

## **A Generative Technique for Mamluk Madrasa Buildings Design**

**Ismail Ahmed Amer**

**Ahmed Ali Ahmed Gaber**

Minia University, Faculty of Fine Arts, Architecture department.

### **Abstract**

Mamluk architecture is widely recognized for its unique and creative designs. This paper explores one possible way - A design Strategy – through which Mamluk architect produced the Madrasa building design. From analyzing Mamluk architecture the research problem emerges as a question that the research will try to answer: What is the generative technique (if any) for the design of Madrasa Buildings?. As no textual or graphic evidence explains the ways in which the architects transformed the two-dimensional drawings of building design into three-dimensional forms, the research will concentrate only on the process of plan generation. The research depended mainly on one hypothesis which is "There is a systematic technique the mamluk architect depended on it to generate the design of the Madrasa buildings". The research aims to enrich our knowledge of historical design methods, besides explains our current understanding of design. In this paper, monuments from the Mamluk periods will be examined in order to understand Mamluk's theories of design and their builders' methods. The authors also observe that "often the design units remain disconnected as if to offer the reader the opportunity to interpret the design in several possible ways."

### **Key words**

Generative technique, Islamic architecture, Madrasa, design methods, design units.

## **1 Theoretical Study (Historical Background)**

### **1.1. Participants in Design Process in Mamluk architecture**

No Mamluk artist or architect seems to have left us any writing about his profession, his individual work, his general concepts of art and architecture, or craft schools he might have belonged to, in a manner comparable to the familiar way in which other cultural agents did, especially the Ulama and literati in their assorted array of professions (Rabbat, 1998, p.34). The control of the design of projects and their construction by the medieval patron was to a large extent a product of his material wealth. While a patron's longing for his everlasting recognition as a powerful ruler initiated the design of buildings, in such cases, he himself became the designer. The capacity of the patron to participate in the process of design is best proven by his ability to compose architectural drawings. In these cases, the patron fulfills his role as the financial source for a project, as well as the role of a designer by producing design drawings (Yousefi, 2005, p.42)

There are eight persons participate in the design of Madrasa buildings as follows: Patrons (Sultan), Architects (mi 'maran). Enginers or Geometrician (muhandisin), Mathematican (hesabii), Astronomers (falakii), Builders (banayyan), Craftsmen (sanaii), Master (ustadan). While the desire to erect buildings as free-standing monuments may

not have been the decision of architects and can more appropriately be connected with the patron's desire to emphasize monumentality as a symbol of his sovereignty, this trend in Mamluk architecture resulted in concentrated attention on the design of facades and exterior features of buildings.

In the building crafts, there seems to have been no single word in the Mamluk period to encompass the meaning of "designer" or "architect" as we understand them today. The term mi'mar, used today in most Islamic languages to mean "architect," appears in the Mamluk sources only in the sense of "mason". In the building crafts, the most frequently encountered terms are mu'alim, mi'mar, muhandis, and shad. In the arts, most terms, on the face of it, seem to designate specific vocations or skills, such as muzawwiq, nuqqash, musawwir, and muzammik, while some appear to be generic, such as mu'alim and sani'. (Rabbat, 1998, p.31). The nature of the projects determined the ways in which they were organized and conducted. Designers, builders, and craftsmen in all their variety who might have been involved in the actual design and execution of the buildings and their decoration are very rarely identified.

The practice of all aspects of construction, formally regulated by the Mamluk sultan al-Nasir Muhammad (1293-1340, with two interruptions), chroniclers of the period attribute to him the establishment of a special department for building (diwan al-'ama'ir) to coordinate the multitude of land-reclamation projects and social and religious/charitable structures in which he and his emirs were engaged. (Maqrizi, 1854, p.306). It was then that the shaddal-'ama'ir (superintendent of buildings) became a regular title of an important position held by a first-rank emir at the Mamluk court. While the monumentality of Mamluk buildings reflects the grandeur of the patron's sovereignty, patrons were in some cases involved with the process of design and construction.

### 1.2. Representation methods in Mamluk architecture

An indefatigable inquirer and researcher, Abd al-Latif al-Baghdadi. An extract of a huge compendium on Egypt that he composed during his intermittent residence in Cairo between 1190 and 1206 survived and was translated into Latin, German, English, and French. This short book, entitled "al-Ifāda wa i'tibar fi 'alumūr al-mushāhada wa 'alhawadith al-mu'āyana bi-ard Misr" (Benefit and Lessons from Things Observed and Events Examined in the Land of Egypt), provides a first-hand and lively account of the monuments of Egypt, In chapter five from this book he notes:

ويحكون قنوات المراحض حتى انه تخرب الدار والقناة قائمة ويحفرون الكنف الى المعين فيغير عليهم ابرهة من الدهر طوي اية ولا يقترا الى كسبح واذا ارادوا بنا ربع اودار ملكية ارقيسار يذمتحض المهندس وفوض اليه العمل فيعبد الى العرصة وهي تل تراب او نحوه فيقسمها في ذهنه ويرتبها بحسب ما يقترح عليه ثم يهد الى جزء من تلك العرصة فيعمره ويكمله بحيث ينتفع به على انقراده ويسكن ثم يهد الى جزء آخر ولا يزال كذلك حتى تكمل الجملة بكامل الاجزاء من غير خلل ولا استدراك  
وأما المسناة فيسمونها الزربية ولهم في بناؤها اتقان حسن وصفته ان يحفر الاساس حتى تظهر النداءة وتبرز الماء فينثدي بوضع ملين من خشب الجيز أو نحوه على تلك الارض



Should someone want to build a *dar* [house, somewhat on the fancy side but not necessarily a palace], a caravanserai, or a *rab'* (tenement house), he would hire a *muhandis* who would then divide the empty lot *in his mind* and arrange the laying out of its parts as commissioned. The *muhandis* would then proceed to construct those parts one by one in a way so that he would complete each part in its entirety and deliver it to the occupants before moving on to the next part, until the whole was finished, without distortion or revision. (al-Baghdādī, 1286, p.39).

He was particularly fascinated by three aspects of the building process he describes, which together indicate a different approach to design in medieval Egypt, an approach that might persuade us to reevaluate our received understanding of design and its historical evolution. First is the mental imagining and visualization of the architectural plan and structure without the idea being translated into some graphic or visual representation or model. Second is the sequential execution of the structure's components so that they can be completed and used autonomously as the rest of the building is still under construction, and still without a represented overall plan. This remark of course bolsters the singularity of the mental visualization as it confirms its validity in practice, at least as observed by Abd al-Latif. Third is the apparent efficacy of the method, with the building completed as planned and the alignment of its different components achieved without mistake. (Rabbat, 2008, p.149).

Abd al-Latif says nothing about monumental or custom-designed structures such as mosques, palaces, madrasas, and the like—building types more innovative in design, which might have required some kind of marking out of their plans before their execution. Abd al-Latif also says nothing about the conception of the structural system in the building or about the elaborate articulation of façades. The most important and tantalizingly suggestive aspect of the report is its confirmation of the existence, in Egypt at least, of a design technique without representation.

Representing a monument before constructing it was a process known throughout the medieval Islamic world. (Rabbat, 2008, p.150) From Egypt, we have a few written references from various periods but no material evidence until the nineteenth century of monuments being represented by drawings for their patrons before construction. (Creswell, 1940, p.79). Judging by the scant evidence of the written sources, it seems to have been called for only in specific and genuinely cases such as the madrasa of Sultan Hasan. In the fifteenth century, the historian Khalil al-Zahiri reported that:

واما مدرسة السلطان حسن تجاه القلعة المنصورة فليس لها نظير في الدنيا حتى ان الملك الناصر حسن المشار اليه لما امر بعمارته طلب جميع المهندسين من اطراف الارض وامرهم بعمارة مدرسة يكون ليس عمراً اعلى منها على وجه الارض وسألهم اتى الاماكن اعلى في الدنيا في العمارة فقبل له ايوان كسرى انوشروان فامر ان يقاس ويحترق وتعمّر المدرسة اعلى منه بعشرة اذرع فعمّرت وجرّ بها اربع منارات وقيل ثلاث في ارتفاع المدرسة ايضاً ثم هدم بعض المنارات واستمرت الآن على اثنتين وايوان كسرى كان واحداً وبهذا اربعة او اوبى وهي عجيبه من عجائب الدنيا سمك جدارها ثمانية عشر ذراعاً بالمصري حتى ان

Sultan Hasan, when he ordered its construction, summoned all the architects (*muhandisin*) from all the countries and asked them, "Which is the highest building in the world?" He was told, "Iwan Kisra Anushirwan [the Iwan of Khusraw, at Ctesiphon]." So he ordered that the iwan should be measured and revised (*yuharrar*) and that his madrasa should be 10 cubits higher than it, and it was thus constructed. (al-Zāhirī, 1894, p.31)

In this anecdote, "Iwan Kisra" is clearly the model for the proposed madrasa. But what is more important for our analysis is that it was measured and the measurement transmitted—possibly as a drawing, although we cannot tell from this or any other source. (Rabbat, 2008, p.151).

**As a conclusion from this section is: "There must be representation drawing for the design of Madrasa building" and that for the following reasons:**

- Representation a necessary mode for communicating design because of the professionalization of both architecture and construction and, more important, of the separation between designer and builder.
- Representation is to establish the dimensions and proportions of the building and its various components on the ground.
- The design with-representation method was used in Mamluk era, especially using brick as their essential construction material, which would necessitate the use of measuring units.
- The visualization and graphic or three-dimensional representation in Mamluk architecture are normally seen as necessary and inevitable steps in the transformation of design from idea to communicable visual image.
- It is impossible to imagine an architect conveying the design to the builder by referring to an already existing example and asking for a replica or an approximation, but the shared knowledge between designer and builder should be by a representation tool as drawings.
- What the designer should be verbally communicating to the builder is the type of the building, which establishes the sequence of spaces and their relative relationships to each other, and the numerical dimensions of each of these spaces.

- Imagining and conceptualization have always been recognized as formative stages in the process of design and drawing guaranteed constructing buildings with multiple components incrementally and without any mistake in alignment.
- A complex design based on a mental concept can apparently be communicated and executed with an intermediary stage of representation.

The previous remarks leads us to ask: What is the design technique had used in the design of Madrasa buildings? The answer of this question can be easily in formulating the Madrasa building design in sequential design steps in a representation tool.

### 1.3. The use of drawing in Mamluk architecture

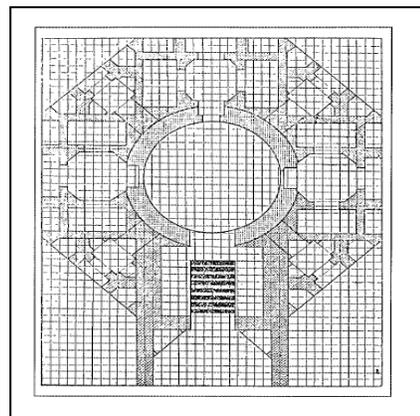
Islamic drawings had arrived at high levels of complexity. Proof for this claim is found within the drawings of both Tashkent and Topkapi scrolls, in which techniques for representing complex spatial features as scaled two-dimensional projections and the use of conventions to clarify spatial relationships within the drawings, had not been seen before. What is puzzling, however, is why such innovations in representational and graphic techniques did not result in elevating the role of their authors, who were supposedly skilled designers. (Yousefi, 2005, p.44). While an examination of medieval Islamic drawings confirm the two dimensional logic of their constructions. (Yousefi, 2005, p.27) It is strongly suggested that drawings allowed the designers of buildings to develop more complex variations than what they previously had been able to produce.

It is common knowledge that paper was introduced into the Middle East in the eighth century, when Muslim troops captured Chinese papermakers in Central Asia, and that sometimes in the subsequent two centuries the technology of papermaking was altered there. Its raw material was no longer bamboo, but rags and old papers. In the process of constructing a building, from the initial order (or program), to design and layout, to on-site work, accounts, and representation of the finishing building, the appearance of paper is an element in the process of transmission and reception of architectural knowledge whose discardable, recyclable aspect still needs to be discovered.

The following paper document is represented by the plans and drawings of so-called Bukhara master. It establishes the existence of architectural notation on paper. The ground plan (fig 000) on carefully constructed graph paper and is comparable to analogous modern plans in that they show a horizontal section taken at ground level or a some fixed point above the foundation. (Holod,1988, p.5) The use of graph paper is most significant. It tells us that the draftsmen worked with compasses and straight edges.

The research presents three main questions: the first: student book, or a collection of building types, and not the second: If there were a presentation drawings, how it could carry enough information for the non-architect to envision the complet building?, the third: If they are drawings by

Fig (1) A probable plan of a mausoleum



(Holod,1988,p.5)

a designer, the making of the plan, then, could be a function separate from the site construction itself, and the grid was the measured module to suggest a series of ideal designs?. These are not questions which can be answered here. Though the existence of even later drawings on paper would indicate that designs for geometric ornament were carefully executed and kept as privileged information.

There are two kind of drawing, the first is the obvious single-objective freehand diagram. This type of drawing is meant to capture a particular concept underlying a spatial sequence, or a comparison between contrasting formal structure. A second kind of drawing is the less obvious reductive or analytical one. For an architect this second type is more challenging, because it allows one to manipulate the conventional plan, section, elevation or axonometric. Every drawing is analytical because its making is the result of many decisions about what to show, and, more important, what to leave out.

For the construction of Madrasa buildings, both architects (*mi 'maran*) and engineers (*muhandisin*) gathered to draw the design on tablets. In another instance, the plan (*tarh*) of the Madrasa first necessitated the drawing of its plans which was done through a collaborative effort between Masters (*Ustadan*), builders versed in engineering (*banayyan-i muhandis*). It is noteworthy that the recurrence of *muhandis* (engineer) in both cases confirms the technical character of drawings.

As architectural drawings are often conceived as vehicles through which ideas about design are communicated. A privileged group of designers responsible for the production of ideas, and the masses of lay workers who, with no input in the design process, translate ideas into built-form. (Yousefi, 2005, p.46). The assertion that drawings function as communicative devices between professional designers and undistinguished lay workers assumes a minimum amount of intervention in the process of design by the latter. Mamluk Architects are in such cases expected to act as the sole designers of a project, leaving no room for craftsmen to interpret their work.

#### **1.4. Design Units in Mamluk Architecture**

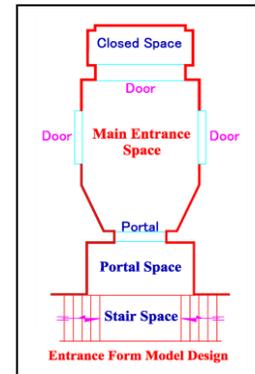
The Madrasa buildings were essentially a flexible composition of modules combined ad hoc, according to the requirements of each site. Ideas were pragmatically subordinated to the particular circumstances of a building's location and its patronage. (Behrens-Abouseif, 2007, p.71). In this section an attempt is made to present the design aspects of the main design units used in the design of Madrasa buildings. These units are: the entrance, the courtyard and Iwans, the mausoleum and the attached functions (Sabil and Kuttab, and ablutary spaces, accommodation cells,...etc). In order to uncover the design principles, an analysis of the design of these design units will be conducted.

This will show that the design analysis provides a better understanding of Madrasa buildings because this analysis depends on an implicit design knowledge that was ignored in almost all previous historical analysis. It has to be taken into consideration that this is not a historical presentation of these monuments, but only explains how Mamluk architects designed these buildings in pure expression or hidden order.

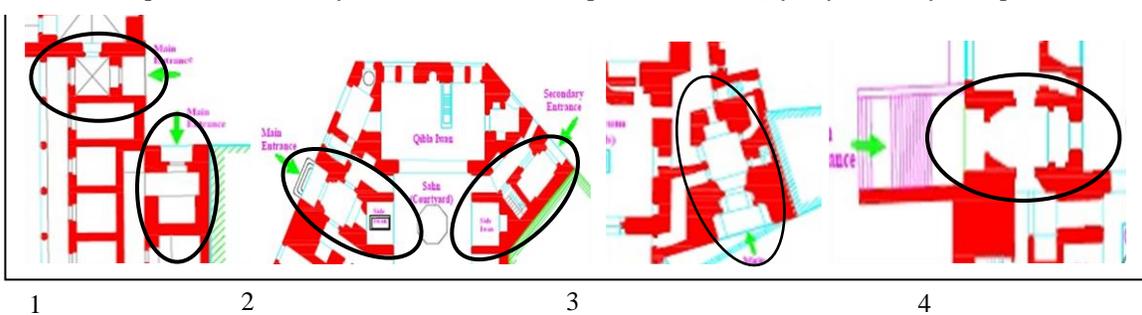
### 1.4.1. The entrance

From the analysis of the entrance in the Mamluk religious buildings it is found that it consists of four main parts: the entrance stair space, the portal space, the portal, the entrance hall. The entrance facades always followed both the alignment of the street, and the orientation of the prayer area (towards Makkah), which gave rise to the bent corridor (Majaz) as a mediating between the street and the courtyard (sahn), (Gaber, 2011, p.36). The bent corridor provides utilitarian functions, for example in this area the ablutionaries and the services are located, because these elements do not need to be regular in form.

**Figure (2)** Entrance form design in Mamluk Madrasa buildings (authors)

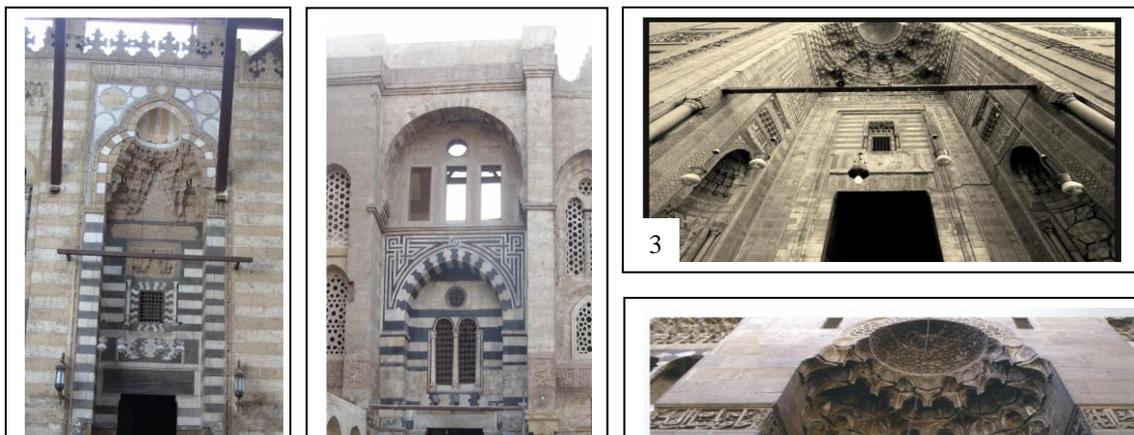


**Figure (3)** Entrance form design (authors): 1- Kamaliyya al-Adimiya Madrasa, 2- Amir Azbak al-Yusufi Complex, 3- Sultan Baybars al-Jashankir Complex, 4- Sultan Qaytbay Funerary Complex



The entrances of the Mamluk religious buildings were constructed recessed into the facade rather than protruding into the relatively profane street. The composition of the portal space goes to the full height of the facade, with the silhouette of the recessed area leading up to a semi-dome or a vault with the curvature of a pointed arch covering this recess (Gabr,1992, p.342). Mamluk portals were usually flush with the rest of the elevation with a recessed doorway with some exception, such as the Madrasa of al-Sultan Hassan and the Madrasa of Barquq. In these two buildings, the portals are probably projected to avoid having the corner of the angled portal interfere with the rest of the facade. The portals also have the same height as the rest of the elevation to maintain the sky-line of the building. However, the inscription band that exists in some of the elevations usually stops or frames the entrance decoration (Tantawy, 2002, p.64). The entrance hall has a simple geometric composition; it is accentuated vertically by having eith

**Figure (4)** The compositions of entrances in Mamluk Madrasa buildings (authors)  
 1- Complex of Sultan al-Ghuri, 2- Madrasa of Sultan Qalawun, 3- Madrasa of Sultan Hassan, 4- Complex of Amir Ahmad al-Mihmandar



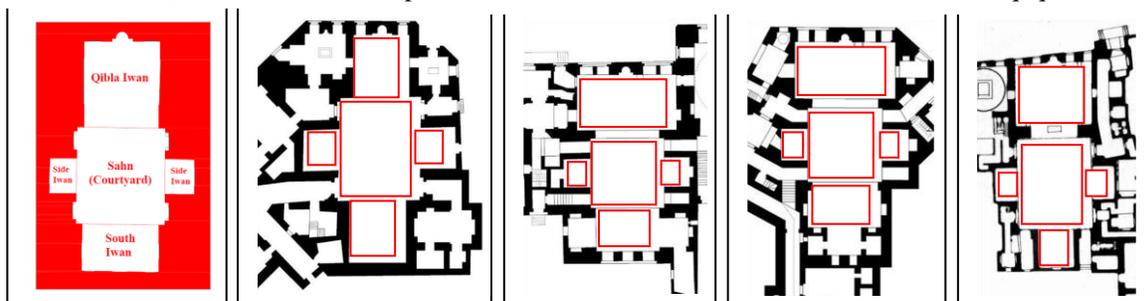
### 1.4.2. The Sahn and Iwans

The courtyard as widely explained in art history is nothing more than a utilitarian architectural device provide privacy and to ameliorate the harshness of the climate.

Although the first four-rite madrasa was found at Baghdad, the first madrasa of cruciform plan was found in Cairo; the cruciform plan was Egyptian in origin and it is practically unknown outside Egypt (Creswell,1922, p.43). By the choice of the courtyard as the heart of almost Mamluk religious building, the Mamluk designers obtained a more feasible “urban” form, capable of providing that the centre in religious building design acts as a generator of form, and the whole organization of the building form starts from the centre extending the design outwards. This architectural tool dominated the architectural activity of “place making” and during the Mamluk period in Egypt became the prototype of place, unifying the individual parts of a building with the whole outside.

The iwan is a vaulted hall, walled on three sides, with one end entirely open. Iwans were common in the Sassanian world before Islam and rapidly became incorporated into Islamic architecture. The greatest period of diffusion was under the Ayyubids in the 10<sup>th</sup> century when iwans became established as one of the basic units of Islamic architecture (Petersen,1999, p.130). One of the most typical iwan arrangements is to have four iwans opening on to a central courtyard. This later became a typical arrangement for mosques, madrasas and palaces in the Mamluk era.

**Figure (5)** the Sahn and Iwans composition in Madrasa buildings (authors) Iwans composition in 1- Madrasa of Umm al-Sultan Sha'ban, 2- Complex of Sultan Qaytbay, Madrasa buildings (authors) 3-Complex of Amir Azbak al-Yusufi, 4- Madrasa of Sultan Barquq



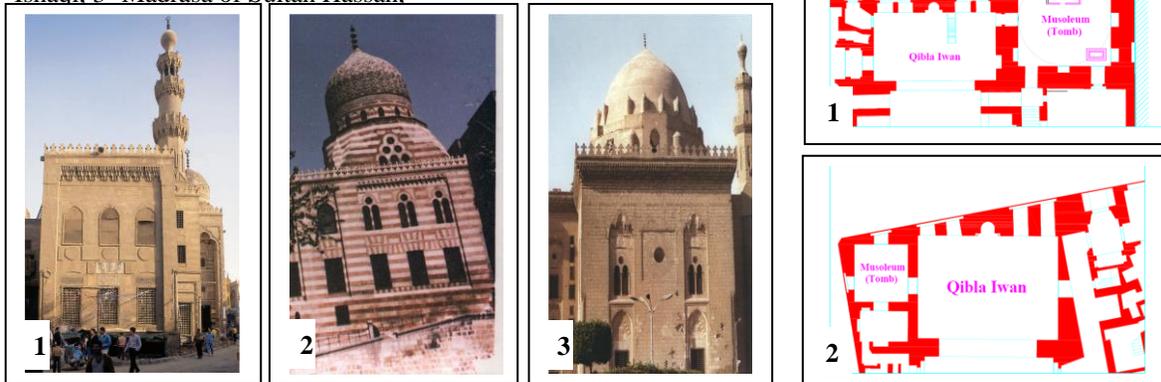
### 1.4.3. The Mausoleum

There are many rules controls the design of the Mausoleum

- it had to be Mecca-oriented at the same time it must be visible from the street
- the optimal positioning of the mausoleum in the context of the city was adjacent to the prayer hall.
- The depth of the mausoleum was either inferior or equal to that of the adjacent prayer hall. Exceptions to this rule can be found in some royal buildings; the size of Qalawun’s mausoleum exceeds that of the madrasa’s prayer hall, and the depth of Qaytbay’s and al-Ghuri’s mausoleums exceed that of their respective sanctuaries, which are, however, wider.
- it must be integrated in the design of the façade.
- sometimes there was a window between the mausoleum and the prayer hall to communicate prayers performed in the sanctuary to the tomb, thus bestowing blessings on it, while deceased ever-present in the city.

**Figure (8)** The positioning of the mausoleum to the prayer hall (authors).  
1- Complex of Sultan Qaytbay, 2- Madrasa of Sultan Ashraf Barsbay

**Figure (7)** The fenestration system of the mausoleum (authors):  
1- Mosque of Emir Qanibay Qara, 2- Mosque of Emir Qijmaa al-Ishaqi, 3- Madrasa of Sultan Hassan.



**Figure (9)** The geometric composition of the Mausoleum (authors):  
1- Complex of Khayrbak, 2- Baybars al-Jashankir Complex, 3- Sultan Qala'un Complex

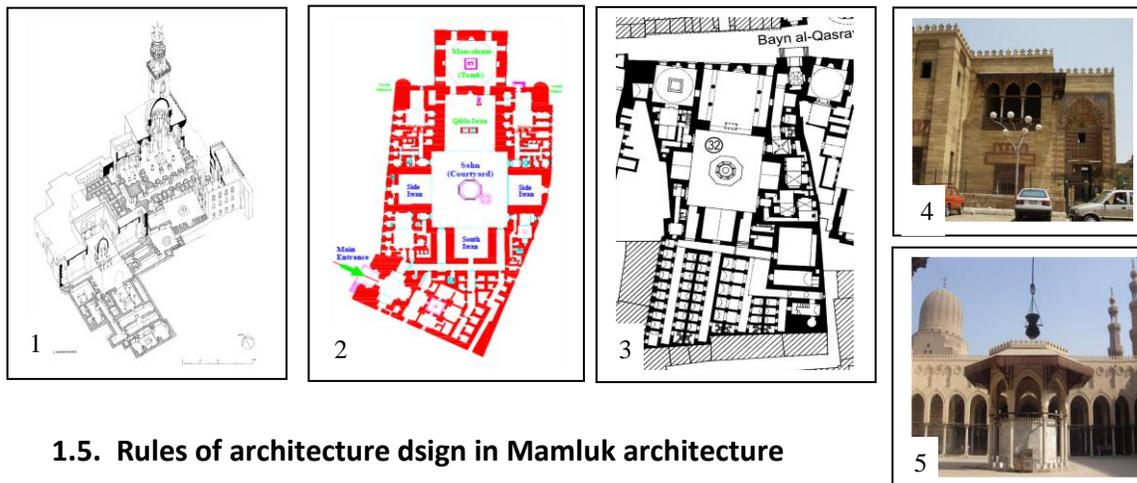


#### 1.4.4. The attached functions

From analysing Madrasa buildings, many attached function were observed: Sabil-Kuttab, minerate, madrasa for teaching the four "Mazhabs", Māistān (hospital or medical units), ablutary spaces, stores, Suffis rooms, accommodation and students cell.

From the late Bahri period a corner was occupied by the composite structure of the sabil-maktab, which appear for the first time at the madrasa of Uljay al-Yusufi, (Behrens-Abouseif, 2007, p.84), and eventually became a standard feature of a Madras buildings. The structure corner windows, surmouneted by the classroom of a primary school for boys, the maktab, overlooking the street through an arched wooden loggia. Both the sabil and maktab already belonged to the auxiliaries of a Madras, and they were combined in an architectural composition that characterized the façade.

**Figure (10)** the attached functions to Madrasa buildings (authors): 1- maristan in Complex of Qala'un, 2- services in Madrasa of Sultan Hassan, 3- room cells in Madrasa of Barquq, 4- Sabil-Kuttab in Madrasa of Farag ibn Barquq, 5- ablutary fountain in Mosque of Muiyyd Shaykh,



#### 1.5. Rules of architecture dsign in Mamluk architecture

The designation of an architect as the principle designer is complicated by considering the absence of building documentation of the design process, and also through historical sources that recognize patrons as architects, so that This section discusses the design rules to enrich our understanding of the identity Mamluk designers

##### 1.5.1. Islamic context of architecture and architectural messages

The 'context' as a scientific term is more universal and comprehensive than 'function' which is governed by engineering, technical and economical determinates aiming at achieving the best utilization of space. Function in architectural action, while context is an expression that includes the functional, together with the social and human needs. In Islamic architecture the context is related to Islamic values and instructions that should be provided in different building types (‘Abdel-Baqī Ibrāhīm, 1986, p.78).

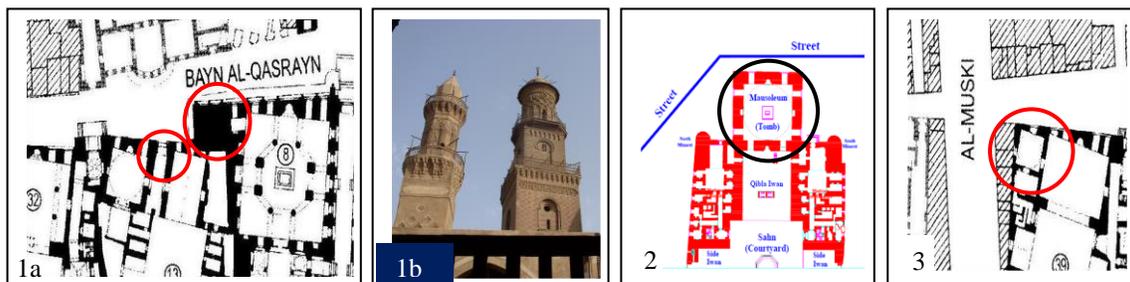
The Islamic context an expression that combines the functional and convictional aspects, is considered the basic approach to the Islamic perspective of architecture. It is afterwards finished off with formal values related to the local environmental cultural and historical background of the place. The context is thus the constant (universal) aspect of the Islamic perspective of architecture, while the form is the variable (local) aspect. The Islamic context of architecture is directly or comparatively related to Quran instructions and the Sunnah of the Prophet (p.u.b.h.). The Islamic context in the first place, determines the forms and spaces composing the architectural work and organizes the functional relations between them, then comes the artistic expression through local building material and methods, in addition to the technical and cultural inherited values of the society. In other words, we can say that Muslim's architecture is considered a local architecture based upon Islamic values. ((OICC), 1992, p.486).

The Mamluk architect behind the positioning of architectural elements inside the building want to send many messages from the Sultan to the ruled, for example:

- The position of Sultan Hassan mausoleum in his Madrasas building send a message to pedestrians and the ruled, he wanted to said that "he is the leader of people to bring them together to the God
- The minaret of Sultan Mohammed Ibn Qalaun, he want to send a message of respect to his father behind it's volume and position, it's volum is smaller than his father minaret and it's position is recessed to back from his father one.
- The position of the mausoleum attached directly to the street is to send a message of strong relationships between the sultan him and the rulers.
- External facades reflected the internal design in a manner that made it possible to distinguish the façade of the Mausoleum from that of the Madrasa; also the qibla Iwan from other Iwans, that as a kind of simplicity and clarity.
- The building reflected the material and metod of construction hoping to prolong the life span of the building and thus to immortalize the name of the founder. While we find simplicity in exterior formations, which is community's façade, we find richness in interiors with stucco decorations and other different materials especially in the Qibla wall, in the ceillings.

**Figure (11)** involved messages in design (authors)

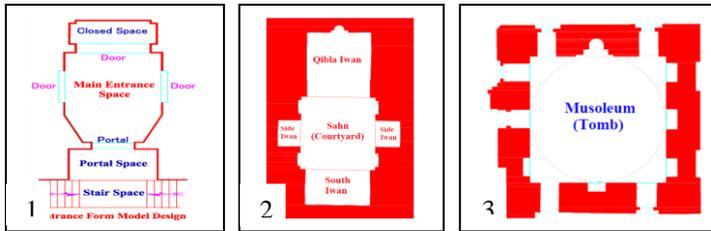
1(a,b) - The relation between Sultan Qala'un minerate and Sultan Mohammed Ibn Qala'un minerate, 2- The position of Mausoleum in Madrasa of Sultan Hassan, 3- the position of Mausoleum in Madrasa of Sultan Ashraf Barsbay,



### 1.5.2. Depending on Design Units

Design units were fixed in its shape and composition. Designer could not omit or neglect them in the design of the building. The research had found that, there were four main design units which the Mamluk architects depended on them: the entrance, the Sahn and Iwans, the Mausoleum, and the attached functions (which can be changed from one building to another such as: student cells, Sabil-Kuttab, mirastan,...etc).

**Figure (12)** the composition of the design units (authors)  
1- the entrance,  
2- the sahn and Iwans,  
3- the mausoleum



### 1.5.3. Design in Context

An initial reading of Mamluk architecture reveals form qualities governed by urban factors, and, as a result, Mamluk monuments cannot simply be read as containers of spaces or objects in space, but rather as complex mediators between interior architectural spaces and exterior urban spaces. Individually, Mamluk monuments were more responsive to their context than initiators or dictators of new ones. It was from their collective power that a new concept of space emerged. It becomes clear that the concept of space expressed in it is not manifested in isolated buildings but in urban infills (Al-Harithy, 2001, p.73). The "urban pocket" is a spatial pause along major spines or paths. The purpose of such was to reorient the observer into a building, or to generate a place of social interaction (Al-Harithy, 2001, p.84).

The Mamluk architect depended on studying the mutual relationship between his building's architectural elements and their distribution in the surrounding urban context, in order to emphasize his notions besides respecting the effect of the urban context on the building design. This section will present three examples which demonstrate that, the Mamluk architect from his studies of these mutual relations he could determine the position of his architectural elements inside his building design.

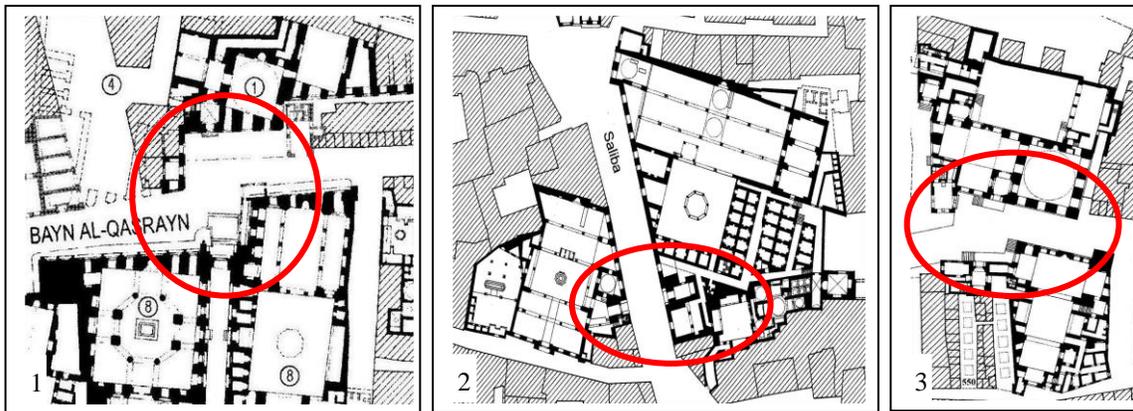
This section presents three examples that show that, the designer mainly depended on the building urban context during the design process, as follows:

- 1- The complex of Qalawun: The projection of the building into al-Mu'izz Street complements the mausoleum of al-Salih and gives the space between the two complexes a sense of enclosure, also the entrance of each one is placed opposite to each other generating a zone of movement across the main avenue.

- 2- The complex of al-Ghuri. It is very clear to see how the Mamluk architect played with the building masses in their urban level to generate a space between the two parts of the building and have a sense of enclosure.
- 3- The Mosque-khanqah of Emir Shaykhu al-Umari, the architect divided the building into two parts and placed them facing each other across the street. However, the two parts are in a very harmonious spatial and a visual relationship.

**Figure (13)** design in context in Madrasa buildings (authors):

1- Complex of Sultan Qala'un, 2- Mosque of Emir Shaykhu al-Umari, 3- Complex of Sultan al-Ghuri

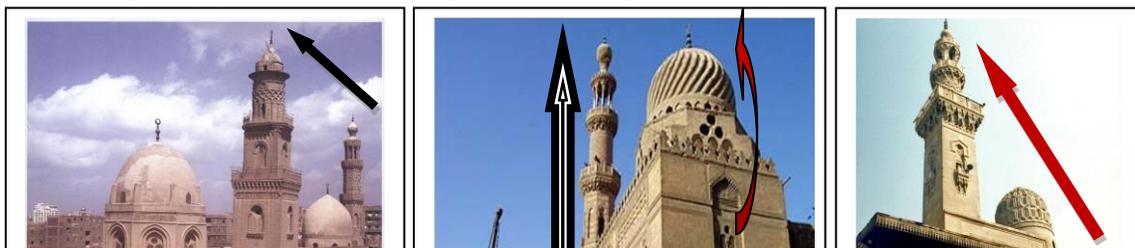


#### 1.5.4. Visual Continuity:

The visual continuity in religious Mamluk architecture can be seen in three positions. The first is the visual continuity in the same building. In this case, the visual continuity occurs in two facades facing two different streets. The second is the visual continuity between different buildings' facades straddling the same street. The third is the visual continuity between the interior architectural space and the exterior urban space (Gaber, 2001, p.91). Because of the growing interdependence between the interior and exterior space in Madrasa buildings the visual continuity between the interior architectural space and the exterior urban space became so important. The transitional space was used to control the degree of fluidity between the two spaces. The indirect entrance became a spatial unit control the sequential transition between the street and the building, and through which the approach to the building was controlled, and privacy ensured.

Visual effects can also be produced by a mixture of stones on facades and around openings. The form most widely used in Cairo was the so-called ablaq, a technique of alternating courses of light and dark stone. It became popular in Egypt where it was introduced by Sultan Baybars, who brought the technique from Syria after 1300. (Creswell, 1952) Well-cut and well-dressed stone is a medium of construction that provides an air of solidity, sobriety, and grandeur to a building. It was used for the facades, the gateway and the internal and external portals

**Figure (14)** The visual continuity in Mamluk religious buildings design (authors)



The first picture shows the visual continuity through the street between Sultan Qalawun and sultan Barquq facades, the second picture shows the visual continuity between the dome and the minaret in the same building in Madrasa of Sultan Ashraf Barsbay, the third picture shows the visual continuity between four elements, the entrance, the Kuttab, the minaret and the dome in the same building in Mosque of Taghribardi.

#### **1.5.5. Dramatic Visual Play of Forms and Volumes**

Mamluk Cairene facades provide a stage for a dramatic visual play of forms and volumes positioned in such a way as to accentuate their contrasting outlines. Here such a configuration is exemplified by the vertical thrust of the minaret terminating in a bulb, the hemispherical counterbalance of the dome, the rectangular frame of the portal, the mass of the facade comprising a tall vertically articulated wall, the sabil strategically carved out at the corner (above which a cubical mass is subtracted from the bulk of the building for the kuttab loggia), and the horizontal band of shurfat to unify the facade. The relationships of these forms to each other give the Cairene facade its originality.

A striking visual statement is produced in Complex of Amir Sarghitmish in Cairo by the projection of the domed mausoleum into the busy street through a rectangular cross-vaulted space. This madrasa shows how the desire to reconcile the facade to the existing street alignment while orienting the interior to the qibla, and the desire to display the mausoleum to the passersby to invoke their blessings produced a unique volumetric composition which provides a rich sequential experience on both the interior and exterior.

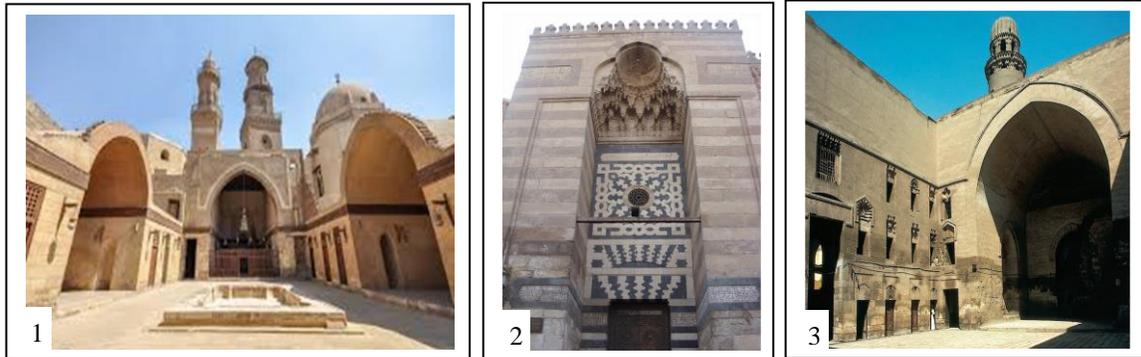
Internal formation regard the different heights in the Madrasa as they changed according to the function of different spaces. This difference was utilized to emphasize the Iwans surrounding the courtyard which occupied the full height of the building, after the gigantic monumental portal, the spaces follow one another in a gradual manner to prepare the transition from the outside to the inside across the vestibule, the main corridor, and the secondary corridors that lead to the different elements of the Madrasa.

The analysis of the internal space's composition presents that, the architectural function affected the formation of internal spaces and the space volume different according to the function, for example, the surmounting of the sabil at the corner of the building with a kuttab, a Qur'anic school for boys, to form a unified volumetric

composition was unprecedented but from then on became a standard practice in religious buildings of Cairo.

**Figure (15):** the volumetric composition of the architectural spaces (authors)

1- the Iwans in Madrasa of Sultan Mohammed Ibn Qala'un, 2- the entance in Mosque of Sultan Muiyyd Shaykh, 3- the Iwans and student cells in Khanqah of Baibars al-Jashankir



### 1.5.6. Inward design

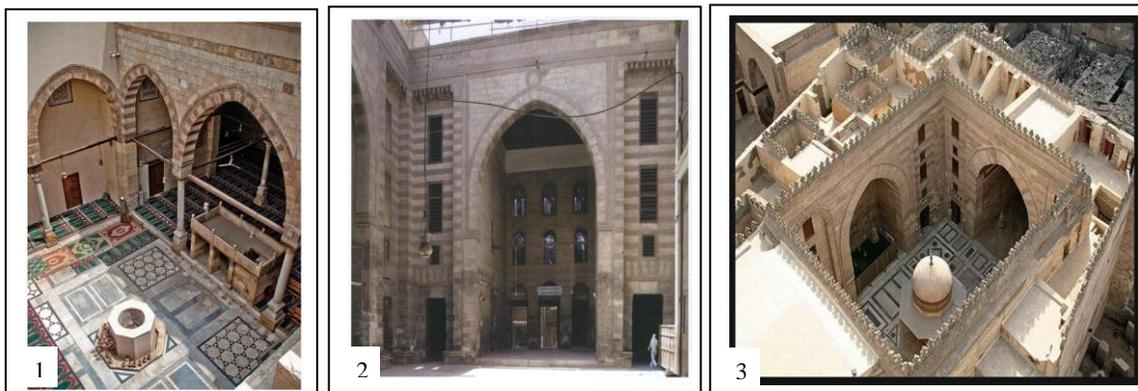
One of the most striking features of all Madrasa buildings is their focus on the enclosed space. The design of the buildings depends on organizing or articulating the main spaces and the total design around an inner courtyard. The transition from the bent entrance to the courtyard through the narrow passage is one from subdued darkness to bright sunlight. The courtyard is used as the heart of the building. The internal courtyard replaces the external environment and includes various activities for the users.

The analysis shows that the design of the plan was based on the direction towards the inside, (introversion), and that tow patterns are predominant: the first is the courtyard surrounded by riwaqs; The second is the Madrasa with four Iwans surrounding a central courtyard. ((OICC),1992, p.159).

With the physical connection of Madrasa Sahn and Iwans to the street, a spatial continuity between the indoor and outdoor is created. For example, in Sultan Baybars al-Jashankir Complex in Cairo The architect created a plan that accommodates a mausoleum with a vestibule that extends to the passersby and allows for a subtle adjustment of the Mecca-oriented interior to the street alignment. This portal helps shift the line of the street between two different parts of the complex, and a minaret carefully positioned to

**Fig. (16)** inward design (authors):

1- Mosque of Shayku, 2- Madraas of Uljay al-Usufi, 3- Madrasa of Barquq orientation of funerary architecture with respect to both the street and Mecca

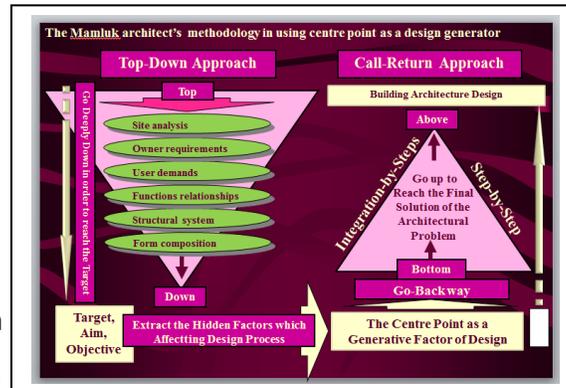


### 1.5.7. The power of the centre point as a design generator

In Mamluk architecture all processes of form generation are based on the transcendent principles of the growth of the point as unity (the point grows into the line, then to the plane, and finally forms the third dimension of a solid). Looking at the overall plan of the madrasa with its central sahn, the most logical starting point for any controlling geometry must be the centre of the sahn. It is here that the two main axes cross, and, as is the case in cruciform-planned madrasas, it was the visual centre (Walls,1990, p.41)

From analyzing the Madrasa buildings, the research had found that, the Mamluk architect had depended on geometry as a main tool in all design process's steps, and the center point is the "Reference point" which actually all the building design revolve around it, like the point of falling down stone in the water, from this point all waves go and extractes and refer to it. The following figure shows how the Mamluk architect depended on the power of the centre point as a design genertaor.

Fig. (17) the power of the centre point in design process (authors)



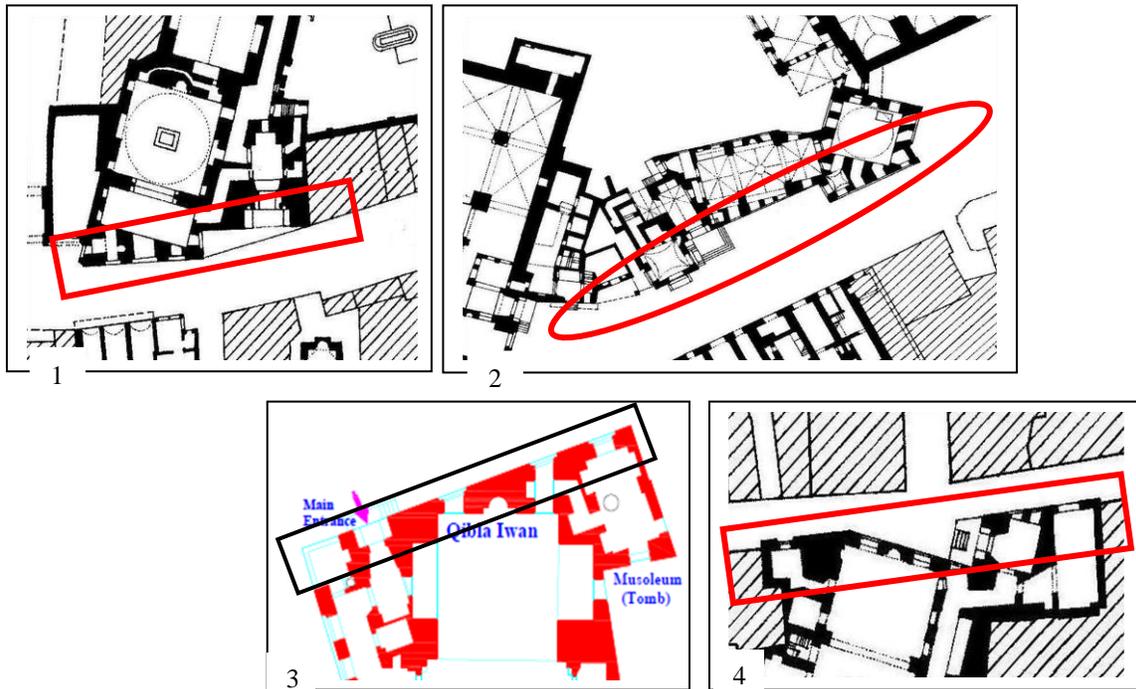
### 1.5.8. Urban

The urban wall is the building's interior design and the outer site urban design. These urban walls emerge when the building site is an awkward shape or when turning inside spaces to Qibla direction<sup>(1)</sup>, its role is to absorb internal space's deformations to generate regular spaces inside the building. The Mamluk architect depended on the thickness of wall to avoid the negative effect of the deformation on the enclosed designed space. The architect respect the street orientation from the outside and the direction of the Qibla from the inside, a matter which led to the variation of walls' thickness, as an image of the reflection of religion rules on design

<sup>1</sup> The qibla direction: which indicates the prayer orientation to Makkah to pray, as one of the most religion rules is orienting face to Kabba.

In Madrasa of Amir Mithqal al-Anuqi in Cairo, the desire to impose formal architectural design on a constricted irregular site produced an inventive scheme by modifying and attenuated four-iwan plan. An unusual engineering feat is the suspension of the whole structure over an alley, producing a hanging madrasa.

**Fig. (18)** The urban wall design (authors): 1- Khanqah of Baybars al-Jashankir, 2- Complex of Amir Khayrbak, 3- Madrasa of Qadi 'Abd al-Basit, 4- Mosque of al-Maridani



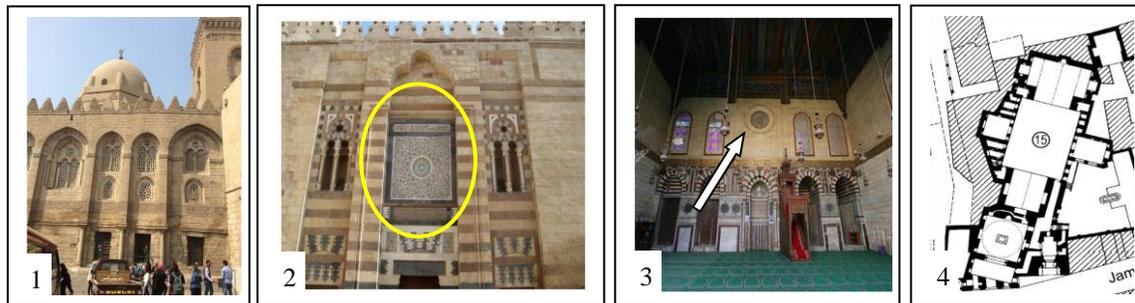
### 1.5.9. System of Fenestration

From analyzing the Madrasa building's fenestration system, there were six types of fenestration system as follows:

- **Windows in recesses panel:** Paneling facades with recesses pierced with windows, even when windows were not necessary.
- **Large rectangular windows:** it had been pierced on facades to allow visual communication with the street.
- **Ceremonial windows:** As the Madras already received enough light from its large courtyard, the windows might have had a ceremonial significance , for communication with the site, where it once faced the royal palaces.
- **The tripartite window:** with an oculus above a double arched opening. (it appears for the first tie in the monuments of Qalaun)

- **Qamariyya:** it is an Inner arched window, has a stucco grille filled with coloured glass. The qamariyya were a relieving device as well as a decorative one that adorned the façade and added colour to the interior, rather than serving as a source of light.
- **Blind windows** in the façade: as in Madrasa of Um al Sultan sha'ba'n the symmetry of the exterior fenestration mad it necessary to include blind windows in the façade.
- **Omitted windows:** In a Madrasa where the iwans do not open on the street but receive their light from the courtyard windows could be omitted altogether (as in khanqah of Baybars al-Jashnakir, which is equipped with airshafts for ventilation, and in the madrasa of Um al-Sultan Sha'ban).

**Fig. (19)** fenestration system in Madrasa buildings (authors): 1- The tripartite window in Madrasa of Sultan Qala'un, 2- blind window in mosque of Aslam alselhdar, 3- Qamariyya in Madrasa of Sultan al-ashraf barsbay, 4- omitted windows in the Iwans in Khanqah of Baybars al-Jashankir



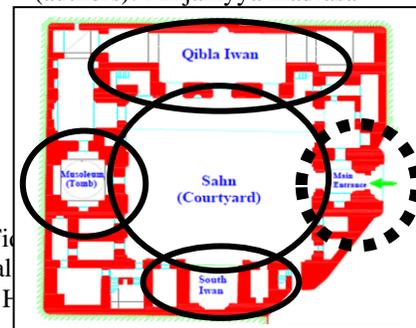
### 1.5.10. Architectonic and dynamic functions

Dynamic function mean that any function inside the building can be replaced with another at the same architectural space. For example in case of Amir khayerbak the designer narrwing the side iwan to make large space free for the mausoleum, in madrasa of Mirjaniyya in Baghdad the designer place the entrance in the place of side iwan, and in Madrasa of sultan hassan the designer attaced the four school of Fiqh<sup>2</sup> to the four iwans in a flexible matter

Unlike the cruciform madrasas style, in complex of Amir Sarghitmish in Cairo the side iwans are of a considerable size and consequently leave little room on the lateral sides of the courtyard `for the student living units, most of which have their windows on the exterior. This marks the beginning of integrating madrasas into urban life.

Architectonic function mean the designer can change its composition from one building to another, for example in the complex of Sultan Baybars al-Jashankir in Cairo the mausoleum extends to the street through a vestibule. The bay of the portal, which usually opens directly onto the street, is in this khanqah preceded by

**Figure (20)** architectonic function (authors): Mirjaniyya madrasa



<sup>2</sup> **Fiqh [fiqāh]** is Islamic jurisprudence (the explanation of Sunnah). Fiqh deals with the observance of rituals, morals and social prominent schools of fiqh, the Madh'hab (Maliki, Hanafi, Shafi'i, and F

a larger entrance bay which opens directly onto the street through a lofty with cushion voussoirs.

### 1.5.11. Applying religion rules in relation with buildings

Science was an important dimension of the Islamic city. One element was the time-keeping (miqat) in the mosques. Astronomy was necessary to view the lunar crescent for religious purposes. It must not be forgotten that each of the large mosques had an astronomer associated with it. (Rashed, 2003)

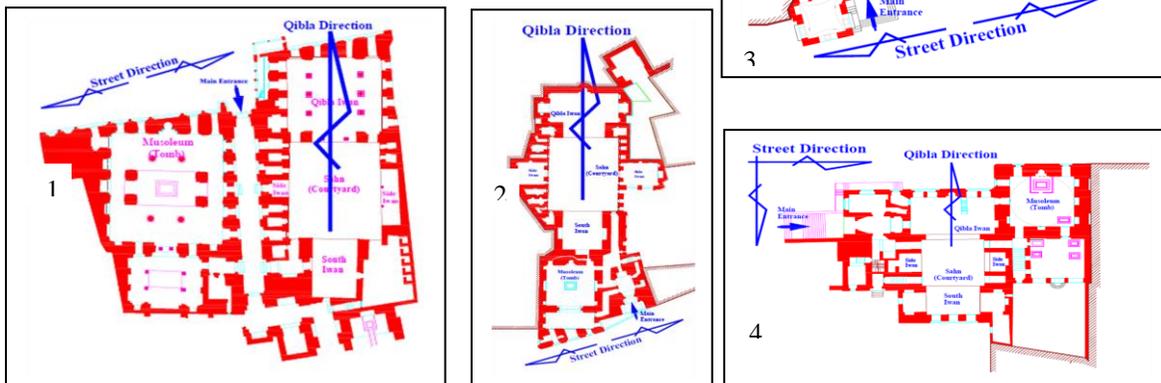
In fact, few religions have given practical mathematicians so much to think about as Islam, with its lunar months which start at the moment when the new crescent is visible, its carefully defined five prayer-times a day. Both al- Biruni and his modern commentators have claimed more; that such knowledge was essential for religious purposes, since to design the layout of a mosque correctly it was essential to determine the direction of Mecca where the faithful should turn for prayer. As he says:

"Let us point out the great need for ascertaining the direction of the qibla in order to hold the prayer which is the pillar of Islam and also its pole. God, be He exalted, says: 'So from wheresoever thou startest forth, turn thy face in the direction of the Sacred Mosque, and wheresoever ye are, turn your face thither.' (Qur'an, Sura 2:150). (Al-Bīrūnī, 1967, pp. 11–12).

The major or the most important religion rules is orienting the main function in Madrasa building (worship spaces which are Iwans) to the Qibla direction neglecting the orientation of the site boundaries (streets, neighbourhoods, ...etc). the following figures shows the mutual relationship between the qibla direction and building composition.

**Fig. (21)** the mutual relationship between the Qibla direction and the building composition (authors):

1- Madrasa of Sultan Qala'un, 2- Khanqah of Baybars al-Jashankir, 3- Complex of Amir Khayrbak, 4- Complex of Sultan Qaytbay



### 1.5.12. Adaptability of environment

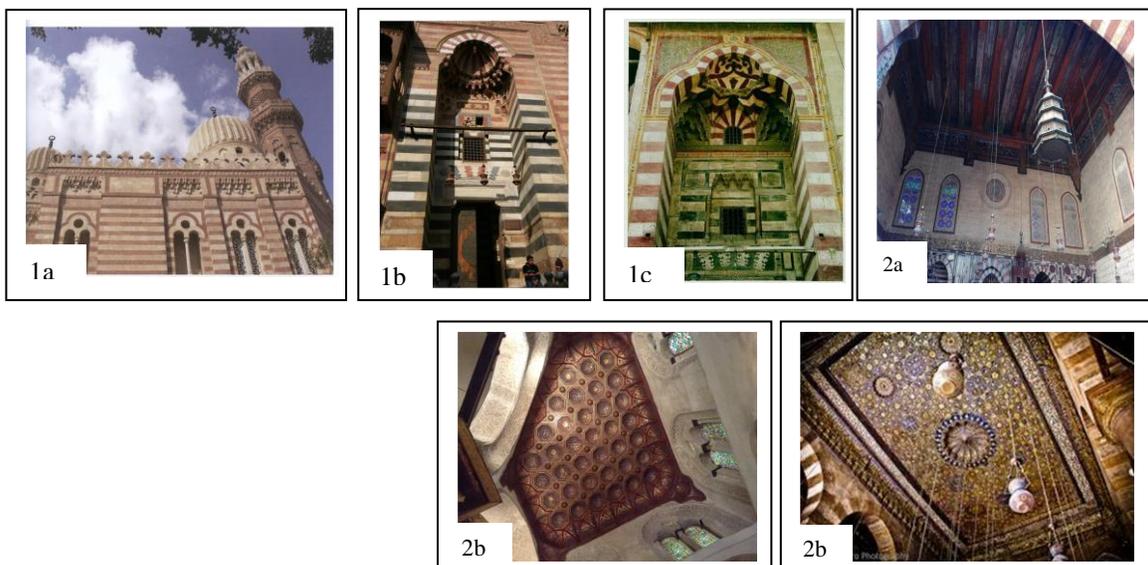
Natural materials are used for building the Madrasa: lime-stone is basically used especially for building vaults that cover the Iwans, the four centered pointed arches and the external walls; red bricks were used for building the dome that covers the tomb and minaret; marble is used for floors and skirtings, stone is used in the mushahar style in the formation of the facades, and wood is used for covering the corridor that follows the entrance. These materials are utilized on their natural form especially for the external façade, which inspires sincerity of expression in using the material and enhancing the integration of the building to the surrounding environment.

As for the interior, floral and geometrical decorations were used, in addition to using the method of alternating black and white, red and white courses. Pointed and circular arches were also used. Red brick were used in walls, wood for the ceiling. Using these materials reflected adaptability to environment.

Also architectural elements were used to cope with climatic conditions such as the wind catchers which were used as means of ventilation and cooling for the first time in al-salih Tala'i' mosque. For constructions, pointed arches were used, red bricks for interior buildings, tile stones for facades, wood for the ceilings. In Madrasa buildings all the material used were from surrounding environment, portraying the relations with the local.

**Fig. (22)** Natural materials in the building of Madrasa (authors):

1- mushahar style: a- Madrasa of Um al-Sultan Shab'an, b- Madrasa of Sultan al-ashraf barsbay, c- Complex of Sultan Qaytbay, 2- Wood ceilings: a- Qibla Iwan in complex of Sultan al-Ghuri, b- the Mausoleum in Madrasa of Sultan Qala'un,



## 2 The generative technique for Mamluk Madrasa building design

### **2.1. The generative technique description**

The absence of drawings can be explained as the capability of their craftsmen to understand and utilize this mode of representation, a better explanation is that such drawings were not seen as essential to the processes of design and construction in medieval Islam. (Yousefi, 2005, p.19) from this notion the research suggests this technique for building design which is a fixed consequence steps and it must be applied as it is to generate the building design, and any deviation or change or any disorder in the sequences of it's steps leads to the deformation of the building design, also taking in consideration the following points:

- 1- The manipulation with design units, which represent the main functions, must be according to the functions relationship requirements.
- 2- The tendency of the Islamic builders to determine the final design of Madrasa at the site of construction is also one probability, but we must differentiates between design elements that are fixed, and the filler units which are loosely arranged and may have been decided upon as last-minute design choices.
- 3- The spaces in between and along the outer edges of the design units are often completed with components as a filler units whose less precise shapes would allow them to be adapted to the varying profiles of sites during construction.
- 4- While the plan of the Madrasa utilizes a simple arrangements which consists of four main components, additional geometric exercises were necessary to accommodate the plan into its site.
- 5-

### **2.2. The generative technique idea**

The generative technique extracted its ides from three points

- 1- The analysis of the Islamic ornamentation presents that the designer relies heavily on the art of repetition and symmetry to generate a pattern. This pattern play the role of design generator, so it repeated to generate the whole design, and by reflecting this idea on the architecture design of the Madrasa buildings we can discover that there are design units which repeated to generate the building whole design, these units vary in complexity from simple to highly sophisticated designs
- 2- Each culture has its central symbols. In the Islamic culture, the Ka'ba is the symbol of the House of God, to which the face of worshipers in their prayers must be oriented. From the architectural point of view in the doctrine of the Muslims the Ka'ba is the most important building in the Islamic world and therefore placed in the heart of the Islamic world. From here we derive two bases: 1- the most important architectural element in the building must be placed in the center and the heart of the building, 2- All other elements of the building must be distributed and wrapped around it to enhance its architectural function performance.

- 3- lines used to define spaces, so Mamluk architects had begun the design of Madrasa buildings as purely two-dimensional exercises and quickly advanced to an exploration of three-dimensional forms.

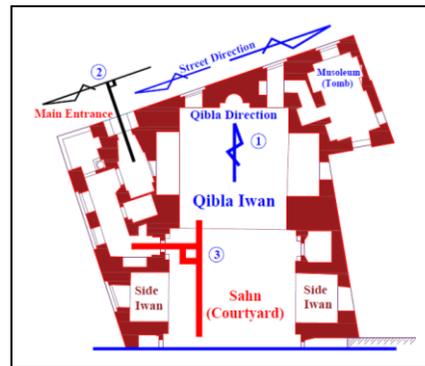
### 2.3. The generative technique rules

There were several rules Mamluk architect had applied them during the design process to generate the design of the Madrasa building, they were summerized as follows:

- ✓ The Qibla Iwan must be oriented to the Qibla direction.
- ✓ The entrance and mausoleum must be perpendicular to the street direction
- ✓ The transition from the entrance to the Sahn must be in perpendicular direction

**Fig. (23)** design rules in Madrasa of Qadi 'Abd al-Basit (authors):

- 1- The Qibla Iwan is oriented to the Qibla direction,
- 2- The entrance is perpendicular to the street direction,
- 3- The transition from the entrance to the Sahn is in perpendicular direction



- ✓ After determining the position of the Sahn and the four Iwans, the designer can replace any of the main functions of the building as the entrance or the Mausoleum instead of one of the Iwans despite the Qibla Iwan, (this rule can be applied on the side or the south Iwan only) as in Baghdad Madrasa or Aleppo Madrasa.
- ✓ Any main step of the technique steps the designer is allowed to branche it to any sub-steps in order to complet the attached components, as in Sultan Hassan Madrasa in the step of completting the design of the Sahn and the Four Iwans the designer go to put the design of the four school of Islamic jurisprudence.
- ✓ The deigner is allowed to reject or cancel any technique steps according to the building site circumstances

### 2.4. The generative technique components

There are two main components of the generative technique which are suggested here.

- The first: the basic design units, which the designer depended on them to design the functions relationships.

- The second: the hidden design rules and principles, which plays the role of the secret factor which controls the building design and by which designer can solve the different architectural problems in the design process.

There are some restricts control the relationship between these components such as:

- The main functions must take the qibla direction (Makkah direction).
- Entering any one of the design units must be in a perpendicular direction to it.
- The building contains a courtyard (Sahn) and it may be roofed or not.
- The four iwans are roofed and their height equals the building's total height.
- The qibla wall is always square shaped.
- There must be geometric integration between the spaces geometric shapes.

### 2.5. The generative technique steps

The geometric steps for plan generation can be ordered in five steps as follows:

#### 1- Designing: (design units)

Designing the building components each one separately as a design unit (entrancs, Sahn and the four Iwan, the Mausoleum and minerate and the attached components)

#### 2- Analysing

Presenting the building site analysis from three points:

- Mutual relationship between the building and the neighbourhoods
- The relationship between the building and the deviation of surrounding streets
- The of the building deviation from the Qibla direction

#### 3- Placing:

Placing the design units (entrancs, Sahn and the four Iwan, the Mausoleum and minerate)

#### 4- Orienting: the four design units inside the building must be oriented as follows:

The Entrance: The entrance is **oriented to be perpendicular** on street

The Sahn and the Iwans: the Sahn and the four Iwns are **oriented to be parallel** to the Qibla direction

The Mausoleum and the Minerate: Mausoleum and Minerate must be oriented to be **parallel** to the Qibla directon and **perpendicular** on the street in the same time

#### 5- Placing: placing the attached components

The following figure concluded the generative technique steps:

Fig. (24) the generative technique steps (authors)



## 2.6. The generative technique methodology for of generating the plan design

The methodology of generating the Madrasa plan design is going in nine steps as follows:

- Step 1 : Determine thw site boundry.
- Step 2 : Determine the qibla direction.
- Step 3 : Placing the Sahn and the four Iwans.
- Step 4 : Placing and orienting the entrance.
- Step 5 : Placing and orienting the Mausoleum.
- Step 6 : Completing the design of the Sahn and the four Iwans.
- Step 7 : Completing the design of the entrance.
- Step 8 : Completing the design of the Mausoleum.
- Step 9 : Completing the design of the attached components of the building.

## 3 The Applied Study

In this paper, a systematic method of design for the derivation of the plans of madrasas buildings in Mamluk architecture is presented. The method is constructed using a corpus of seventeen Mamluk madrasas that were built in Egypt, Syria, and Palestine during the Mamluk period. The most concern for this research understands how madrasa buildings may have been designed in the first place by the aid of systematic technique.

### 3.1. Applied study limitation

There are many limitation affect the applied study, they are as follows:

- Madrasa drawings are strictly limited to the representations of their plans. Building drawing analyzed to highlight the two-dimensional logic which governs the design of the plan.
- The underlying consequence order of the drawing becomes visible when the design units is drawn, according to which the users circulation and functions are arranged
- While the rules that organize the components of the plan - which only become visible with the drawing of their function relationships - can be understood as integral parts of the two-dimensional order of its plan.

### 3.2. Case-study buildings

The research applied the suggested methodology in seventeen case study buildings as follows<sup>(3)</sup>:

**Table (1)** Case-study buildings and its distribution in Islamic world

Location	Case-study	Date
Damascus	1- Adiliyya Madrasa	1215/611 AH
Baghdad	2- Mirjaniyya Madrasa	1227-34/625-631 AH
Aleppo	3- Kamaliyya al-Adimiya Madrasa	1241-1251/639-649 AH
Cairo	4- Complex of Sultan Qala'un Funerary	1284-1285/683 AH
	5- Complex of Sultan Baybars al-Jashankir	1307-1310/706-710 AH
	6- Madrasa of Amir il-Malik al-Jukandar	1319/718-719 AH
	7- Complex of Amir Ahmad al-Mihmandar	1324-1325/725 AH
	8- Complex of Amir Sarghitmish	1356/756-757 AH
	9- Complex of Sultan Hasan	1356-1362/757-764 AH
	10- Complex of Amir Mithqal al-Anuqi	1361-1363/762-764 AH
	11- Complex of Amir Iljay al-Yusufi	1372/773-774 AH
	12- Mosque and Madrasa of Qadi 'Abd al-Basit	1419-20/822-23 AH
	13- Complex of Sultan al-Ashraf Barsbay	1432-1433/836 AH
	14- Complex of Sultan Qaytbay (at Northern Cemetery)	1472-1474/876-879 AH
15- Complex of Amir Azbak al-Yusufi	1494-1495/900 AH	
16- Complex of Amir Khayrbak	1502-20/907-26 AH	
Al-Qudss (Jerusalem)	17- Madrasa of Tashtamur al-'Ala'i	1382-1383/784 AH

#### 3.2.1. Adiliyya Madrasa, Damascus

##### 3.2.1.1. Building's general description

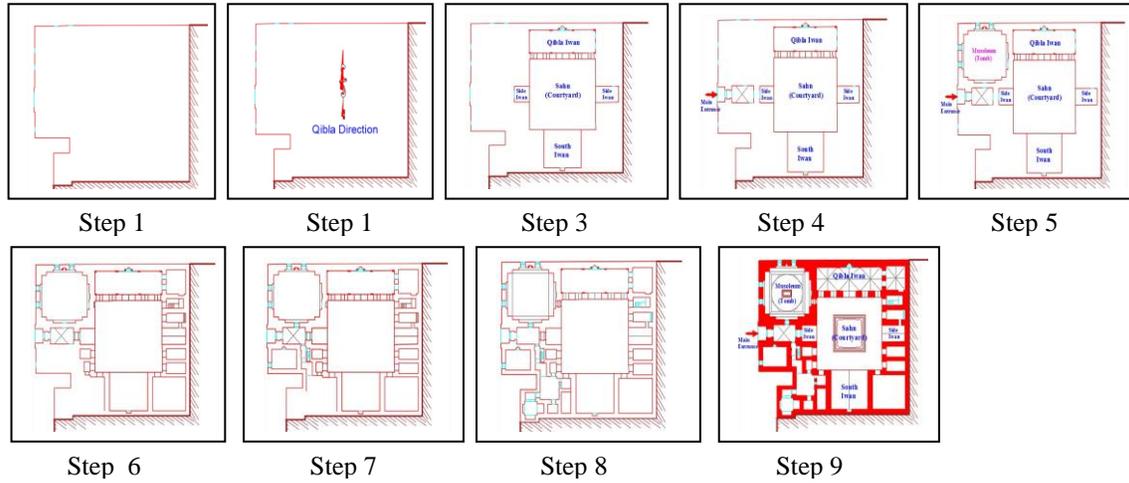


Style period	Zangid
Date	1215/611 AH
Address	
Building type	educational
Building usage	madrasa

<sup>3</sup> The drawings for all these case-study building are on the archnet website: <https://archnet.org/collections/843/publications/1369>

### 3.2.1.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building



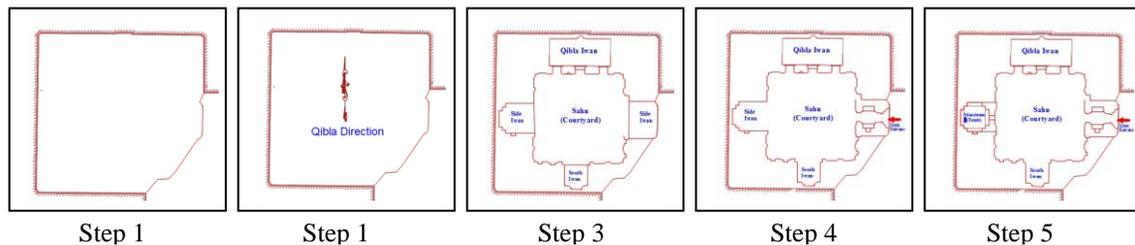
### 3.2.2. Madrasah al-Mustansiriyah (Mirjaniyya), Baghda

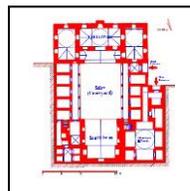
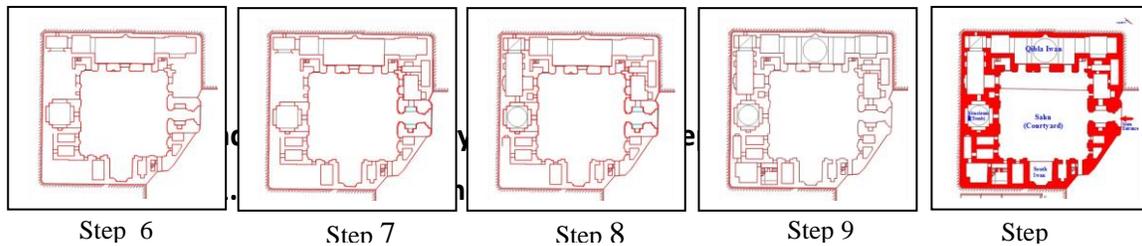
#### 3.2.2.1. Building's general description

	Style period: <a href="#">Abbasid</a>
	Date: 1227-34/625-631 AH
	Address: downstream side of the Shuhada' Bridge
	Building type: <a href="#">educational</a>
	Building usage: <a href="#">madrasa</a>

#### 3.2.2.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building

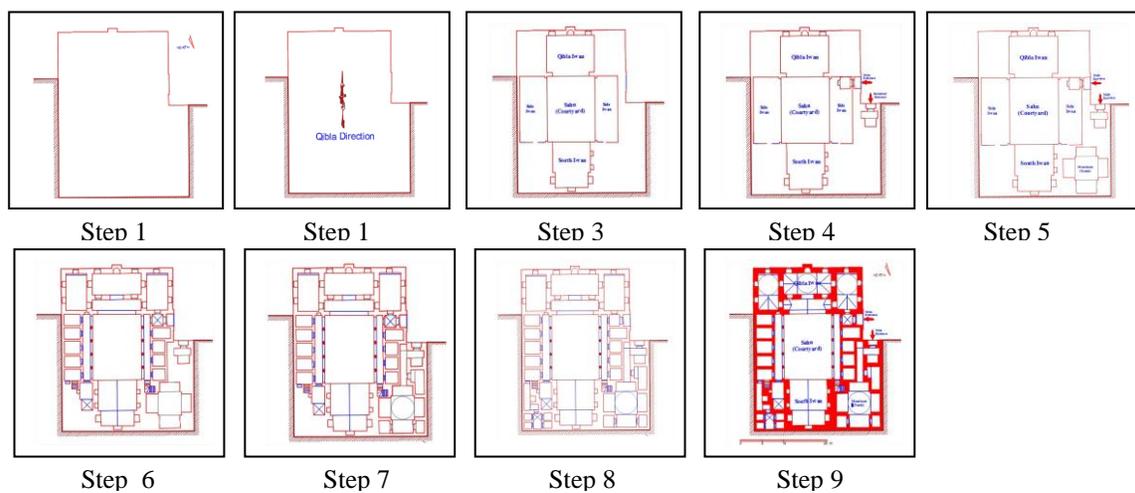




Style period: <a href="#">Ayyubid</a>
Date: 1241-1251/639-649 AH.
Address: Aleppo, Bab al-Nayrab
Building type: <a href="#">educational</a>
Building usage: <a href="#">madrasa</a>

### 3.2.3.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building



### 3.2.4. Complex of Sultan Qala'un, Cairo,

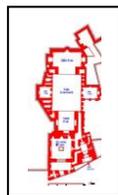
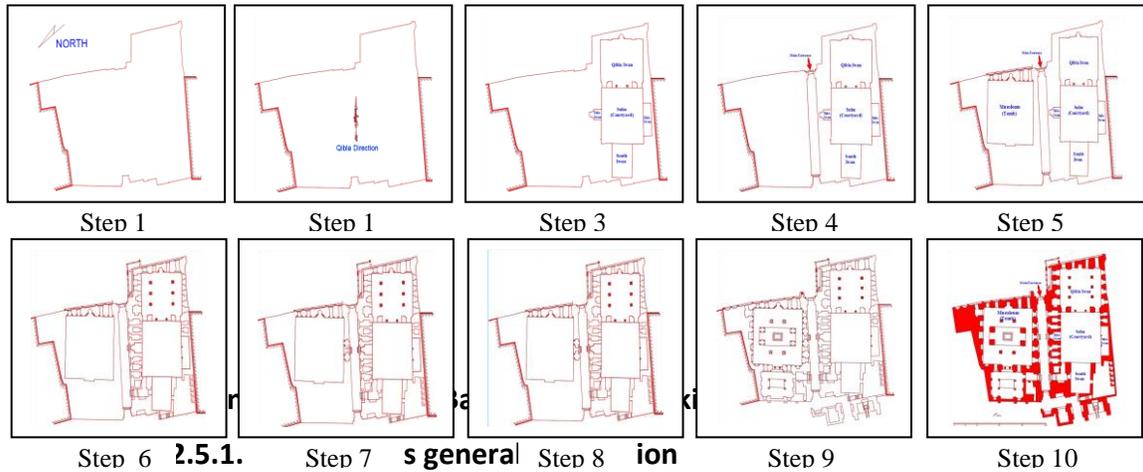
#### 3.2.4.1. Building's general description



Style period: <a href="#">Mamluk</a>
Date: 1284-1285/683 AH
Address: Shari' al-Mu'izz li-Din Allah, Cairo.
Building type <a href="#">educational</a> , <a href="#">health care</a> , <a href="#">religious</a>
Building usage <a href="#">hospital</a> , <a href="#">madrasa</a> , <a href="#">mosque</a>

#### 3.2.4.2. Applying the generative technique on building design

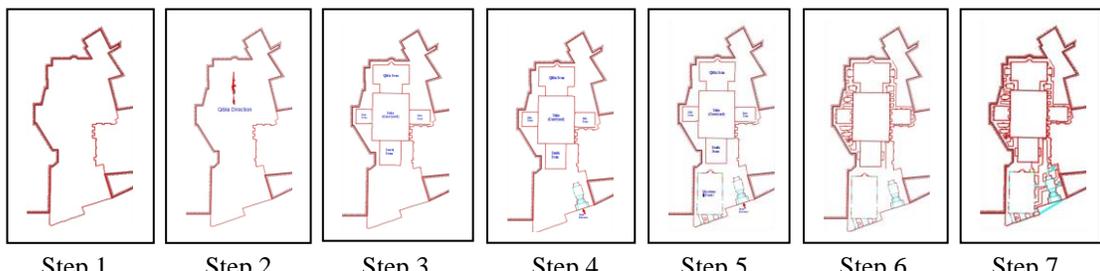
The following is the consequence steps of generating the design of the building

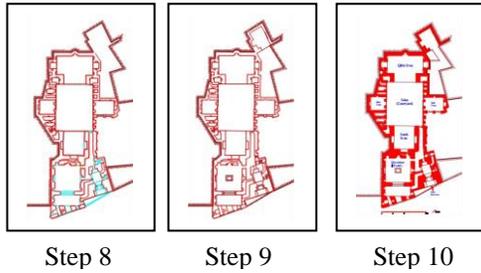


Style period: <a href="#">Mamluk</a>
Date: 1307-1310/706-710 AH
Address: Shari' Bab al-Nasr, al-Gamaliyya Quarter, Cairo.
Building type: <a href="#">funerary</a> , <a href="#">religious</a>
Building usage: <a href="#">khanqah</a> , <a href="#">mausoleum</a>

#### 3.2.5.2. Applying the generative technique on building design

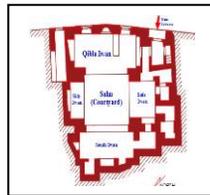
The following is the consequence steps of generating the design of the building





### 3.2.6. Madrasa of Amir il-Malik al-Jukandar, Cairo,

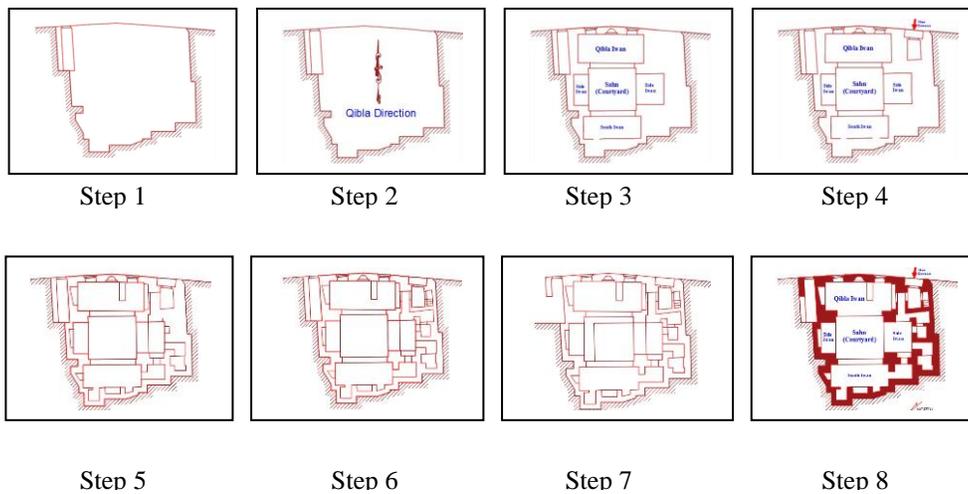
#### 3.2.6.1. Building's general description



Style period: <a href="#">Mamluk</a>
Date: 1319/718-719 AH
Address: Shari' Umm al-Ghulam, Cairo.
Building type: <a href="#">educational</a>
Building usage: <a href="#">madrasa</a>

#### 3.2.6.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building



### 3.2.7. Complex of Amir Ahmad al-Mihmandar, Cairo

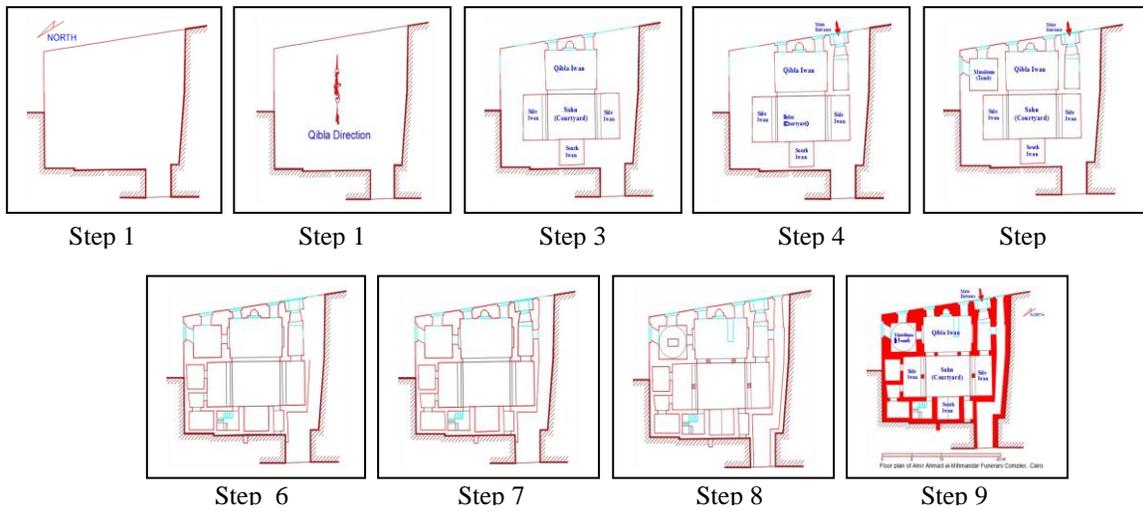
### 3.2.7.1. Building's general description



Style period: <a href="#">Mamluk</a>
Date: 1324-1325/725 AH, restored 1722-1723/1135 AH
Address: Al-Darb al-Ahmar, Cairo, al-Qahirah
Building type: <a href="#">educational</a> , <a href="#">funerary</a> , <a href="#">religious</a>
Building usage: <a href="#">khanqah</a> , <a href="#">madrasa</a> , <a href="#">mausoleum</a>

### 3.2.7.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building



### 3.2.8. Complex of Amir Sarghitmish, Cairo,

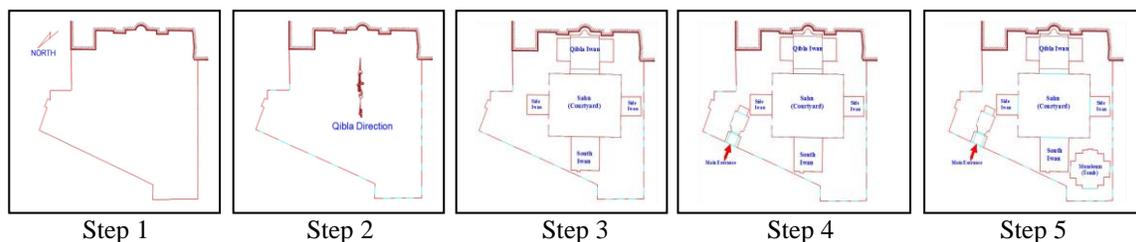
#### 3.2.8.1. Building's general description

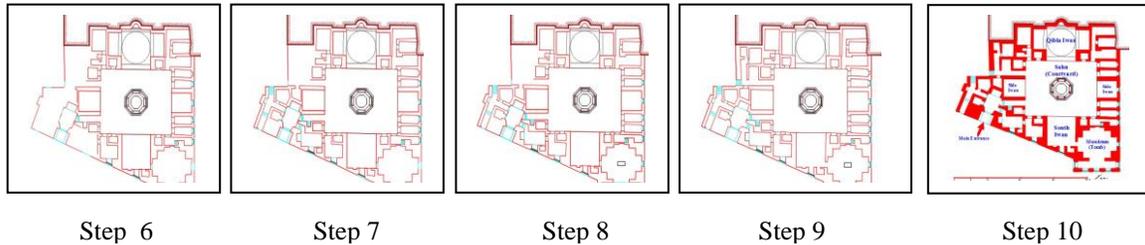


Style period: <a href="#">Mamluk</a>
Date: 1356/756-757 AH
Address: Shari' al-Khudayri, al-Sayyidah Zaynab, Cairo.
Building type; <a href="#">educational</a> , <a href="#">funerary</a> , <a href="#">religious</a>
Building usage; <a href="#">madrasa</a> , <a href="#">mausoleum</a> , <a href="#">mosque</a>

### 3.2.8.2. Applying the generative technique on building design

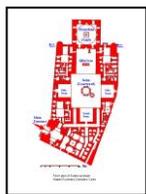
The following is the consequence steps of generating the design of the building





**3.2.9. Complex of Sultan al-Nasir Hasan, Cairo,**

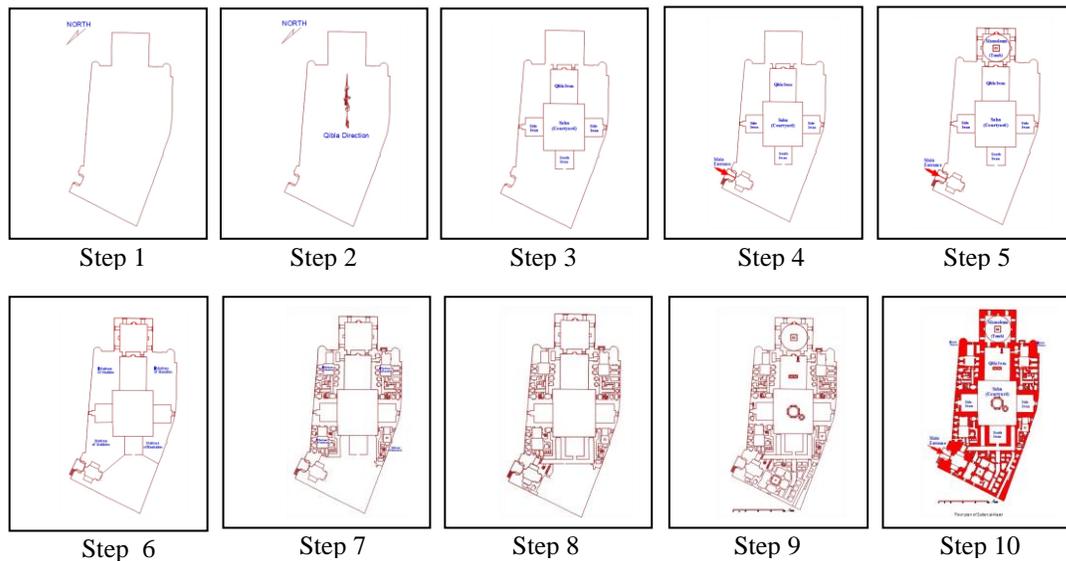
**3.2.9.1. Building's general description**



Style period: <a href="#">Mamluk</a>
Date: 1356-1362/757-764 AH
Address: Shari' al-Qal'ah, Cairo, al-Qahirah
Building type: <a href="#">educational</a> , <a href="#">funerary</a> , <a href="#">religious</a>
Building usage: <a href="#">madrasa</a> , <a href="#">mausoleum</a> , <a href="#">mosque</a>

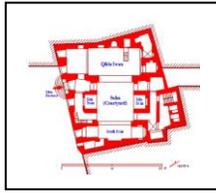
**3.2.9.2. Applying the generative technique on building design**

The following is the consequence steps of generating the design of the building



**3.2.10. Complex of Amir Mithqal al-Anuqi, Cairo.**

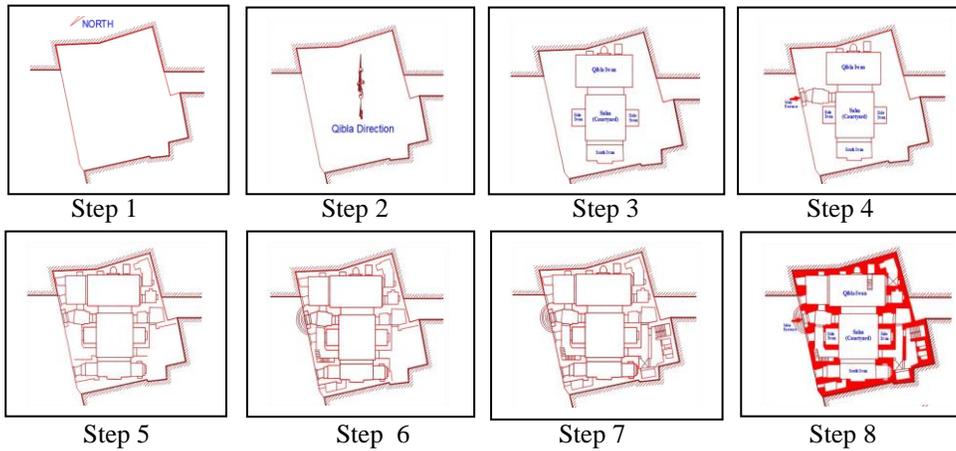
### 3.2.10.1. Building's general description



Style period: <a href="#">Mamluk</a>
Date: 1361-1363/762-764 AH
Address: Darb Qirmiz, Cairo.
Building type: <a href="#">educational</a> , <a href="#">religious</a>
Building usage: <a href="#">madrasa</a> , <a href="#">mosque</a>

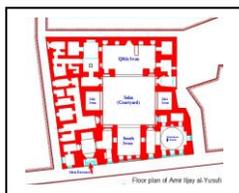
### 3.2.10.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building



### 3.2.11. Complex of Amir Iljay al-Yusufi, Cairo.

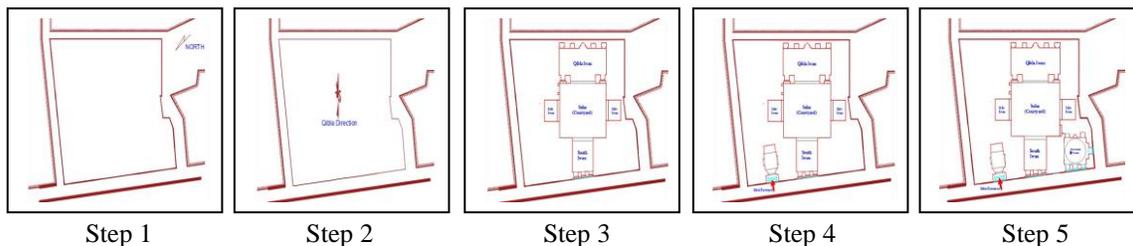
#### 3.2.11.1. Building's general description

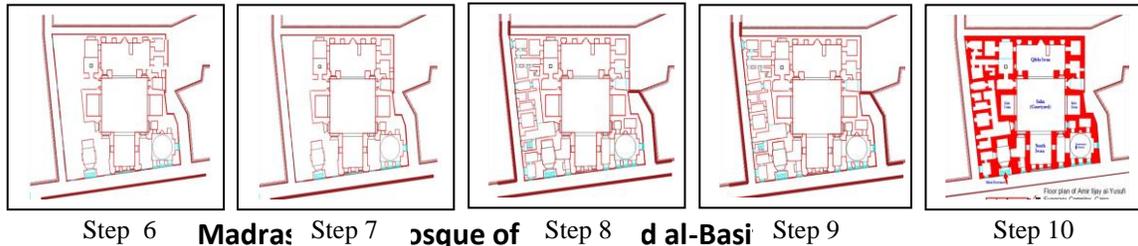


Style period: <a href="#">Mamluk</a>
Date: 1372/773-774 AH
Address: Shari' Suq al-Silah, Cairo.
Building type: <a href="#">educational</a> , <a href="#">funerary</a>
Building usage: <a href="#">madrasa</a> , <a href="#">mausoleum</a>

#### 3.2.11.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building





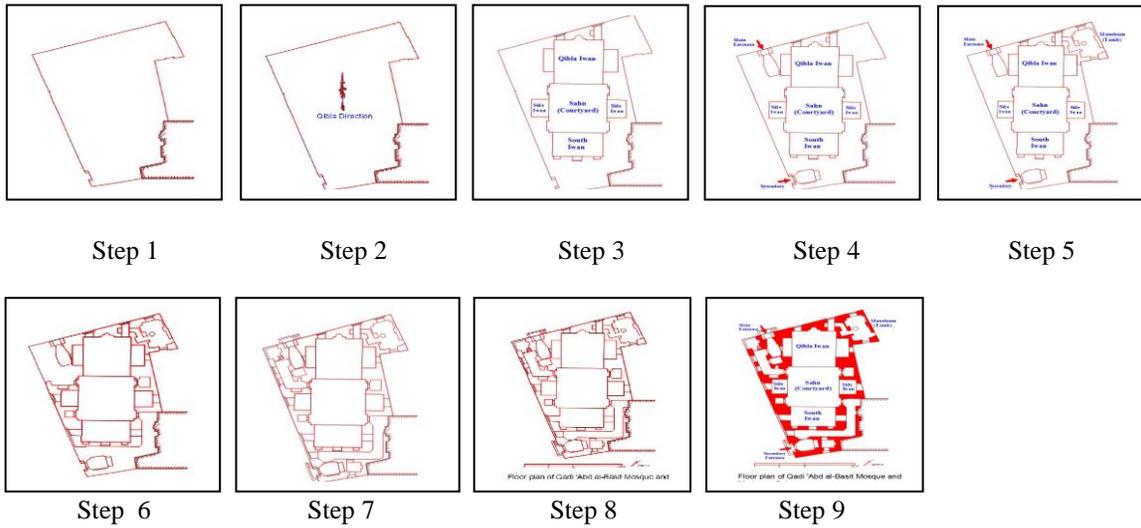
**3.2.12.1. Building's general description**



Style period: <a href="#">Mamluk</a>
Date: 1419-20/822-23 AH
Address
Building type: <a href="#">educational</a> , <a href="#">religious</a>
Building usage: <a href="#">madrasa</a> , <a href="#">mosque</a>

**3.2.12.2. Applying the generative technique on building design**

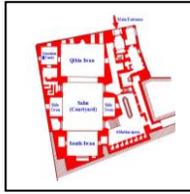
The following is the consequence steps of generating the design of the building



**3.2.13. Sultan al-Ashraf Barsbay Funerary Complex, Cairo,**

**3.2.13.1. Building's general description**

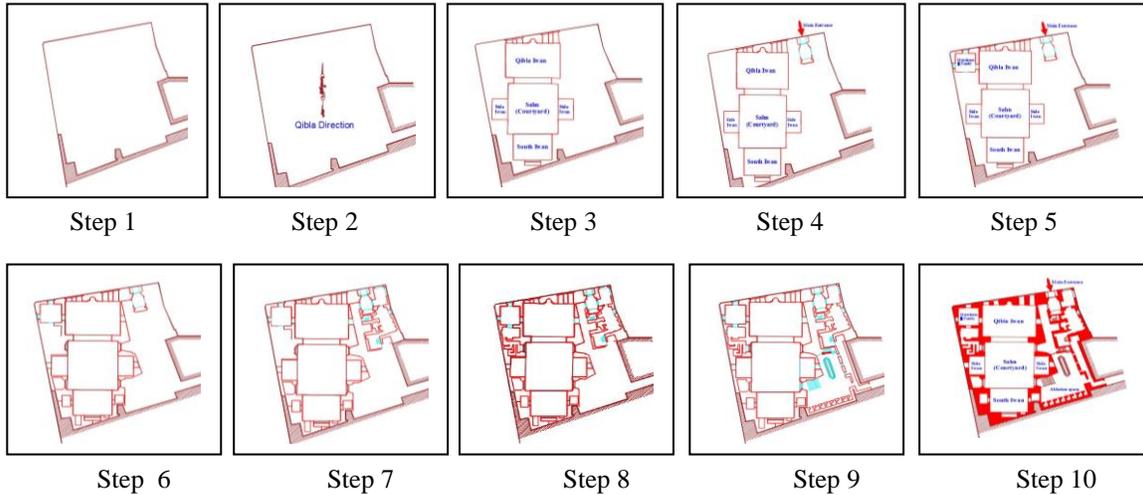
Style period: <a href="#">Mamluk</a>
--------------------------------------



Date: 1432-1433/836 AH, restored 1478/882-883 AH
Address: Qarafa al-Kubra, Cairo.
Building type: <a href="#">educational</a> , <a href="#">funerary</a> , <a href="#">religious</a>
Building usage: <a href="#">khanqah</a> , <a href="#">madrasa</a> , <a href="#">mausoleum</a>

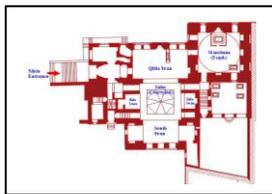
### 3.2.13.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building



### 3.2.14. Sultan Qaytbay Funerary Complex at the Northern Cemetery, Cairo

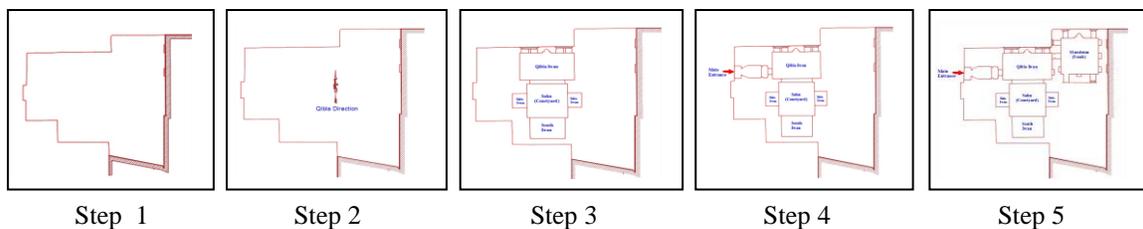
#### 3.2.14.1. Building's general description

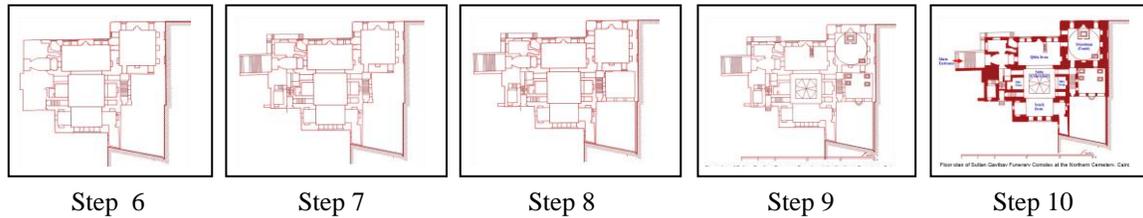


Style period: <a href="#">Mamluk</a>
Date: 1472-1474/876-879 AH
Address: Al-Qarafa al-Kubra, al-Qahirah, Cairo.
Building type: <a href="#">educational</a> , <a href="#">funerary</a> , <a href="#">waterworks</a>
Building usage: <a href="#">madrasa</a> , <a href="#">mausoleum</a> , <a href="#">sabil</a>

#### 3.2.14.1. Applying the generative technique on building design

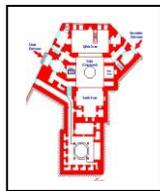
The following is the consequence steps of generating the design of the building





### 3.2.15. Complex of Amir Azbak al-Yusufi, Cairo,

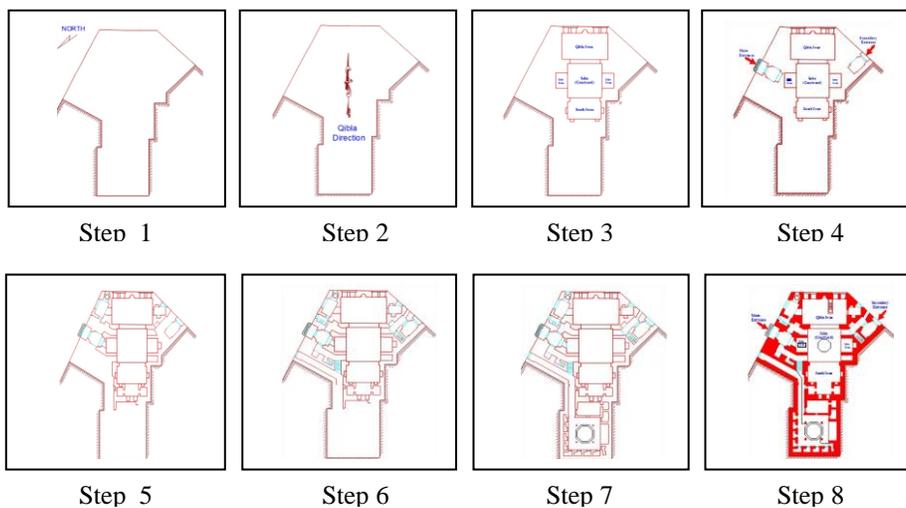
#### 3.2.15.1. Building's general description



Style period: <a href="#">Mamluk</a>
Date: 1494-1495/900 AH
Address: Shari' Azbak, Cairo, al-Qahirah
Building type: <a href="#">educational</a> , <a href="#">funerary</a> , <a href="#">religious</a>
Building usage: <a href="#">madrasa</a> , <a href="#">mausoleum</a> , <a href="#">mosque</a>

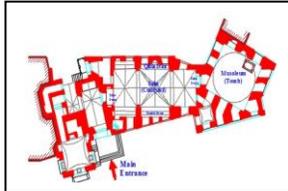
#### 3.2.15.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building



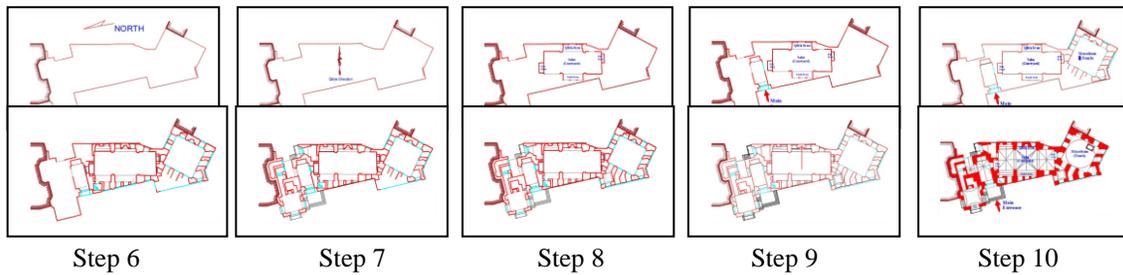
### 3.2.16. Complex of Amir Khayrbak, Cairo,

### 3.2.16.1. Building's general description

	Style period; <a href="#">Mamluk</a>
	Date: 1502-20/907-26 AH, restored 2000s/1400s AH
	Address: Shari' Bab al-Wazir, Cairo, al-Qahirah
	Building type: <a href="#">educational</a> , <a href="#">funerary</a> , <a href="#">waterworks</a>
	Building usage: <a href="#">madrasa</a> , <a href="#">mausoleum</a> , <a href="#">sabil</a>

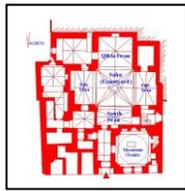
### 3.2.16.2. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building



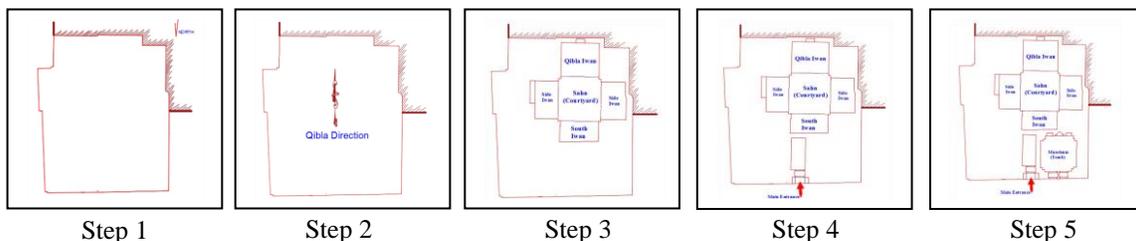
### 3.2.17. Madrasa of Tashtamur al-'Ala'i, Al-Qudss (Jerusalem)

#### 3.2.17.1. Building's general description

	Style period: <a href="#">Mamluk</a>
	Date: 1382-1383/784 AH
	Address: Tariq Bab al-Silsila, Jerusalem
	Building type: <a href="#">educational</a> , <a href="#">funerary</a>
	Building usage: <a href="#">madrasa</a> , <a href="#">tomb</a>

#### 3.2.17.1. Applying the generative technique on building design

The following is the consequence steps of generating the design of the building





#### 4 Conclusion

Among the cities associated with the Islamic civilization, Cairo is perhaps the most representative culturally and certainly the richest architecturally. Its most spectacular age, however, was the Mamluk period (1250-1517). In this paper, monuments from Mamluk periods had examined in order to understand medieval Islamic theories of design. Although no drawings remain from Mamluk era, an examination of architectural evidence reveals their builders' methods. Detailed analyses of various designs of Mamluk madrasas are presented to illustrate how design idea and the building design have been derived systematically by depending on the design units, which remain the backbone of the process of “designing” of Mamluk madrasas buildings, and it played the role of design generator which control all the design process. The systematic steps to derive Mamluk madrasa plans are formulated to establish a basis for a generative technique of design for the automatic derivation of Mamluk madrasa plans. The research aim is “outline a new method of design depends mainly on design strategy in different steps of architecture design process, so the research name it "Generative Technique". This is being essential not only to the process of traditional architecture but also to the understanding it.

We can summarize the conclusion in the following points:

- This paper has illustrated the design generative technique of Madrasa buildings in Mamluk architecture,
- Mamluk builders were primarily concerned with manipulations of two dimensional design units to generate the design of Madrasa buildings.
- In spite of all these various surveys the buildings have never been thoroughly and systematically studied as works of architecture from a design methods point of view.
- The analysis shows that the religion rules, orientation of spaces, site restricts, acted as fillers whenever users circulation demands interrupted the order of the design.

In conclusion, we can say that using an approach that takes into consideration the types of design methods of the past might be of great values, it make the architectural language richer. The architect should search for new design techniques and not be distracted by illusions. This requires a total vision of the environment and not just partial solutions to its problems at every scale. It also requires that architecture not be seen as a

series of isolated objects but as part of the physical and social context of the city. Only in this way can unity be achieved.

Finally the research reached that, there is a systematic technique the mamluk architect depended on it to generate the design of the Madrasa plan. This systematic technique controll the design of Madrasa buildings during the Mamluk period and it was spread and cover all Madrasa buildings in the Mamluk empire.

## 5 References:

- Akbar, J. (1988). *Theories and principles of design in the architecture of Islamic socities: Accretion of decisions: A design strategy*. Age Khan Program for Islamic Architecture. Editions Margaret Bentley Sevckenko, Cambridge.
- Al-Bīrūnī, A. M. (1967). (Abū al-Raiḥān Muhammad ibn Ahmad al-Bīrūnī), *The determination of the coordinates of position for the correction of distances between cities*, tr. and ed. Jamil Ali, Beirut: American University of Beirut.
- al-Baghdādī, ‘A. (1286). *al-Ifāda wa i’tibar fi ‘alumūr al-mushāhada wa ‘alhawadith al-muāyana bi-ard Misr*. first edition, Maktbat Wady el-nile. (52;idem, Relation de L’Egypt, ed. Silvestre de Sacy (Paris, 1810), 295-96).
- Al-Harithy, H. (2001). *The concept of space in Mamluk architecture*. Muqarnas XVIII: An Annual on Islamic Art and Architecture. Leiden: E.J. Brill.
- Al-Zāhirī, K. S. (1894). *Kitāb zubdat kashf al-mamālik wa-bayān al-turuq wa ‘lmasālik*, ed. P. Ravaisse, Paris.
- Antoniou, A. (1998). *Historic cairo: A walk through the Islamic city*, The American University in Cairo Press, Cairo.
- Behrens-Abouseif, D. (1995). *Muhandis, shad, mu’allim-note on the building craft in the Mamluk period*. Der Islam 72/2. p.293-309.
- Behrens-Abouseif, D. (2007). *Cairo of the Mamluks : A history of architecture and its culture*, The American University in Cairo Press, Cairo, Egypt.
- Creswell. K. A. C. (1922). *The origin of the cruciform plan of Cairene Madrasas*, Le Caire : Institut Français d’Archéologie Orientale.
- Creswell. K. A. C. (1940). *Early Muslim Architecture*, 2 vols. Oxford University Press. Oxford.
- Creswell. K. A. C. (1952), *The Muslim architecture of egypt (henceforth MAE)*, 2 vols. Clarendon Press, 1952-59), 2:171, 260-64. Oxford.
- Gaber, A. A. (2011). *The methodology of geometric order in the design of traditional Islamic buildings*, PhD, Karlsruhe Institute of Technology, Germany.
- Gabr, A.H. (1992). *The influence of traditional muslim beliefs on medieval religious architecture*, Phd, University of Edinburg, Department of Architecture Edinburg.
- Hodgkin, L. (2005). *A history of mathematics: From mesopotamia to modernity*, Oxford University Press Inc., NewYork, U.S.A.
- Holod, R. (1988). *Theories and principles of design in the architecture of Islamic socities: Text, plan and building: On the transmission of architectural knowledge*. Massachusetts: Age Khan Program for Islamic Architecture, Editions Margaret Bentley Sevckenko, Cambridge.

- Liebich, S. H. (1983). *The architecture of the Mamluk city of Tripoli*, The Aga Khan Program for Islamic Architecture at Harvard University and the Massachusetts Institute of Technology, Cambridge, Massachusetts.
- Maqrizi, S. (1854). *Tarikh al-Malik al-Nasir Muhammad Qalawun al-Salihi wa-Awladahu*, ed. B. Schafer (Wiesbaden: Franz Steiner Verlag, 1977), pp. 113-14; Ibn Taghri-Birdi, *al-Nujum al-Zahira fi Muluk Misr wa-1-Qahira*, ed. M. Ramzi, 16 vols. (Cairo: Dar al-Kutub, 1929-56), vol. 9, pp. 178-98; Maqrizi, *Kitab al-Mawa'iz waul-I'tibar bi-Dhikr ul-Khitat wa-ul-Athar*, ed. M.Q. al-Adawi, 2 vols. (Bulaq, Egypt: Dar al-Kutub, 1854), vol. 2, p. 306; and Maqrizi, *Suluk*, vol. 2, p. 130.
- Petersen, A. (1999). *Dictionary of islamic architecture*, Routledge, London.
- Rabbat, N. (1998). *Architects and Artists in Mamluk Society: The Perspective of the Sources*. *Journal of Architectural Education* 52, no.1, p.30-37, 1998.
- Rabbat, N. (2008). *Design without representation in medieval Egypt*. In *Muqarnas: An Annual on the Visual Culture of the Islamic World XXV*. 146-154.
- Rashed, R. (2003). *The end matters*. Retrieved from <http://cc.usu.edu/bekir/rashed/interview Islam Science.htm>
- Tabbaa, Y. (1988). *Theories and Principles of Design in the Architecture of Islamic Societies: "Geometry and Memory in The Design of Madrasat al-Firdaws in Aleppo*. Massachusetts: Age Khan Program for Islamic Architecture, Editions Margaret Bentley Sevcenko, Cambridge.
- Tantawy, S. M. (2002). *Conceptualizing Mamluk architectural heritage for a contemporary society: Issues of design within a preservation and conservation paradigm*, Phd, Cairo University, Cairo.
- Thackston, W. M. (1989). *A century of princess: Sources on Timurid history and art*. Cambridge (Ma).
- Great Buildings online. Retrieved from <http://www.greatbuildings.com/architects/Imhotep.html>; *Encyclopedia Britannica Online*, s.v. "Imhotep"; Adolf K. Placzek, ed., *Macmillan Encyclopedia of Architects*, 4 vols. (London: The Free Press, 1982), 2:454-64.
- Ibrāhīm, 'A. (1986). *Al-mandhwur al-islamy llnadhariya al-islamiya: Al-madmwn al-islamy llimara*, The Center for Planning and Architectural Studies (CPAS), Cairo.
- Walls, A. G. (1990). *Geometry and architecture in islamic jerusalem: A Study of the ashrafiyya*, Scorpion Publishing LTD, England.

## 6 Illustrations

All illustrations incorporated in the text of this paper are the author's own, except when stated otherwise. Where plans have been redrawn, corrected or edited, the word *After* followed by the name of the author or source is added between brackets after the caption.

All the photos and images in the text of this thesis are from the following sources:

- Taken by the authors themselves during the visit to Islamic Cairo.

- Many internet websites (such as Archnet.com, Flickr.com and Egyptarchitecture.com).
- Two main books: (“Cairo of the Mamluks: A History of Architecture and its Culture” published in Cairo, Egypt, 2007 by Doris Behrens-Abouseif, and “The Art and Architecture of Islamic Cairo”, published in Reading, UK, 2006 by Richard Yeomans).

The plans which the thesis relied on it for the analytical study are from the book “Principles of Architectural Design and Urban Planning During Different Islamic Eras” published in Jeddah, Saudi Arabia, 1992, by the Organization of Islamic Capitals and Cities (OICC).