next to where the mausoleum existed - at the beginning of Mamluk Bahri era were among the highest; nevertheless, as time passed, the highest integration and connectivity values were along the lines stretching towards the mausoleum itself.

These patterns motivated the visitors to stop, particularly in the court, and look around where the strong lines shifted the focus towards Qibla-iwan and on to the mausoleum, inviting both students and passers-by to stop and look through the opening of the mausoleum. In several cases, the strong lines of movement, ultimately led the visitor who reached ablution space before the prayers, to view the mausoleum. Together with earlier findings, the present study showed that Qibla-iwan did not really demonstrate a certain element of informality. In fact, Qibla-iwan built on its sacredness at prayer times and its busy cycles of activities during study sessions to direct attention to the mausoleum. These observations revealed that the court, and in some instances, the Qibla-iwan functioned to facilitate user orientation and provided possibilities for a restorative break by projecting vision to further positions. These practices reflected the trend in Mamluk period (Michael, 1995) “towards sacredization of architectural parts, which provided signposts for places of religious observance” (Newhall, 1987). Moreover, the concern of Mamluk about indirectly integrating the mausoleum without violating the practice of Islam outlawed the building of mausoleums (Al-Harithy 2001).

5.4. Visual graph analysis

Given their potential importance in sharpening the understanding of space and highlighting the differences in experiences, the visibility properties of layouts of the madrasah were examined using Depthmap (Hillier and Tzortzi, 2006; Pinelo and Turner, 2013). The single point visual fields (isovists) created from a certain vantage points and the “visibility structure” in the studied areas were used to examine the visibility characteristics of the spaces. Our aim is to sharpen the comprehension of the earlier findings and to examine how the spatial and formal properties of the layouts were developed to signify certain conceptual and perceived relations.

The graphs seen in (Fig. 5) confirmed that the court had the highest visual integration, which made it visually close to every other point in the layout and allowed its users to

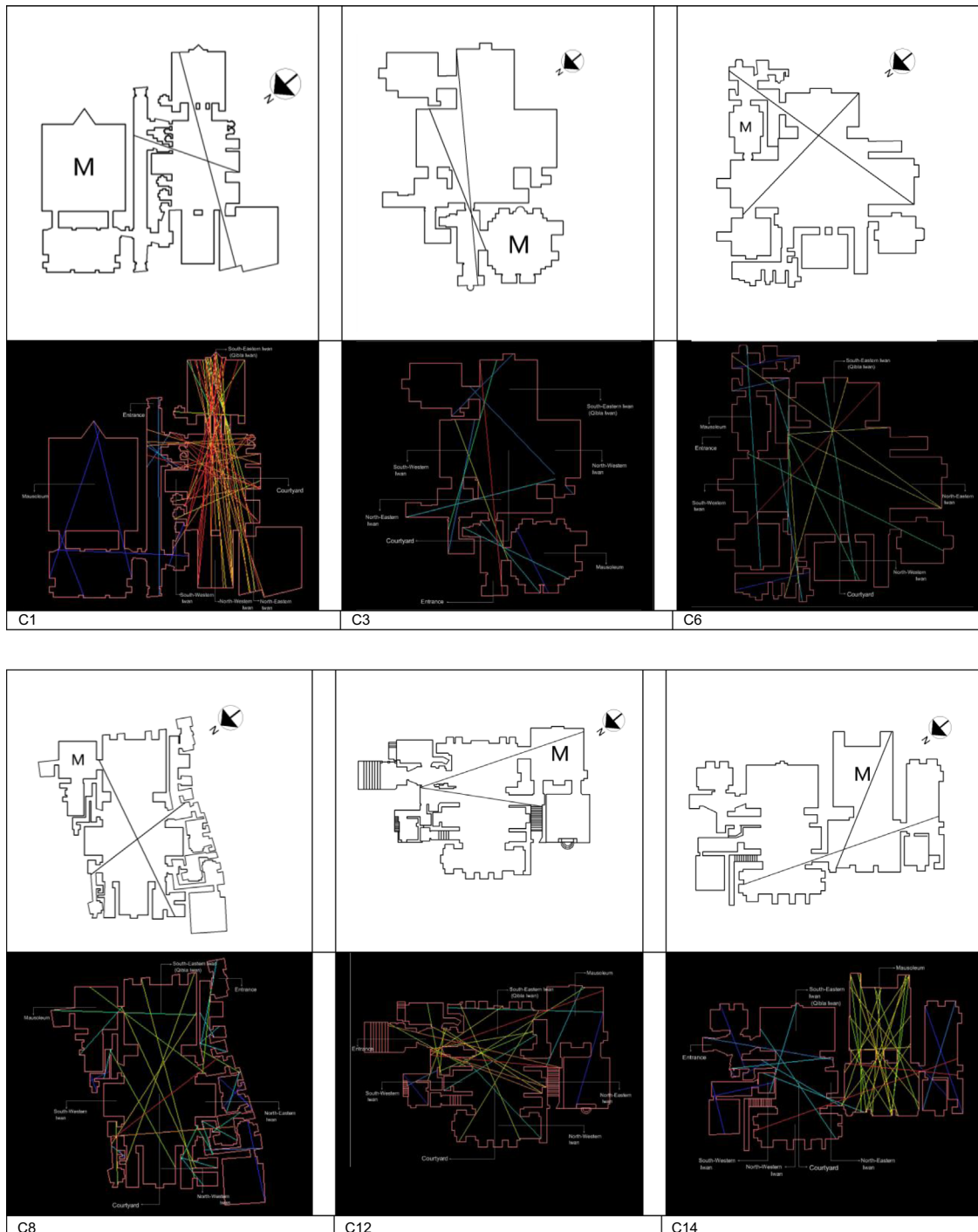


Fig. 4 Global Integration axial analysis of representative complex spaces using Depthmap. (Colors range from red, for the most integrated, to blue, for the least integrated. The most highly integrated lines are highlighted by varying the thickness of the lines—from thick to thin.)

have visual access to the largest possible area in the layout. The court property meant that the designers intended to give the user-student visual information of the whole layout throughout their spatial exploration. In contrast, entrances and mausoleums occupied the other end of the visual integration values, indicating that the amount of information captured was reduced, a finding that requires further investigation.

When the isovists from the center of spaces were examined for each of these diverse functional areas over time, the graphs reflected interesting characteristics of both the entrances of madrassas and the mausoleums. A chronological investigation of the isovists in Fig. 6 would clarify how the configurational relations of the madrassas had developed over time. The degree by which the spikiness of the one isovist juxtaposed with the other

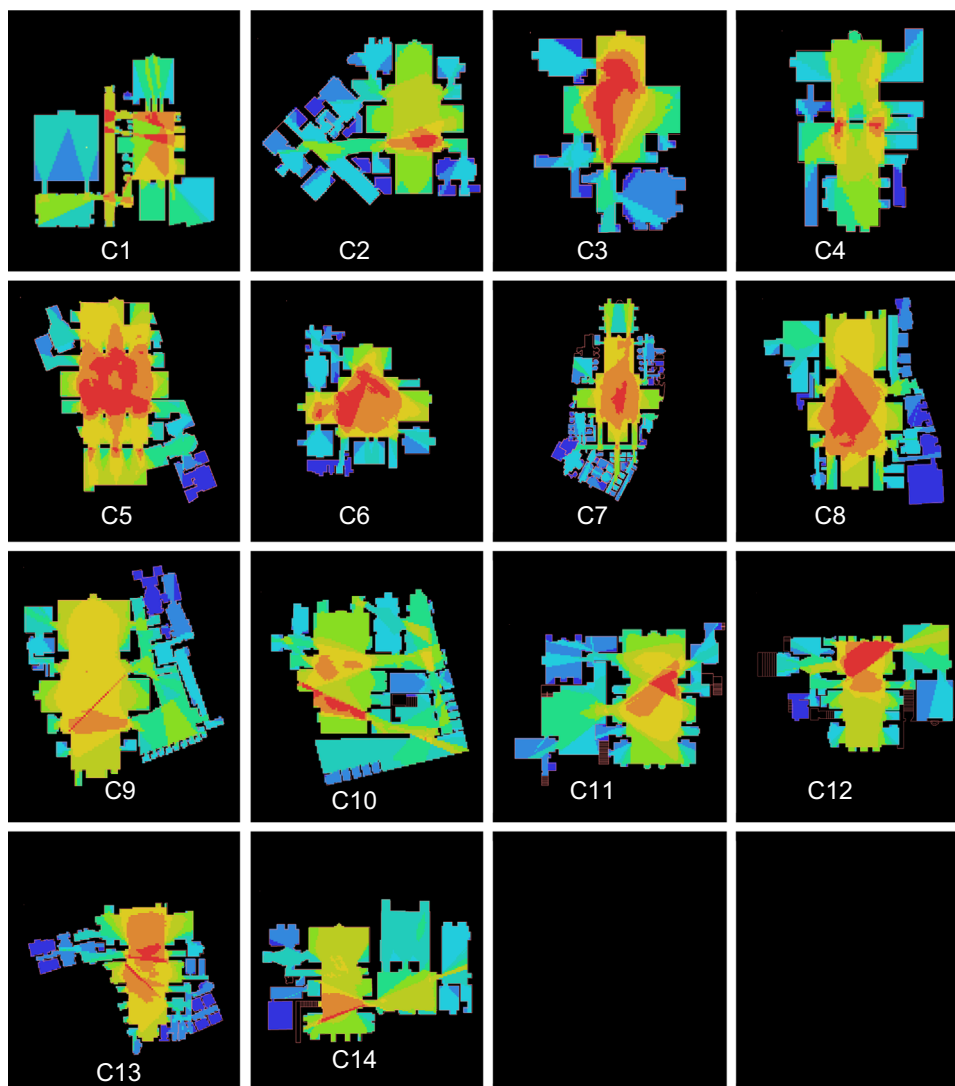


Fig. 5 Visual integration graphs of the interiors of the 14 madrasa complexes.

was viewed as an indication of the intention of the makers to encourage encounters. Visually, the entry point at the beginning of the Bahri period was totally detached from both the court and the mausoleum, as seen in C1-1284 A. D. Not a single point of overlap in the visual fields was detected; however, this isolation began to diminish over time. The visual fields began to gradually by developing different levels of interaction between the entrance-court and entrance-mausoleum, and court-mausoleum throughout Bahri period.

Madrassa C7-1356 A.D., the most distinctive in the Bahri period had an unexpected location of the mausoleum placed at the end of the Qibla-iwan, establishing a precedent for the inner-madrassa focused mausoleum. Exposed on its main side, the madrasa was a bold transplant of this architectural type. From that date, isovists analysis reflected a progressing development of the juxtapositions of visual fields in relation to different functions (Fig. 6). The emphasis on intensifying and juxtaposing the mausoleum, court, and entrance for the mausoleum to be the focal point of the viewers as they experienced the spatial composition

was extremely elaborate. The relations with visibility according to Hanson were “means by which the basic permeability syntax of a complex is fine-tuned into a more effective device for interfacing or distancing different kinds of relationships” (Hanson, 1988). This virtue certainly seemed very clear in the configurational development of the mausoleum as seen in the layered and consistent results of the last three examples at the end of the Mamluk Sultanate C12, C13, and C14 (Fig. 7). Overtime, all of these madrasas generated lines of sight originating in their courts then passed through towards the mausoleum. In a total contrast, the visibility relations in C1 from the educational part towards the mausoleum were absent (Fig. 8); none of the various interfaces of visibility towards the mausoleum was realized to any degree. To be in the mausoleum of C1 was only to be in that space, not to be visibly part of a complex system of spaces involving both the mausoleum and the educational part.

Those findings had never been adequately or explicitly addressed in the earlier findings, drawing the argument to the influence of the moves of the designers and their intended

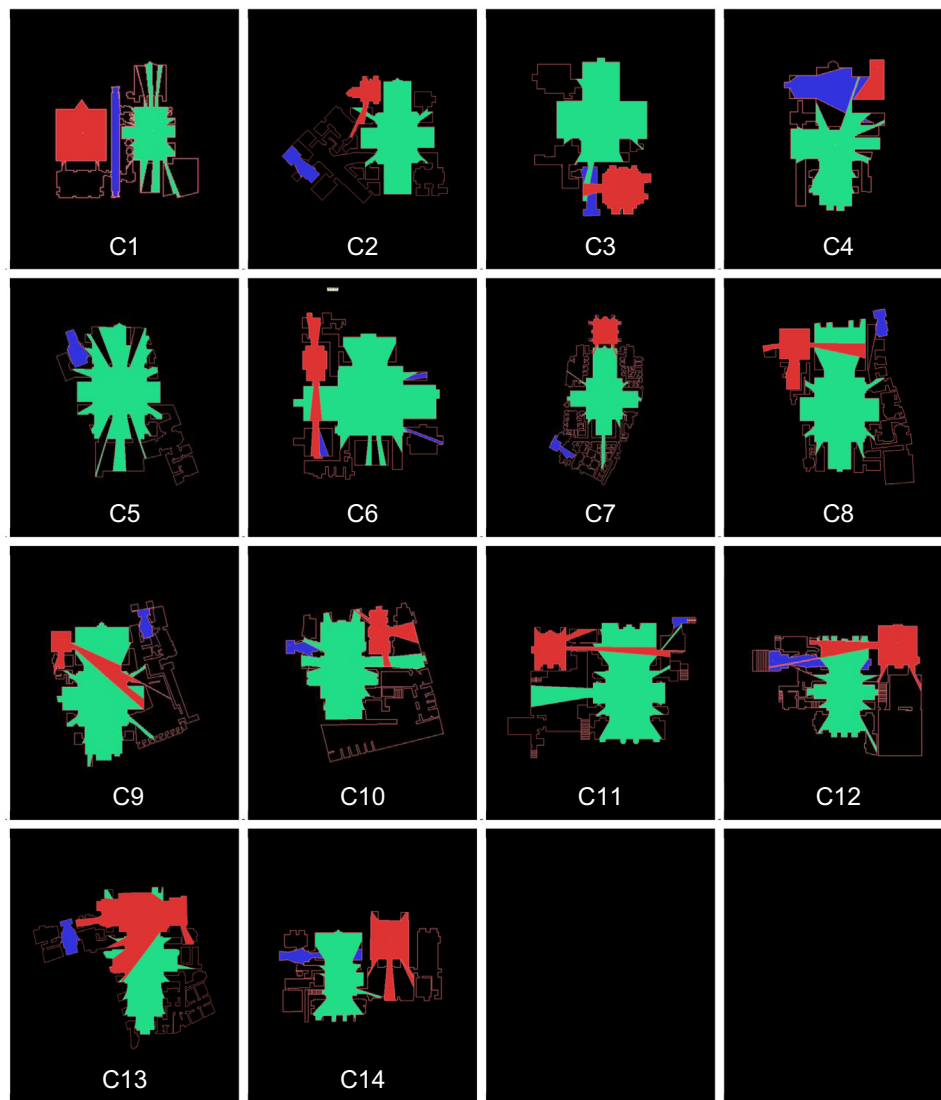


Fig. 6 Comparison of the visual fields from the specified vantage points of entry locations, centers of the courts, and mausoleums in the madrasa complexes. (Blue for entry locations, green for centers of the courts, and red for mausoleums).

symbolic intentions on the morphologies of the designs and confirming that the intention in those buildings was spatially and configurationally produced. The spaces seen from certain points provided clues to their existence. Those glimpses of visual fields to the location of the mausoleum were used not to separate but to heighten the perception of the mausoleum. Although affiliating the mausoleum was historically prohibited within the city, the designers solved this conflict through these practices. Mausoleums were spatially distant or remote, yet visually and configurationally seen, as shown from the visibility analysis. The entrance was part of the progressive configurational and visual scenario, which developed overtime. Although, mausoleums were spatially and visually detached, and was highly dependent on its relative placement to the street facade at the beginning of the sultanate. Over time, designers developed the skill of preserving the serenity of the educational center without scarifying the importance of the entry point.

Despite the differences between the examples, all madrasas showed recurrent characteristics that together

demonstrated certain cultural consistencies that emerged over time. The form makers were engaged with how space and forms interacted to construct configurational content. The strength of space syntax lies in its ability to illustrate elegantly any hidden logic by the proof of measures, an issue that researchers have noted in their narrative descriptions but have been unable to quantify to date (Kahil, 2002; Michael, 1995; Newhall, 1987). The clearest example in the development of Mamluk architecture was evidently demonstrated in the diverse results in the intelligibility of the three chronologically distanced examples, C1 ($R^2 = .00250561$) at the beginning of the era, C7 ($R^2 = 0.919247$) at its mid, and C14 ($R^2 = 0.789512$) at its end.

6. Conclusions: nature of the conceived space

When the Mamluks injected the first ever funerary structure to be introduced into the vibrant fabric of the city within its religious institutions, they initiated the development of a

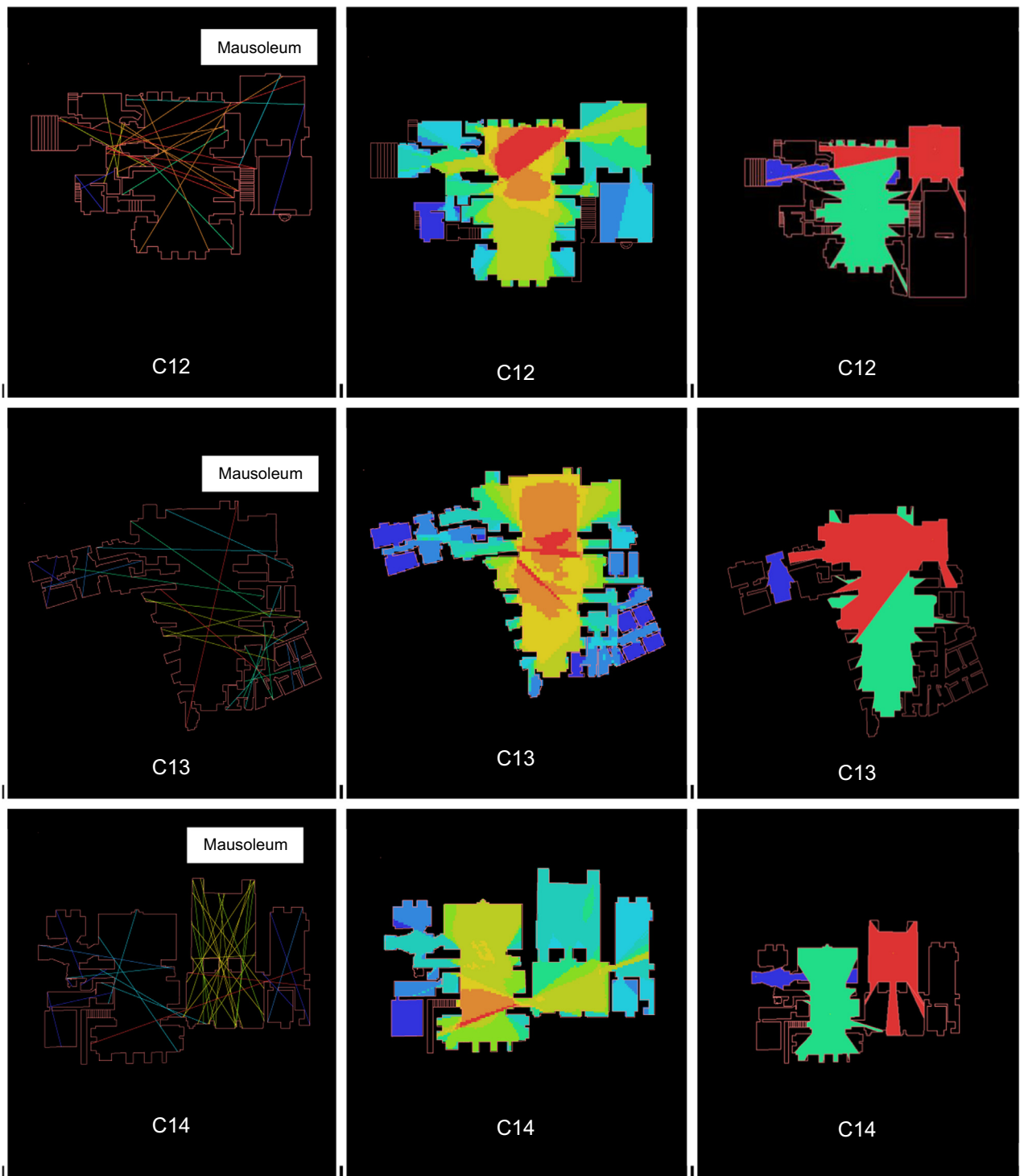


Fig. 7 Axial analysis, global integration, and visual fields of the last three chronologically ordered madrasa complexes.

new spatial and functional paradigm. They satisfied its new spatial program exclusively in sophisticated architectural terms, simultaneously allowing a much-admired balanced interior in one stroke and an experiencing space that genuinely responded to the entire range of physical, functional, and perceptual challenges. Although no obvious footprint madrasa-mausoleum type could be recognized, this research traced the trends across the sample in terms of how these buildings revealed their narratives and how

they navigated the visitors and their journeys through the space. The sophisticated configuration of the clearly geometric, syntactically integrated, and weakly differentiated cruciform; the symmetrical and syntactically segregated mausoleum; and the irregular transitional, highly segregated spaces allowed the complex to modulate its patterns of encounter. This research marked the stage in history when the madrasa-mausoleum paradigm actually began and showed how its fine mutations developed over time.

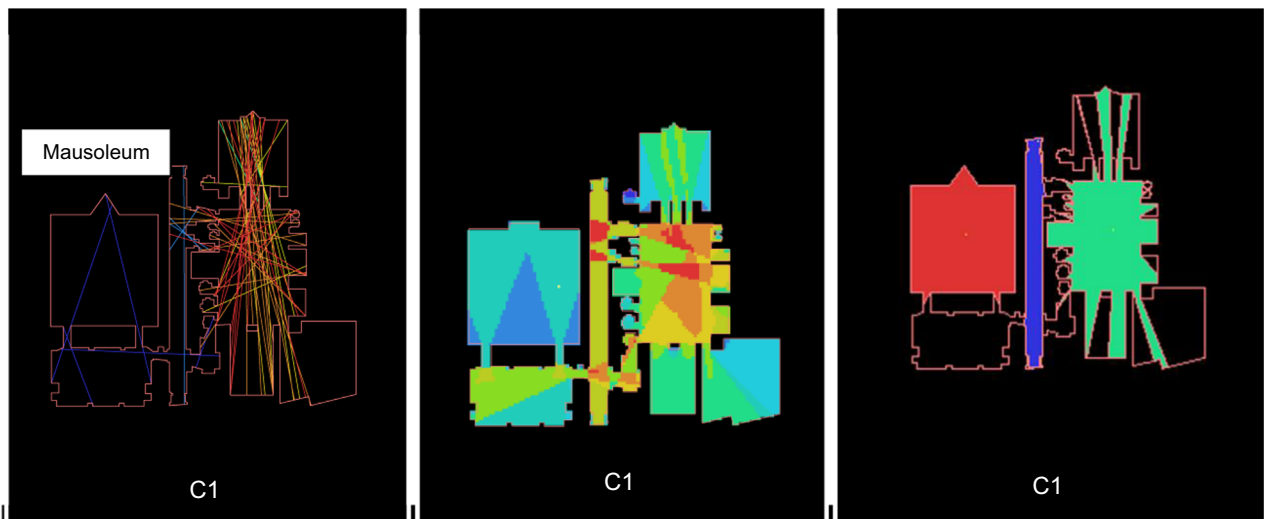


Fig. 8 Axial analysis, global integration, and visual fields of the first chronologically ordered madrasa.

The Qalawun complex represented the first example in the Mamluk Bahri sample that was geometrically and syntactically different from any other example. The articulated structural relations of its mausoleum and educational parts were assigned a spatial character shaped by separation rather than the creation of interrelations of permeability and visibility. In contrast to the strict rules that governed the mausoleum-educational configurational relationships of the Qalawun complex, the Mamluk madrasa-mausoleum in general evolved over time, allowing the two functions to coexist. The layouts of the later Bahri and Burji periods presented a more delicate articulation of the relationship between the geometry of space and its conceived experience. The visual fields were the narratives the builders used to respond to the individual constraints of each site. The visibility inspections highlighted the recurrent relationships of contiguity and accessibility and the symbolic conventions governing madrasa-mausoleum chronological forms.

All examples were semantically rich, exploiting a distinct spatial impression created by articulating spatial boundaries, axial directions, and views within a plan instead of differentiating zones within a simple shape. The properties of the conceptual ordering and the perceptual experience were focused on drawing the attention of the different types of users sequentially and delivering a certain intended message spatially. Despite the variability of the footprints of madrasa-mausoleums, a similar hidden logic controlled the nature of their spatial navigation. The combination of strong local enclosures with direct accessibility and visual connectivity allowed the mausoleum to coexist with the educational part despite the significant variations in the ways by which such coexistence was realized. By articulating the walls and openings of the functional and transitional zones and visually inviting the visitor to have glimpses of the mausoleum, the mausoleum in these madrasas mutated from enacting its secluded position to being part of the educational environment visually. The fusion of these two functions in a building made the mausoleum a part of the layout. It became pivotal, and the patron was part of the experience without violating the traditions, which spatially

place the founder in a shady zone. All the examples showed how the spatial configuration was dependent on the relative position of the physical elements; they confirmed that their architectures followed the law, and that these laws could be semantically read regardless of the clarity of its physical boundaries.

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