Yuzuncu Yil University
Journal of the Institute of Natural & Applied Sciences
https://dergipark.org.tr/en/pub/yyufbed

Research Article

A Research on the Proportion, Balance, and Modulation Relationship of the Caravanserais Built Under the Patronage of Kayqubad I †

Melek ERSOY[1], Tuğba ERDİL DİNÇEL[*2]

[1]Akdeniz University, Mediterranean Civilisations Research Institute, 07070, Antalya, Türkiye
[2]Medipol University, Department of Architecture, School of Fine Arts Design and Architecture, 34810, İstanbul, Türkiye
*Corresponding author e-mail: tugba.erdil@medipol.edu.tr

Abstract: This study aims to examine the caravanserais (khans) built during the patronage of Kayqubad I in terms of proportion, balance, and modulation. These structures reflect the architectural understanding and technical skills of that period in both aesthetic and functional terms. The study addresses the importance of the culture of patronage within the social structure by examining the period of a ruler rather than focusing on a specific region or city. Caravanserais, particularly those from the Anatolian Seljuks, are discussed in detail concerning their structural properties, plan typologies, facade features, supporting structures, materials used, and decorations. The research also explores the role of proportion, balance, and modulation across different cultures and their interactions with Anatolian Seljuk architecture. Additionally, the presence of these concepts within Anatolian Seljuk architecture is questioned. Observational methods adopted from Orhan Cezmi Tuncer's analysis and measurements of the Sivas Gök Medrese serve as the basis for this study. Specific khans built during the era of Kayqubad I, such as Aksaray Sultan Hanı, Tuzhisarı Sultan Hanı and Alara Han, are examined. These structures have been analyzed with regard to proportion, balance, and modulation in their plans, facades, and crown gates. The structural properties of the khans have been investigated using drawings, photographs, and digital tools. To this end, this study provides a comprehensive architectural analysis of Anatolian Seljuk period caravanserais, examining their aesthetic and structural features through the concepts of proportion, balance, and modulation.

Keywords: Anatolian Seljuk, Balance, Caravanserais, Modulation, Proportion

I. Alaeddin Keykubat'ın Baniliğinde Yapılan Hanların Orantı, Denge ve Modülasyon İlişkisi Üzerine Bir İnceleme

Öz: Bu çalışmada, I. Alaeddin Keykubat döneminde yapılan kervansarayların (hanların) orantı, denge ve modülasyon açısından incelenmesi amaçlanmıştır. Bu yapılar, estetik ve işlevsel anlamda o dönemin mimari anlayışını ve teknik becerilerini yansıtmaktadır. Çalışma, bölge veya şehir yerine bir hükümdar dönemini ele alarak, banilik kültürünün sosyal yapı içindeki önemine değinmiştir. Kervansarayların, Anadolu Selçuklu kervansaraylarının yapısal özellikleriyle, plan tipolojileri, cephe özellikleri, taşıyıcı yapılar, malzeme kullanımı ve süslemeler gibi başlıklar altında detaylı bir şekilde ele alınmıştır. Araştırma, orantı, denge ve modülasyonun farklı kültürlerdeki yerini ve Anadolu Selçuklu mimarisiyle olan etkileşimini incelemiştir. Ayrıca, Anadolu Selçuklu mimarisinde bu kavramların varlığı da sorgulanmıştır. Gözlem yöntemi olarak Orhan Cezmi Tuncer'in Sivas Gök Medrese örneğinde yaptığı analiz ve ölçümler esas alınmıştır. I. Alaeddin Keykubat döneminde yapılan özel hanlar arasında Aksaray Sultan Hanı, Tuzhisarı Sultan Hanı ve Alara Han incelenmiştir. Bu yapıların plan, cephe ve taçkapısında orantı, denge ve modülasyon incelemesi yapılmıştır. Hanların yapısal özellikleri, çizimler, fotoğraflar

† This study is derived from the master's thesis titled "I. Alaeddin Keykubat'ın Baniliğinde Yapılan Hanların Orantı, Denge ve Modülasyon İlişkisi Üzerine Bir İnceleme" written by Melek Ersoy under the supervision of Tuğba Erdil Dinçel at Haliç University in 2021.

Received: 29.05.2024
Accepted: 01.01.2025

How to cite: Erdil Dinçel, T., & Ersoy, M. (2025). A research on the proportion, balance, and modulation relationship of the caravanserais built under the patronage of Kayqubad I. *Yuzuncu Yil University Journal of the Institute of Natural and Applied Sciences, 30*(1), 235-257. https://doi.org/10.53433/yyufbed.1492154

ve dijital araçlar kullanılarak incelenmiştir. Özet olarak, bu çalışma, Anadolu Selçuklu dönemi kervansaraylarının mimari analizini, orantı, denge ve modülasyon kavramları üzerinden ele alarak, bu yapıların estetik ve yapısal özelliklerini kapsamlı bir şekilde değerlendirmiştir.

Anahtar Kelimeler: Anadolu Selçuklu, Denge, Kervansaray, Modülasyon, Orantı

1. Introduction

Throughout history, Anatolia has hosted many civilizations and has been a crossroads for various cultural interactions due to its strategic location. The Seljuk period, in particular, was a time when Anatolian architecture and urban development were significantly shaped. The reign of Kayqubad I stands out as a particularly productive period in terms of architecture and urban planning among the Anatolian Seljuks. The caravanserais built during this period played an important role not only as safe havens on trade routes but also as centers of social and cultural activities. Many of the Seljuk khans were constructed under the patronage of Kayqubad I, and these structures are among the most impressive examples of Seljuk architecture that have survived to the present day. This research aims to provide a detailed analysis of the architectural features of these khans, as well as the geometric and aesthetic principles of proportion, balance, and modulation. These structures reflect the architectural understanding and technical skills of that period in both aesthetic and functional terms. The study of Seljuk caravanserais reveals how these structures were planned, their aesthetic and functional characteristics, and their impact on social and economic life. Additionally, the research will examine the relationship between the architectural analysis of the khans and the overall economic and sociological structure of the Seljuk period. The study will scrutinize the place of the concepts of proportion, balance, and modulation in Seljuk architecture and their interactions with various cultures. In this context, this study aims to offer new perspectives on understanding and evaluating Seljuk architecture. Furthermore, information on the current preservation status and restoration works of these khans will be provided to raise awareness for the protection of cultural heritage. This introduction sets the general framework and outline of the thesis, and the following sections will present detailed architectural analyses of the Khans and their cultural interactions. These analyses will help us better understand the place and importance of these significant structures, built under the patronage of Kayqubad I, within Anatolian Seljuk architecture.

2. Material and Methods

This study aims to examine the caravanserais built during the reign of Kayqubad I of the Anatolian Seljuks in terms of proportion, balance, and modulation. The structures selected for analysis, such as Aksaray Sultan Han, Tuzhisarı Sultan Han, and Alara Han, are significant examples that reflect the aesthetic and functional characteristics of Seljuk architecture. These buildings were analyzed with a focus on their plan typologies, facade characteristics, and crown gates.

The research includes a literature review focusing on the socio-economic and architectural context of the Seljuk period. Key sources such as Kuban (1981), Tuncer (1981; 2015), and Turan & Kırpık (2016) provided the theoretical framework. Kuban (1981) examines Anatolian Seljuk architecture within a historical, sociocultural, and artistic context, highlighting the functional and symbolic aspects of Seljuk structures, with a focus on concepts like proportion and symmetry. Tuncer (1981; 2015)'s studies focus on the use of proportion and modulation in Anatolian Seljuk architecture, underscoring the importance of mathematical relationships and providing detailed analyses, such as his work on the Sivas Gök Medrese, to demonstrate the geometric schemes contributing to the aesthetic and structural unity of Seljuk architecture. Meanwhile, Turan & Kırpık (2016) emphasize the social and economic impact of architecture during the Seljuk period, discussing how caravanserais served as vital centers for trade, security, and cultural interactions. The literature review highlighted that these caravanserais were not only architectural monuments but also played an integral role in the social and economic structure of the period. As such, this study examined the caravanserais not only through the lens of architectural analysis but also in terms of their socio-economic significance. These structures functioned as social and commercial hubs, offering insights into the cultural and economic dynamics of the Seljuk period. Building on this theoretical foundation, the present study specifically investigates the

role of proportion, balance, and modulation in caravanserais constructed during the reign of Alaeddin Keykubat I, thus providing unique insights and filling specific gaps in the existing literature on Seljuk architecture.

Methodologically, this research is based on the analyses of Orhan Cezmi Tuncer, who has extensively studied proportion and modulation in Anatolian Seljuk architecture. Tuncer's work, particularly his geometric and proportional studies on the Sivas Gök Medrese, forms the foundation of this analysis. In this study, the selected caravanserais were analyzed using Tuncer's methods, with a particular emphasis on the repetition of modular units and their role in establishing aesthetic and structural harmony. Each structure's plan was divided into grid units, and these modules were used to evaluate the balance and symmetry within the overall composition.

Digital tools were employed to conduct detailed analyses of the proportion and modulation characteristics of these structures, allowing for a more precise understanding of their geometric properties. Due to the limitations on fieldwork imposed by the pandemic, digital modeling techniques were used to assess the facade layouts, plan features, and proportional systems of the caravanserais. For example, in the analysis of Aksaray Sultan Hanı, the 2/3 Seljuk ratio was identified as a key element of its aesthetic balance. Similar proportional and modular analyses were conducted for the other caravanserais, revealing that each structure adhered to its unique system of proportions.

Both quantitative and qualitative analyses were employed in this study. Quantitative analysis involved measuring and comparing the geometric dimensions of the structures, while qualitative analysis focused on the historical and cultural significance of their decorative elements, materials, and spatial organization. This combined approach allowed for a comprehensive understanding of the caravanserais as architectural works that not only demonstrated aesthetic coherence but also played a vital role in shaping the socio-economic landscape of their time.

2.1. Anatolian Seljuk architecture and the cross-cultural examination of proportion, balance, and modulation

A whole is made up of parts. The mathematical relationship between these parts is called proportion. Structures raise the question of how existing proportions have influenced architects. Throughout history, humanity has adopted certain ratios and gained experience using them. The Egyptians applied ratios such as the 3x4x5 triangle as well as ratios like 1/2, 5/8, and 4/3. The golden ratio was also used in Greek architecture. There is also a proportion in nature, and this creates balance (Tuncer, 1981). According to Plato, beauty lies in simple geometric shapes. He says that what creates the beauty of form is the mathematical order created by numbers and their ratios. This order creates harmony. In nature or art, what makes them beautiful is not their content but their forms. These shapes are simple circles and rectangles. Therefore, the real reason that creates all beauty is the numbers and the ratio between numbers (Kalaycı, 1994). Even the juxtaposition of opposite shapes can be perceived as beautiful with a good balance. A triangle and a vertical line, a semicircle, and a vertical line can be seen in the silhouette of our classical mosques. This represents the balance of a pyramid and a cylinder. It is seen that when these two geometric shapes are placed side by side with a good ratio in volume, they do not overpower each other but instead strengthen each other (Tuncer, 1981). Modulation is the repetition of a measure or a geometric shape determined as a unit (Tuncer, 2015). Modulation is related to proportion. The repetition of a unit by multiplying it creates the concept of modulation. It can be seen sometimes in details and sometimes in the entire section, plan, and view. According to Vitruvius, when designing a structure, a unit should be determined as a standard, and the exact proportions of the structure should be determined according to this unit. The dimensions and sizes that will form the symmetry should be adjusted in this way. Fixed measurements that will form symmetry should be decided. Changes can be made based on this basic measure. After determining the dimensions, proportions should be made to ensure that the appearance of the structure is proper (Vitruvius, 2019).

The points in the section The Role of Proportion, Balance, and Modulation in Anatolian Seljuk Architecture, it is observed that the architectural style diverges from classical Anatolian Seljuk architecture. In the section Interpretation of Universal Geometric Proportions, the concept of proportion in architecture is discussed as a universal principle and is related to various civilizations such as Egypt, Greece, and Rome were examined. However, in classical Anatolian Seljuk architecture, proportions are primarily based on local traditions and practical applications. While global geometric influences play a

secondary role in Seljuk structures, the primary focus is on achieving functionality and aesthetic balance (Erzen, 1976). In the Mathematical Basis of Modulation section, modulation is presented as a mathematical structure based on the repetition of measurement units, grounded in Vitruvius' understanding of classical architecture. However, in Seljuk architecture, modulation is used to achieve functional and aesthetic balance, and the proportions of structures are more shaped by local and practical needs (Goodwin, 1997). Finally in the section Relationship Between Nature and Architecture, it's seen that the natural proportions and balance in architecture are linked to the ideas of philosophers like Plato. However, in Seljuk architecture, the understanding of beauty is more closely associated with faith and functionality. In Seljuk structures, aesthetics are integrated with the functional and religious significance of the building, rather than being based purely on mathematical beauty (Scruton, 1979).

Since ancient Egypt, Byzantium, and Rome, the relationship of balance and proportion between the parts and the whole has been known (Lubicz, 1981). In these civilizations, the relationship of balance and proportion is defined mathematically. They created beautiful appearances with the golden ratio (Tuncer, 2010).

Since the first civilizations, proportions have been applied to plans, sections, and views to achieve balance. Architects have used compasses for this. Greek temples, peripteral and dipteral, and their derivatives are the peak of this development, starting from the megaron (Figure 1).

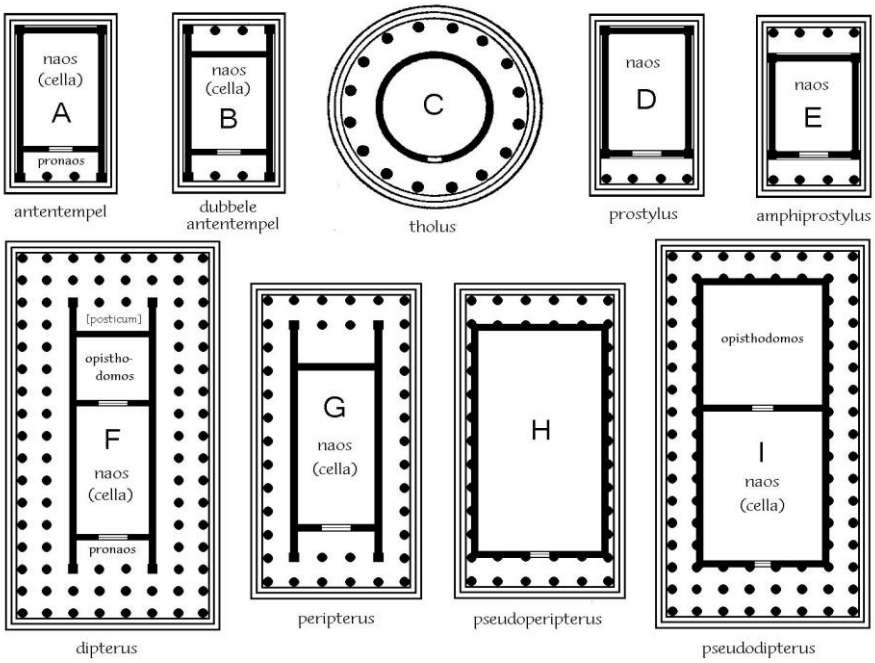

Figure 1. Balance from megaron to Greek temples (Vitruvius, 2019).

Balance and proportion are also seen in the Abu Simbel Temple in Egypt. As seen in the plan of the Abu Simbel Temple, a grid system was used. On the facade, proportion was achieved with two circles (Figure 2). The Poseidoma (Paestum) Temple also uses a grid plan. In the section, as seen, the fullness and void ratio of the interior volume is balanced using a circle (Figure 3).

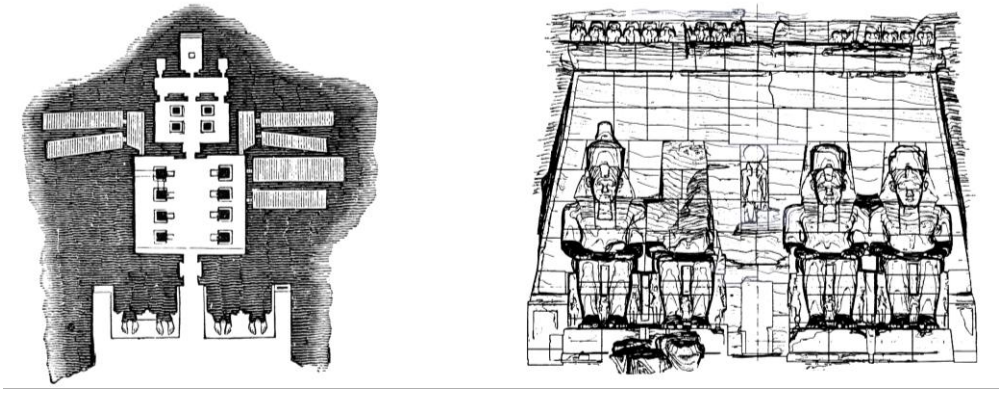

Figure 2. Plan and facade of the Abu Simbel Temple (Schliephacke, 1968).

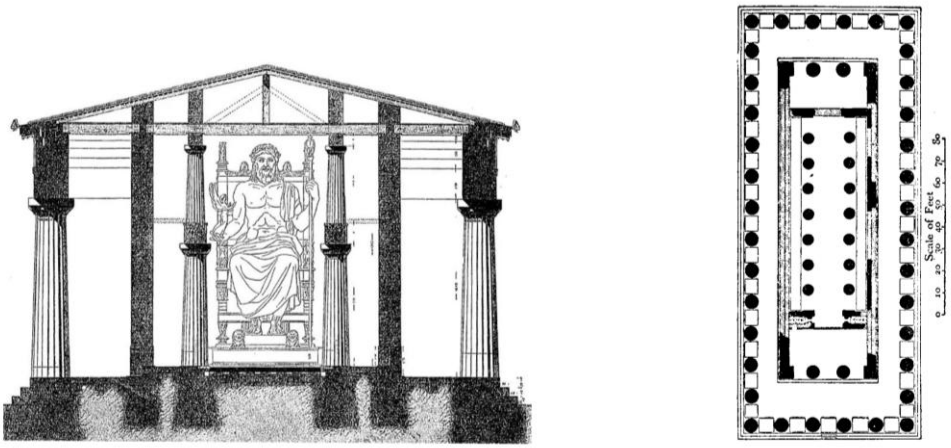

Figure 3. Section and plan of the Poseidoma (Paestum) Temple (Yalouris & Yalouris, 1995).

The proportion of the Khafre Pyramid in Egypt is approximately 2x6.5. In Etruscan temples, the height of the columns is five times the radius of the base. This column height reaches seven times inside the temple. The proportion found in classical Greek architectural works, the Doric, Ionic, and Corinthian orders, rises to 1/10-1/11 (Jones, 1989). The grid system created by arranging squares in the plan plane was solved by considering important factors that bind the structure, such as wall openings, wall thicknesses, and wall heights. Thus, a unit measure and scale were created, establishing the modulation system. Technically, the architectural drawing was achieved with a compass, making the drawing easy to read and simplifying the application.

Some examples of structures that can be given in this context include:

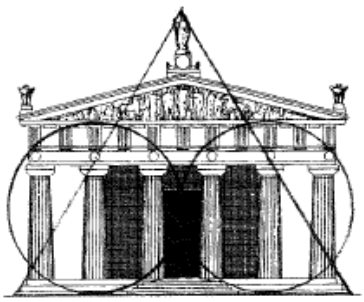

Figure 4. Temple of Zeus at Olympus (Coulton, 1974; Bommelaer, 1985).

The geometric design of the facade of the Temple of Zeus at Olympus is structured with two circles and an equilateral triangle, achieving balance through this method (Figure 4).

Ribat structures were small defensive buildings in the Islamic world that combined social, economic, and religious functions. Particularly prominent in Central Asia and the Transoxiana region, these structures served both as centers for religious education and as protection points along trade routes. Examples such as Ribat-I Melik hold a significant place in the architectural and functional evolution of these buildings (Yavuz, 1997; Ettinghausen et al., 2001; Kuban, 2010). This can be clearly observed in the architectural articulation and ornamental details of the portal of Ribat-ı Melik (Figure 5).

One notable ribat structure, known as "Ribat 1," is located in the Beykend settlement south of Bukhara, a region historically said to have housed more than 1,000 ribats (Figure 6). Situated along the Samarkand-Amul route on the Silk Road, Beykend is now within the borders of Navoiy, Turkmenistan. Studies on this ribat suggest that it might have been constructed in the 10th century or rebuilt on an existing structure in the 12th century (Mirzaakhmedov, 2016).

Figure 5. Ribat-ı Melik.

Figure 6. Beykent Ribat 1 plan (Mirzaakhmedov & Stark, 2013).

The ribat consists of a courtyard and enclosed spaces, with a nearly square courtyard surrounded by rooms of varying sizes. Measuring approximately 75 meters on each side, the structure features two entrances and cylindrical towers at its four corners. The eastern entrance protrudes outward, indicating its significance as the main gate, marked by its monumental iwan design. Rooms on the northern and southern sides of the courtyard follow a similar plan, and the central spaces, often used for accommodations, were likely utilized by travelers. On the western side, rooms identified as kitchens, ovens, and storage facilities were revealed through excavation, indicating their service-related functions (Arapoğlu, 2024).

Anatolian Seljuk caravanserais, which were a continuation of these ribats, were developed into larger and more complex structures. Seljuk architecture expanded the plan schemes of ribats and adapted them to regional conditions, giving caravanserais a distinctive identity (Hillenbrand, 1994; Yavuz, 1997; Ousterhout, 2019).

The Ismail Samani Mausoleum in Uzbekistan: Built in the 9th century, it consists of a cube. The plan features a square layout with a wall thickness of 3 units and a volume of 12 units, resulting in an 18x18 structure (Figure 7).

Figure 7. Plan, Section View, and Photograph of the Ismail Samani Mausoleum (Necipoglu, 1994).

The Gonbad-e Qabus in Iran dates back to 1006-1007. The height of the structure is three times the diameter of the base it sits on (Figure 8).

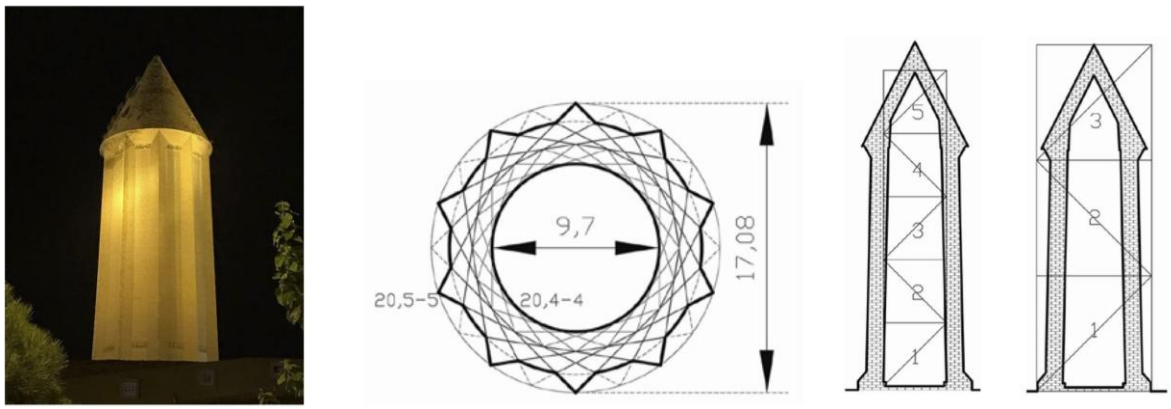

Figure 8. Gonbad-e Qabus (Necipoglu, 1994).

Many people evaluate architectural works based on their exterior appearance. A building is primarily explored from its front facade. The reason the golden ratio is primarily sought on the facade stems from this. The front facade is usually more meticulously designed and grander because it is perceived by more people (Şenyiğit, 2010).

When looking at it, architecture is a derivative of geometry. Proportion, balance, harmony, modulation, composition, and order are mathematical tools in this sense. The geometry obtained by using these tools creates a sense of beauty and art. In addition to these, the ability to draw and understand geometry is sought in architecture. Architecture is an applied art. In this sense, the geometry of architectural works generally has square and rectangular shapes. This was initially understood and applied in Egyptian civilization. The balanced rectangle, the use of the golden ratio, began in Ancient Greece (Tuncer, 2015). The Seljuks used the 2/3 ratio (Figure 9.A).

The Larisa Megaron, built in the 7th century BC and the first type of house, contains a 2a/3a ratio. This is the Seljuk ratio. In its wider types, the 4a/4a ratio was tried (Figure 9.B). The combination

of lines establishes a formal connection between two lengths. This is called proportion, and the mathematical relationship between them is called ratio. Architecture feeds on this connection by establishing a balance between the dimensions, areas, and volumes of lines. Therefore, it can be said that architecture is a proportionally weighted art. Balance, harmony, and beauty are products of this situation. The most commonly used shapes, the balanced rectangle and square, are the manifestations of this sense of harmony and balance. To reinforce intellectual aesthetics, one must have the skills of proportion and ratio. Architecture, an important visual branch, is dependent on harmonious colors, texture, and geometry. The closest ratio to the 60-degree triangle is the Golden Ratio. The Golden Ratio is 58 degrees 17 minutes. The Seljuk triangle has a 2/8 ratio. This corresponds to 56 degrees 19 minutes. Next is the 3x4x5 triangle used by the Egyptians. This corresponds to 53 degrees 7 minutes. It is seen that the Golden Ratio, which is a 60° angle, and the base angle of the 3x4x5 triangle, which is 53°07'48", are very close to each other. The difference between them is less than 2°. In this respect, it is proven that the Seljuk ratio has an international value (Figure 9.C). Unit measures are not only within the boundaries of the structure, but sometimes the plot width also determines this. The grid layout has been used throughout architectural history, and it is still used today in the application of reinforced concrete and steel frames (Tuncer, 2015).

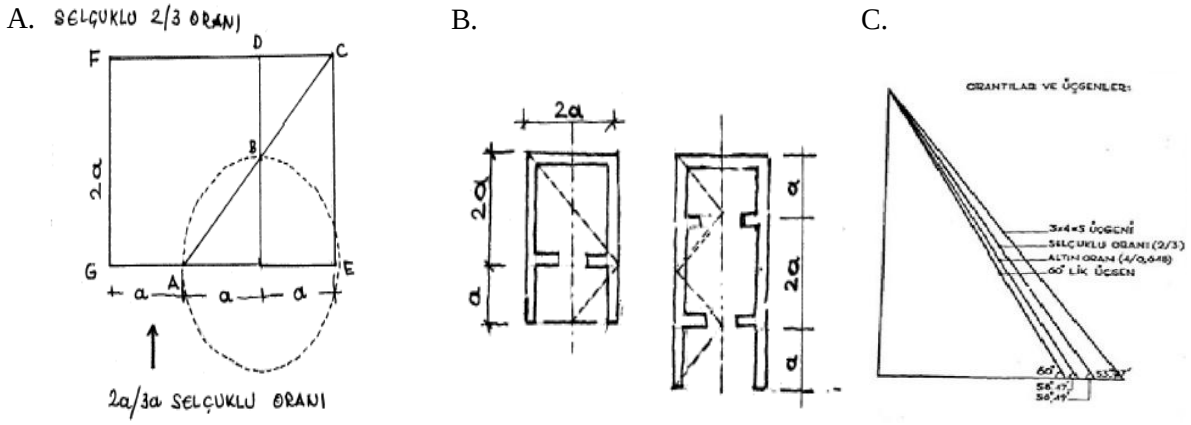

Figure 9. A. Seljuk ratio, B. Larise Larisa Megaron - Troy, C. Ratios and triangles (Tuncer, 2015).

2.2. A method for calculating proportion, modulation, and balance in a medrese facade

The elements of proportion, balance, and modulation in Anatolian Seljuk architecture are the cornerstones of architectural aesthetics and structural functionality. In buildings such as Sultan Han (Aksaray), Buruciye Medrese (Sivas), and Karatay Han (Konya), it is evident that the layout of the courtyard and main entrance is structured with specific proportions, and symmetry and modular design are reflected in both the facade and interior. For example, the spacious courtyard and main entrance area of Sultan Han create a balanced structure that is both functional and aesthetically pleasing (Tuncer, 1981). The geometric motifs used in the facade design of Buruciye Medrese are repeated at specific proportions, providing visual harmony to the structure (Yılmaz, 2017). Similarly, the modulation used in Karatay Han, with the building divided into layers through stone craftsmanship, enhances both the aesthetic appeal and structural integrity of the structure (Çakmak & Şahin, 2018). Additionally, in buildings such as the İnce Minareli Medrese, finely crafted details proportional to facade height are repeated in a modular arrangement, ensuring architectural symmetry and contributing to the slender and elevated visual appearance of the structure (Kuşçu, 2020). These examples underscore the importance of mathematical relationships and aesthetic harmony in Seljuk structures, shaping the architectural understanding of the period (Tuncer, 2015).

One of the most reliable methods in the literature in terms of ratio, balance, and modulation belongs to Orhan Cezmi Tuncer. Orhan Cezmi Tuncer conducted his study by taking on-site measurements. In addition to Tuncer's work, studies by Yılmaz (2017) on the golden ratio in Seljuk madrasas, Çakmak & Şahin (2018) on the use of Seljuk portals in contemporary facades, and Kuşçu (2020) on proportional and modular systems in the Buruciye Madrasa support the importance of

proportional analysis in understanding Seljuk architecture. These works emphasize the significance of mathematical relationships and aesthetic coherence in Seljuk structures, further validating Tuncer's approach. Since this research was conducted during the pandemic, the method was tried to be applied using literature data. Although its original name is Sahip Ata Medrese, it is known as Gök Medrese because of the color of its tiles (Figure 10). It was built in 1271 under the patronage of Vizier Sahip Ata. There are eight-pointed stars on the part that form the lower part of the minaret and frame the crown gate. The crown gate, which contains vegetal and geometric decorations, carries all the characteristics of an Anatolian Seljuk crown gate (Figure 11).

Figure 10. Sivas Gök Medrese crown gate (Anadolu Agency, Access date: March 15, 2024).

Figure 11. Sivas Gök Medrese crown gate (Anadolu Agency, Access date: March 15, 2024).

Apart from deviations of 2-3 cm, its dimensions of 8.00x12.00 m are in the ratio of 2/3, proving this (Figure 14). The bottom row of stones, which can be considered a substructure, does not have decoration. All calculated ratios are made in the order above this row. When each square formed is divided into four equal parts, 24 squares forming the classic crown gate appearance emerge (Figure 12.B).

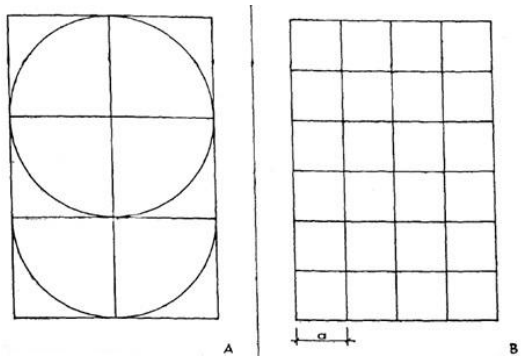

Figure 12. Crown gate proportion (Tuncer, 1981).

We shall designate the side length of the smallest unit square formed in the final arrangement as the "a-unit" measure. It will be observed that all surfaces are constituted through the iterative replication of this fundamental unit. The minaret cubes on the right and left of the crown gate, which provides the 2/3 ratio, are also a-unit tall. Thus, with the frame of the crown gate, it forms 36 units. This reveals a dimension of 12.34 m x 12.34 m (Figure 13.A).

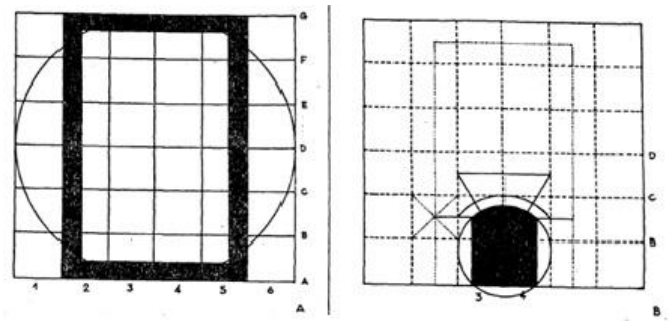

Figure 13. Crown gate proportion 2 (Tuncer, 1981).

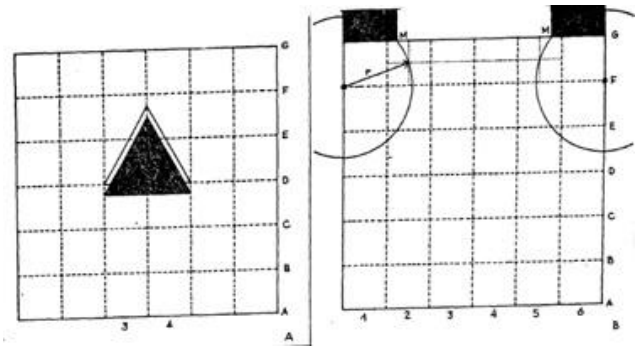

Figure 14. Crown gate proportion 3 (Tuncer, 1981).

When an equilateral triangle is drawn from the 3rd and 4th squares with the middle of the base at the OD, it is seen that the point in the axis corresponds to the center of the arch forming the door arch (Figure 14.B). Its radius is again the *a* unit. When a horizontal line is drawn from the BC middle, the abutment stone is determined, and the door jambs appear.

The equilateral triangle drawn from the 3rd and 4th squares horizontally to D, with its base in the D plane, gives the keystone of the arch surrounding the muqarnas. Shifting this triangle down by the measure of a/4 finds the endpoint of the muqarnas (Figure 12.A). Point M, which is the intersection of the circle with center F, drawn from the middle of squares 2 and 5 in the horizontal FG, is important. The distance MG is the diameter of the circle, and it is proven that this is found with geometric proportions (Figure 13.B). The thickness of the flattened arch in the crown gate is a/4.

The muqarnas begin within the door recess in the middle of the CD height. The steps that form them are within the boundaries of an equilateral triangle. The glazed bricks reflected on the front face of the minaret cube have a diameter and crenel height of a/2 in the circular decoration.

Considering the proportions of the additions made that day when the 6a-diameter circle that includes the crown gate is repeated, it remains high relative to the top of the parapet but too low for the honeycomb termination. According to the measurements at that time, the parapets are 5a above the start of the crenels (Figure 15). It is seen that the facade of the Medrese cannot be squared with the a-unit in the plan. The building is not squared. The qibla side is stepped. The courtyard and iwans do not conform to the known ratio. Tuncer thinks that the reason for this is that the street texture and plan of that day were only suitable for this (Figure 16). Modulation work is only found on the front facade.

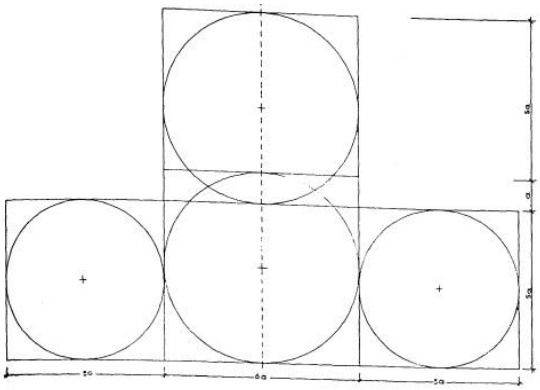

Figure 15. Proportion in the Facade (Tuncer, 1981).

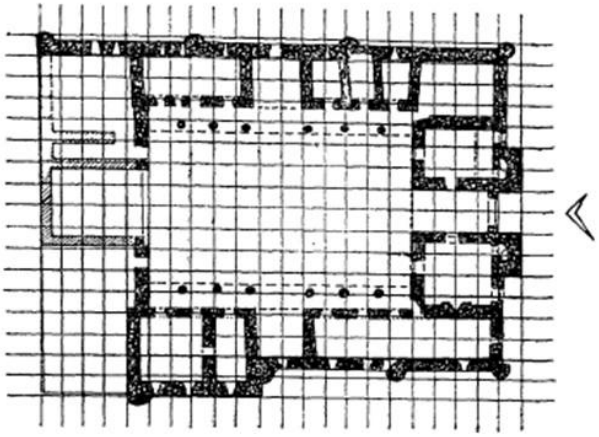

Figure 16. Plan (Tuncer, 1981).

As in antiquity and the Middle Ages, the design of this work is also content with a part, not the whole. There are two types of module work. The first is that a module is determined, and this module dominates the plan, section, and view (especially and usually the view). The second method is that the architectural units are modulated within themselves in appearance. This structure adheres to this. In details:

1/1 upper windows and fountain
1/2 classroom window
2/3 prayer room window
Side wings on the west facade at a ratio of 5a
Crown gate at a ratio of 6a

have been observed. A consistent geometric order and modulation are present on the front part but not found in the plan, section, and other facades (Tuncer, 1981).

There are also similar studies that support these measurements. However, it is observed that these studies also rely on the pioneering work of Tuncer (1981) in this field. The studies that support these measurements are shown in the table below (Table 1).

Table 1. Academic studies related to the subject

Authors	Study Subject
Yılmaz (2017)	Selçuklu Dönemi Medreselerinde Altın Oran-Estetik İlişkisi: Konya Örneği
Çakmak & Şahin (2018)	Selçuklu Portallerinin Günümüz Cephe Elemanı Olarak Kullanılması
Kuşçu (2020)	Sivas Buruciye Medresesi (1271) Ön Yüz Düzeninde Orantu ve Modüler Sistem Arayışı Üzerine Bir Deneme
Gençer (2024)	Anadolu Selçuklu Mimarisinde Birleşik İşlevli Yapılarda Kütle Biçimlenişinin ve Oranlarının Geometrik Analizi
Majewski (2024)	Understanding Geometric Pattern and its Geometry Part 11-Using Anatolian Seljuk Architecture as a Source of Inspiration for Students' Projects in Mathematics

3. Findings

3.1. Proportion, balance, and modulation relationship of the Khans built under the patronage of Kayqubad I

Patron refers to the founder or the person who commissions a structure. It is used for those who have buildings constructed. As in every era, architecture in the Anatolian Seljuk Period was also a demonstration of power and prestige for the ruling authority. The patrons considered the heirs of architecture, were among the sultans, viziers, beys, and commanders (Algan, 2008). The political career of Kayqubad I, one of the important sultans and patrons of the Anatolian Seljuks, progressed in parallel with the architectural works he had built (Yavaş, 2010). The patron Kayqubad I is the tenth ruler of the Anatolian Seljuk State. He is the greatest ruler of the Anatolian Seljuk State, reigning from 1220 to 1237 (Ersoy, 2021). He was particularly interested in architectural works, made plan corrections, directly intervened in the construction process, and determined the locations of buildings that had patron characteristics (Yavaş, 2010).

The Khand built under the patronage of Kayqubad I are as follows:

1. Aksaray Sultan Hanı
   Konya-Aksaray
2. Tuzhisarı Sultan Hanı
   Kayseri-Sivas
3. Alara Han
   Antalya-Alanya

3.2. Proportion, balance, and modulation analysis

Aksaray Sultan Hanı is one of the most monumental examples of Anatolian Seljuk khans. Located between Konya and Aksaray, the Khan is 94 km from Konya and 40 km from Aksaray. It is located in the town of Sultan Hanı, which bears the same name (Rice, 2015).

According to its two inscriptions, Kayqubad I is the Khan’s patron. The hall of the Khan was built in the month of Rajab of the year 626 Hijri. According to the Gregorian calendar, the hall was built in June 1229. The courtyard was completed at the end of 1229. The hall measures 32.50 meters by 55 meters. The courtyard measures 49 meters by 62 meters. Its entire area covers an area of 4475 square meters. The inscription on the courtyard gate indicates that its architect was Muhammad b. Havlan al-Dimashqi.

The crown gate exhibits the Seljuk ratio of 2/3. The door, horizontally divided into seven parts at the threshold level, is supported by two blind two-unit side piers. The arch marked by the radius between the pilasters indicates point A, the horizontal stone row at the upper level of the entrance arch. Drawing a 60-degree line from the pilaster forms an equilateral triangle, with the corner point B being the arch keystone. Starting from the center O, drawing an arc with a radius equal to the door width OD and extending this arc gives point E. Drawing an arc with radius DE and extending this arc gives point F, the end of the frame. The method of forming arcs by shifting the center dates back to Ancient Egypt (Figure 17).

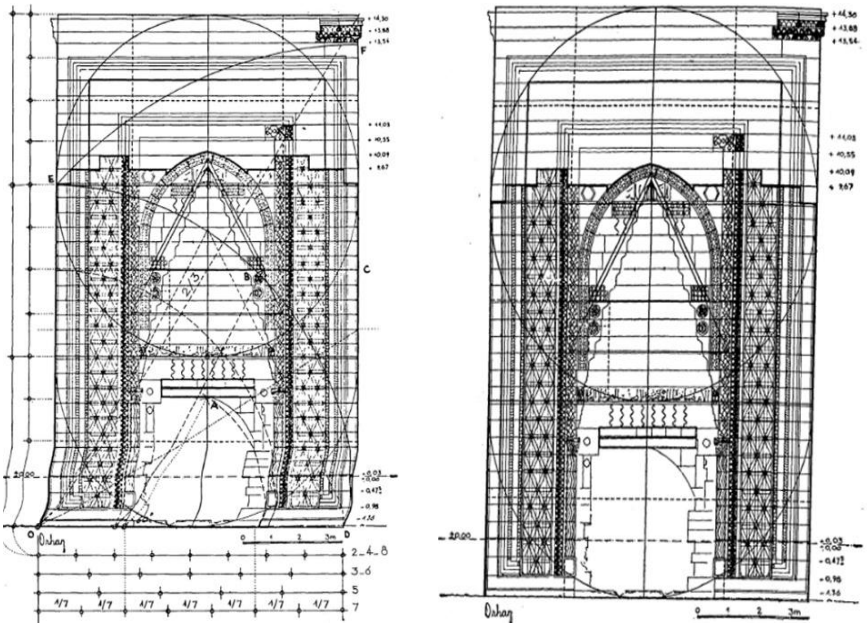

Figure 17. Left: Drawing of the Aksaray Sultan Hanı crown gate, Right: Drawing of the Aksaray Sultan Hanı crown gate 2 (Tuncer, 1982; Khalil & Vahid, 2018).

Since the upper part of the door was reached in a ruined state, the upper part was predicted using the horizontal axis by repeating the geometric and vegetal motifs in the lower parts. It was observed that the 2/3 proportion was achieved in the crown gate with the help of the right upper corner turning stone and muqarnas molding found in the excavation. Thus, the dimensions of the crown gate are determined by the repetition of two squares placed on the base, stacked three times. The line of the arch at the door frame intersects with the top of the first two square series arranged at the base. When the unit squares are divided into four, the equilateral triangle drawn from the middle of the third square from the bottom up marks the end of the muqarnas. A smaller equilateral triangle drawn from the third square marks the arch keystone. All this shows that geometric rules were also included in the design of the Seljuk crown gates (Figure 17).

When the Khan plan is divided into grid modules, the consistently repeating square units in the courtyard section are undefined in the closed section. This may indicate that these two parts were resolved separately. Nevertheless, there is a discernible rhythm when looking at the overall structure (Figure 18). Additionally, it is worth noting that the measurements determining the modulation in the plans of the khans are based on the fundamental proportions and functional requirements of the architectural design. As mentioned in the text, this modulation may not be consistent for every structure. Variations in modulation can result from factors such as the size of the space, functional needs, and sections added to the structure over time.

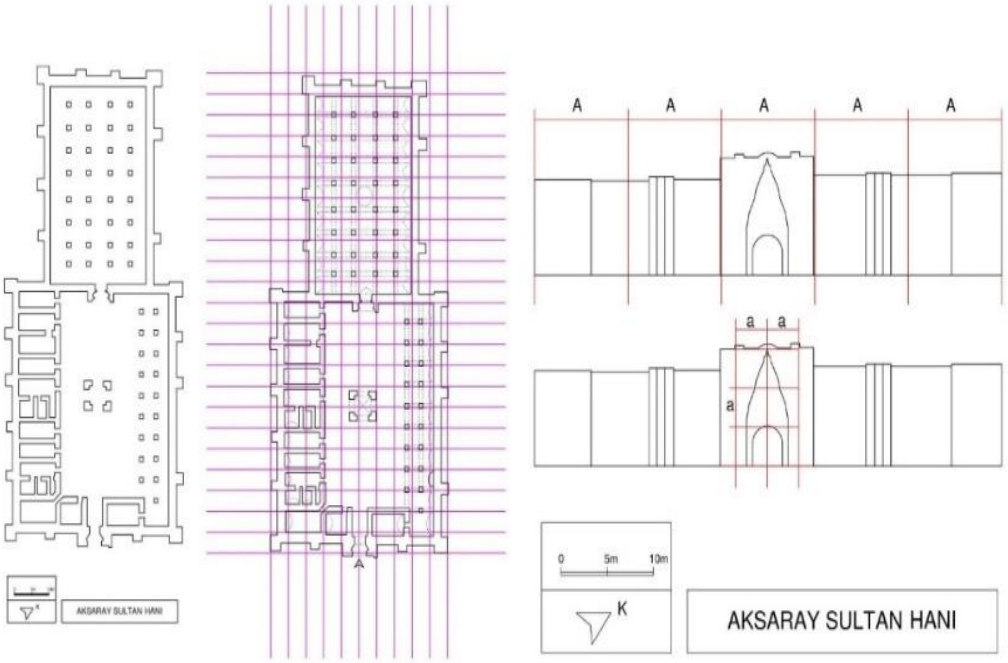

Figure 18. Left: Plan of the Aksaray Sultan Hanı, Right: Facade analysis drawing of the Aksaray Sultan Hanı (Ersoy, 2021).

In the plan and facade analysis of Aksaray Sultan Han, the proportions of the structure are based on specific modules. In the plan, the proportions used in the transition between the spacious courtyard area and the enclosed area support the functionality of the spaces, guiding the user. In the facade analysis, the arches symmetrically placed along the axis and the height of the entrance gate reveal a strong proportional balance, visually reinforcing the structure. These proportions present the building as a balanced whole, both functionally and aesthetically.

Aksaray Sultan Han covers an area of 4,900 square meters and stands out with its 13-meter-high entrance portal. The two-story kiosk mosque located at the center of the courtyard is proportionally positioned between the courtyard and enclosed spaces. Accessed by a double staircase, the mosque features arches adorned with geometric patterns, exemplifying Seljuk stone craftsmanship. This design offers both aesthetic balance and functionality, reflecting the unique proportioning principles of Seljuk architecture (Ertuğ, 1991; Stierlin & Stierlin, 1998; Acun, 2007).

There is balance in the facade. The width created by the crown gate frame and pilasters is one-fifth of the front facade. The end of the gate frame and the right side of the facade are repeated as two-unit repetitions. This does not create a symmetrical and balanced facade (Figure 18).

Looking at the crown gate, the Seljuk proportion of 2/3 is seen. Repeated as two *a* units at the base, it repeats as three *a* units in height (Figure 16). Considering all this, the facade of the structure has a consistent proportion and balance. Although the Khan plan shows consistent grid repetition within the closed and courtyard sections, it is not consistent as a whole. In this sense, it is partially a consistent structure in terms of modulation.

Tuzhisarı Sultan Han is located on the Sivas-Kayseri road, 30-32 kilometers south of the Shah-Rukh Bridge Inn. It is 48-50 kilometers from Kayseri. According to its difficult-to-read inscription, it was built by Kayqubad I between 1232 and 1236. The hall of the khan is 33x45m. The courtyard is 56x42.50m. It covers an area of 3900 square meters (Özergin, 1965).

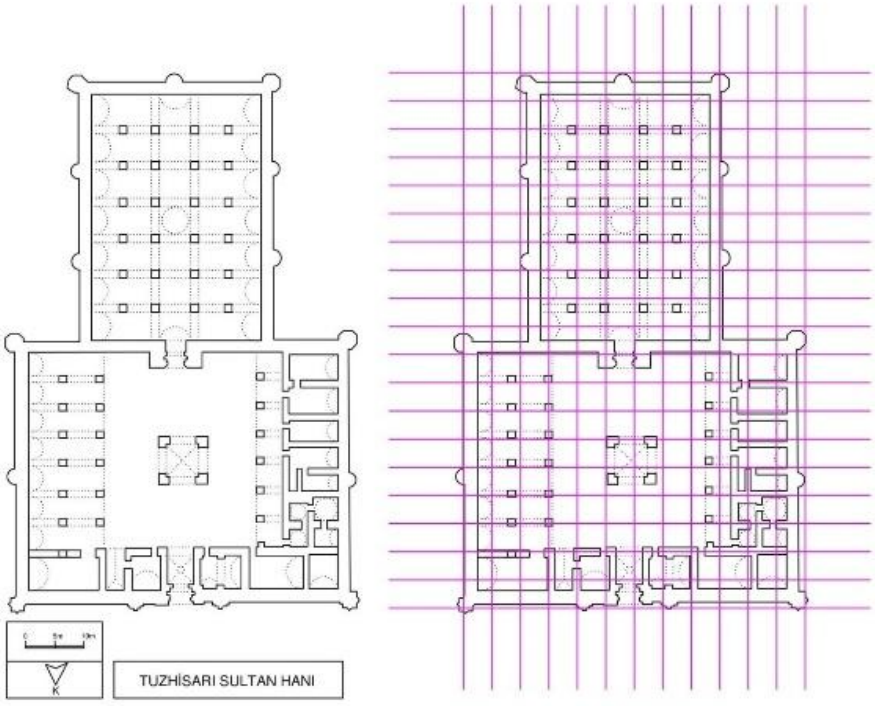

Figure 19. Left: A plan of the Tuzhisarı Sultan Han, Right: Grid system of the plan Tuzhisarı Sultan (Ersoy, 2021).

In the plan of Tuzhisarı Sultan Han, the structure is organized in a modular grid system, with all spaces arranged according to specific proportions. This grid layout provides a structural design that supports both the functional divisions and aesthetic harmony of the building. The modular system applied throughout the entire plan gives the structure a balanced visual appeal, stabilizing it both architecturally and structurally.

Tuzhisarı Sultan Han was built on an area of approximately 3,900 square meters and displays a square plan layout. The courtyard extends in a northwest-southeast direction, with rectangular rooms to the north and south covered by pointed barrel vaults. The modular grid system used in the plan organizes each space according to specific proportions; for instance, the courtyard measures 12 units horizontally and 9 units vertically, while the enclosed area measures 7 units horizontally and 11 units vertically. This proportional arrangement contributes to the building's balanced appearance and structural stability (Gabriel, 1931; Erdmann, 1961).

Additionally, the two-story square-plan kiosk mosque in the center of the courtyard is arranged with aesthetic proportions and supported by four columns. This mosque is adorned with arches featuring geometric motifs, reflecting the craftsmanship typical of Seljuk stonework (TDV İslam Ansiklopedisi). Tuzhisarı Sultan Han bears a resemblance to Aksaray Sultan Han in terms of its layout. It features a classic (hybrid) type plan with both a courtyard and an enclosed area. By examining structures designed with grid plans, as seen in Roman architecture, and referencing the work of Orhan Cezmi Tuncer, this study investigates whether a similar grid plan is present in the layout of Tuzhisarı Sultan Han (Figure 19).

The plan is divided into grids, with the courtyard area measuring twelve units horizontally and nine units vertically, while the enclosed area measures seven units horizontally and eleven units vertically. The main entrance (taçkapı) is not centrally aligned. However, the repeating grid divisions in the courtyard section are consistent in this part. The same unit system is consistently repeated in the enclosed section as well. The column partitions and the outer walls create a balanced composition, forming a total of 178 units in the structure. Overall, the plan appears to be balanced (Figure 19).

On the facade of the structure, there are small columns (sütunces) located to the right and left of the main entrance. The distance from the end of the sütunce on the right side to the end of the outer wall is measured as B units. When this B unit measurement is taken from the end of the sütunce on the left side to the extension of the left outer wall, it does not align with the end of the outer wall (Figure 20).

As shown in the upper diagram, the distance from the sütunce near the main entrance on the left side to the beginning of the buttress at the corner is termed as C units. When the same C unit is applied to the right side under the same conditions, the distance is observed to be less than C units (Figure 23).

Considering all these factors, it is evident that the main entrance is not centrally located on the facade, and the facade itself is not symmetrical or balanced.

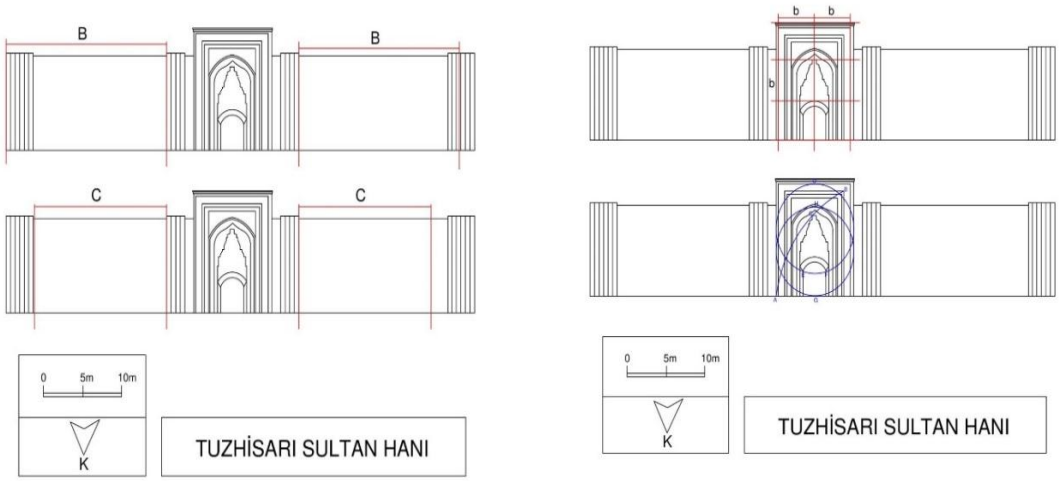

Figure 20. Facade analysis of the Tuzhisarı Sultan Han (Ersoy, 2021).

When examining the crown gate of Tuzhisarı Sultan Han, the base is measured at two b units, while the height of the crown gate is three b units. The same proportion is observed in the crown gate of Aksaray Sultan Han. This proportion is the classic Seljuk ratio of 2/3 (Figure 20).

When the lower base of the crown gate is determined as the radius of the arc, point A, which is the lower left corner, intersects point B, the upper corner of the inner frame of the crown gate, and passes through point C, the upper corner of the muqarnas. The width of the crown gate, taken as the diameter and drawn as a circle tangent to the crown gate arch, touches point G at the base and intersects point H, the keystone of the arch. The same-sized circle drawn tangent to the upper point of the crown gate determines points E and F, the starting and ending points of the door arch, respectively (Figure 20). This analysis reveals that the crown gate has a meticulously thought-out geometric calculation.

Alara Han dates back to 1231-1232 (H.629). The inscription states that it was built under the patronage of Kayqubad I. Alara Han measures 38 m by 50 m, covering an area of 1900 m² (Yavuz, 1991). It is 105 km from Antalya. The central courtyard measures 5 m by 37 m (Özergin, 1965).

Unlike other sultan khans built under the patronage of Kayqubad I, Alara Han was constructed with a different plan type, having a rectangular shape. It has an equal focal plan type, also known as the Constantinian plan type. The galleries surrounding each other symmetrically in the plan provide a symmetrical appearance. With porticos, rooms, stables, and service spaces, it contains all the necessary functions and spaces required for a khan.

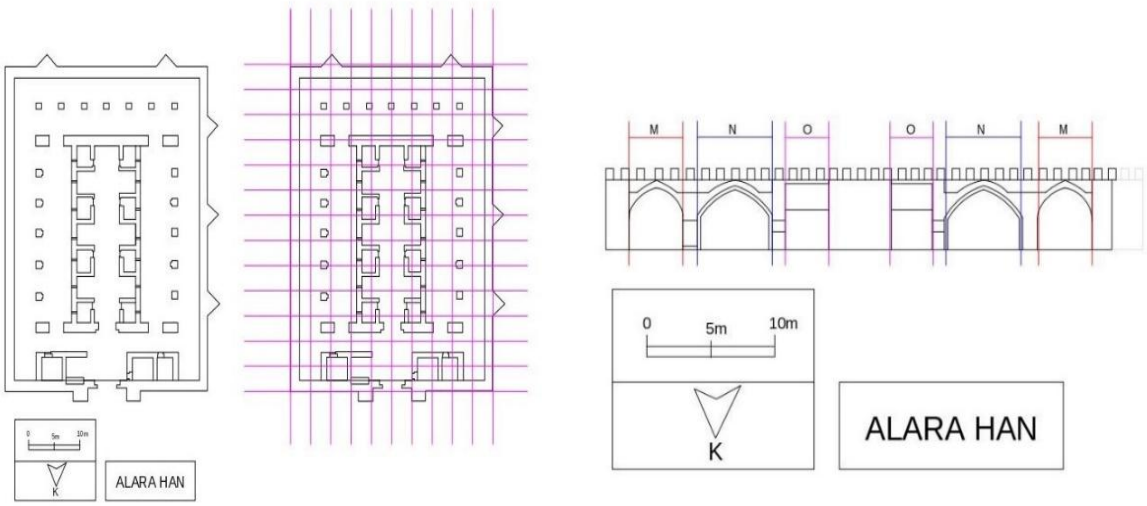

Figure 21. Left: Plan analysis of the Alara Han, Right: Section analysis of the Alara Han (Ersoy, 2021).

Considering the grid repetition seen in Roman architecture and the study conducted by Orhan Cezmi Tuncer, it was investigated whether this feature is present in the plan of Alara Han. The plan was divided into grids. The plan, divided into 10 units horizontally and 13 units vertically, conforms to the grid solution. The grid line passing through the center of the crown gate divides the plan exactly in half. The two units continuing on the right and left of the central line correspond to the central portico section. The 13 units formed horizontally hold the outer walls, creating a balanced appearance. The plan consists of 130 units. Considering the consistency, proportion, and rectangular shape of these repeating units, it is observed that the plan is symmetrical and balanced (Figure 21).

The cross-section of the structure was prepared by cutting through the portico, room, and stable along the window line. On the right side of the section, there is a triangular buttress visible in the appearance. This buttress supports the structure and is located on the western facade of the building. Independently of this, the cross-section consists of the repetition of the portico, room, and stable on the right and left sides. The widths of these repeating volumes on the right and left are equal. The portico scaled by the O unit shows the same measurement on the right and left when the section is centered. The room scaled by the N unit shows the same measurement on the right and left when the section is centered. The stable scaled by the M unit shows the same measurement on the right and left when the section is centered. Considering all these, it is observed that the cross-section of Alara Han also possesses proportion, symmetry, and balance (Figure 21).

There is damage to the tower on the right side of the building facade and the crown gate above it. This damage is directly reflected in the facade drawing. The crown gate is located in the center of the facade, with towers on either side. While the tower on the left is intact, the tower on the right is damaged. The distance from the crown gate to the end of the building wall is the same, which is D units. This repeating D unit on the facade demonstrates the balance and symmetry of the facade (Figure 20).

The distance from the crown gate to the towers is termed F units. The F units repeat twice on both the right and left sides of the crown gate, leaving a small margin at the edges. Due to the pandemic, fieldwork could not be conducted, so millimetric measurements could not be taken. Therefore, this small margin can be disregarded in this context. The measurement of the entire facade, along with the crown gate and its surroundings, is in a ratio of 1:5. The repetition of two F units on the right and left sides of the crown gate shows the symmetry and balance of the facade (Figure 22).

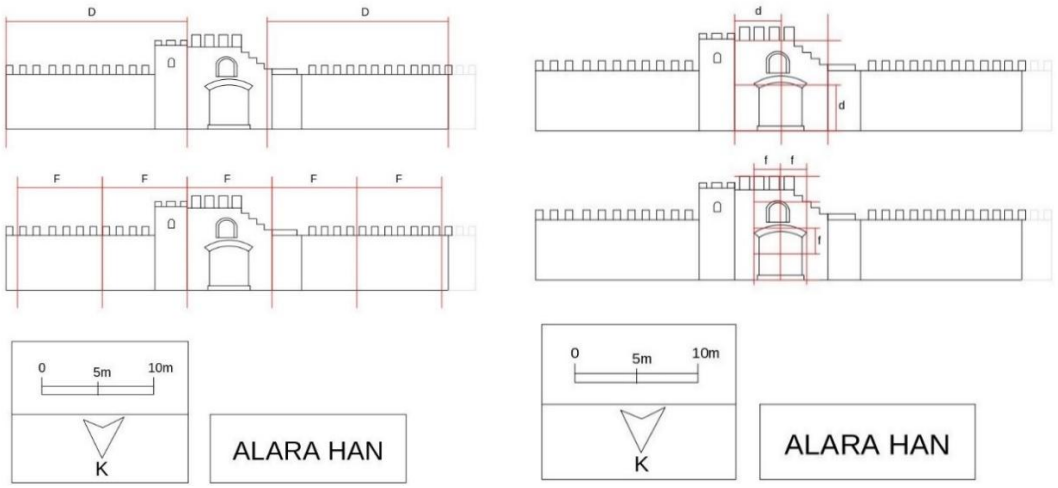

Figure 22. Left: Facade analysis of the Alara Han, Right: Crown gate analysis of the Alara Han (Ersoy, 2021).

Although the Seljuk 2/3 ratio is observed in the crown gates of other khans examined, it is not seen in the crown gate of Alara Han. When looking at the crown gate and its surroundings, the repetition of two d units at the base and two d units in height is observed. Here, the ratio is seen as one-to-one (Figure 22).

Considering only the width of the crown gate, the base of the crown gate is observed to be two f units, and its height is four f units. In the repetition of the f unit, the third f unit from the bottom frames the window above the crown gate. When the two f-unit distance of the base of the crown gate is applied to its height, it coincides with the arch of the entrance gate, showing a one-to-one ratio (Figure 20).

As with the plan, Alara Han is different from the other khans examined in its crown gate as well. However, despite the difference, a proportion is observed in its crown gate. Ratios of 1/1 and 1/2 are observed in the crown gate and its surroundings (Figure 22).

4. Discussion and Conclusion

The geographical position of Anatolia, due to its proximity to different cultures, especially Byzantium and Iran, clearly reveals its influence on architecture. When we examine the social structure of the Anatolian Seljuks, we see that the Turkish population is differentiated into nomadic Turks, semi-nomadic Turks, and urban Turks who came from Central Asia and Iran. These different lifestyles have laid the groundwork for diversified products and production techniques. While nomads have thousands of years of experience in weaving, leatherworking, and metallurgy, semi-nomads have gained knowledge of building techniques and forms, and urban Turks have brought the art and craft knowledge of the Iranian Islamic civilization with them (Kuban, 1981).

The caravan routes passing through Anatolian Seljuk lands have enabled these regions to gain an advanced social and cultural structure. The closed and open markets, bazaars, inns, and caravanserais established along these routes have allowed the region to be economically and culturally nourished (Turan & Kırpık, 2016).

The most distinctive feature of Anatolian Seljuk caravanserais, compared to those in other regions such as Central Asia, Persia, and the Levant, is their unique architectural and functional elements. Caravanserais in regions like Persia and Central Asia, for example, often incorporated extensive decorative elements on their exteriors and had more elaborate façades, reflecting local stylistic preferences. In contrast, due to Anatolia's strategic location and heightened security needs, these structures in the Seljuk period often resembled fortified castles, with thick stone walls, single narrow entrances, and solid towers. Unlike other caravanserais, the Anatolian examples featured minimal external decoration but offered intricate interiors with courtyards, arcades, and large domed spaces. They also balanced open summer areas and enclosed winter rooms, providing year-round

accommodation while functioning as social and commercial hubs, offering free services like food and healthcare, supported by the state (Rice, 2015).

Anatolian Seljuk architecture has gained a unique character through the combination of products and techniques arising from the diversity offered by geography. Architecture, as in every period, was also an important tool for demonstrating the power and prestige of the ruling power in the Anatolian Seljuk Period. The concept of patronage, examined within the boundaries determined by the monarch's period, is particularly significant in this study. Caravanserais, in particular, are multi-functional structures in terms of economy, culture, and architecture, playing critical roles in urban development and cultural transmission. The period of Kayqubad I is noteworthy for the active role he played as a patron in every stage of the construction process (Ertug, 1991).

The golden ratio used in Byzantium was indirectly transferred to Anatolian Seljuk architecture and took on a different form here. When designing a structure, a standard unit is first determined, and the exact proportions of the structures are calculated according to this unit. These ratios and measures are adjusted to ensure symmetry and balance in the structure. Modifications can be made based on this basic measure, and detailed proportioning is done to ensure the aesthetic appearance of the structure (Vitruvius, 2019).

Anatolian Seljuk architecture, particularly its use of geometric proportions and the golden ratio, was not solely influenced by the Byzantine Empire but also bears deep traces of Central Asian and Persian traditions. While the Byzantine legacy played a significant role, particularly in stone masonry and structural elements such as domes, the hallmark of Seljuk architecture lies in its synthesis of various cultural traditions. Concepts like the golden ratio, as seen in many ancient civilizations, were utilized in Seljuk structures to balance both aesthetic and functional principles (Ögel, 1987; Komaroff, & Yalman, 2001). Although the Byzantine influence holds a notable place in Seljuk architecture, this architectural style is far from being limited to Byzantine sources. Instead, elements from Persian, Central Asian, and Islamic traditions were incorporated, creating a rich and unique synthesis that defines the Seljuk architectural identity. This cultural amalgamation is prominently displayed in the Seljuks' famous caravanserais, mosques, and other monumental buildings. These structures exemplify the multilayered and geographically expansive impact of Seljuk cultural heritage (Komaroff, & Yalman, 2001).

This approach to proportion, balance, and modulation has passed from Egypt to the Greeks, gaining an aesthetic appearance with a mathematical expression (Tuncer, 2010). The multiculturalism brought by geography has carried not only geometry and mathematics in architecture but also cultural accumulations. Architecture deals with the deep social values of a culture and expresses these values in a material and aesthetic language.

In terms of method, there are not enough examples in the literature on proportion, balance, and modulation. Among the reliable methods in this field, Orhan Cezmi Tuncer's studies stand out.

Therefore, Tuncer's analyses on the Sivas Gök Medrese were adopted as a methodology in this study. The lack of a detailed examination of proportion, balance, and modulation in Anatolian Seljuk khans previously necessitated this study to be conducted under current conditions and to expand its scope.

The beliefs, lifestyles, needs, and economic structures of society have a decisive impact on the art and architectural works they create. A deep examination of this architectural understanding shows that it carries social and political weight and is shaped by the responsibilities brought by belief. The concept of "patronage" in the Anatolian Seljuk period stands out as an important status symbol in society.

The grid system is a fundamental technique used in architectural design to achieve proportion and modulation. Grid modules are employed to define the placement of key structural elements such as columns, walls, and circulation paths. Through this method, each grid unit is repeated to create proportional unity and balance across the structure. The logic behind the formation of inputs is based on structural requirements and functional purposes (Komaroff, & Yalman, 2001). Grid systems, particularly in Seljuk architecture, combine aesthetics and functionality. The repetition of grid units ensures both structural balance and visual rhythm (Ögel, 1987). Furthermore, grid systems are also used to optimize spatial organization and human circulation (Pinder, 1996). By dividing the plans into grid modules, proportion, balance, and modulation were investigated. Each grid unit was used to create a proportional unity and modulation within the structure by repeating as part of the whole. This method observed how each grid unit affected the structure as a whole. The grid inputs were determined to align

key architectural elements such as columns, walls, and circulation paths. By repeating these units, the method allowed for both spatial coherence and balance, ensuring that each grid's impact on the overall design could be systematically evaluated.

In architectural planning, balance refers to the visual and structural harmony achieved by evenly distributing the visual weight of elements within a space, contributing to both aesthetics and functionality. Symmetrical balance involves mirroring elements along a central axis, creating a sense of order and formality, particularly common in classical architecture. In contrast, asymmetrical balance distributes elements with different forms but equivalent visual weight, adding movement and interest while maintaining harmony. Radial balance arranges elements around a central point, often seen in circular layouts, fostering a sense of unity by directing attention outward from a focal center. Balance in architectural planning is crucial, as it influences the flow and usability of a space, creating an environment that is visually appealing and functional (Rasmussen, 1962; Krier, 1988; Ching, 2014).

Aksaray Sultan Hanı consists of two different masses, including a courtyard part and a completely closed area. When the plan of Aksaray Sultan Hanı is divided with a grid system, it is observed that the grid units arranged in the courtyard section do not align with the spaces in the closed area. This suggests that the closed part while showing symmetrical and balanced characteristics within itself, may not have been planned simultaneously with the courtyard and may have been designed at different times (Table 2).

Table 2. Proportion, balance, and modulation in plan

Khan Name	Proportion in Plan	Balance in Plan	Modulation in Plan
Aksaray Sultan Hanı	Proportional separately in courtyard and closed part	Proportional separately in courtyard and closed part	Proportional separately in courtyard and closed part
Tuzhisarı Sultan Hanı	Proportional	Proportional	Proportional
Alara Han	Proportional	Proportional	Proportional

The plan of Tuzhisarı Sultan Hanı shares similar characteristics with Aksaray Sultan Hanı in shape and plan type. Both structures have a mixed plan type, including a courtyard and a closed area. However, when Tuzhisarı Sultan Hanı is divided into a grid system, the courtyard part and the closed area produce relatively more consistent results. This indicates that the plan is proportional and balanced (Table 2).

Alara Han, on the other hand, is constructed as a single piece with a rectangular form and an equal focal plan type. This plan type, also known as the "Constantinople plan," has four interconnected rings, giving the structure a distinct symmetry. When the plan of Alara Han is divided into a grid system, it is seen that the grids ensure the symmetrical and proportional arrangement of the entire structure (Table 2).

It is necessary first to define the concepts of proportion, balance, and modulation on the facade. Accordingly:

- Proportion on the Facade: Proportion refers to the dimensional relationships established among architectural elements on the facade to create aesthetic harmony. As shown in Table 3, these proportions are observed between features such as door openings, column widths, and arch heights, forming a structured visual unity. This arrangement contributes to a balanced and cohesive facade design.

- Balance on the Facade: Balance on the facade involves the even distribution of visual weight across structural elements. Table 3 illustrates how both symmetrical and asymmetrical balance are achieved. Symmetrical balance is created by placing elements in mirrored positions along a central axis, while asymmetrical balance is achieved by

arranging visually equivalent but varied elements. This balance enhances both the aesthetic and structural stability of the facade.

- Modulation on the Facade: Modulation involves the arrangement of architectural elements in a modular system based on a repeating unit of measurement. In Table 3, this modular system is exemplified by the repetition of elements like arches, columns, or openings. Such rhythmic repetition contributes to the facade's visual flow and aesthetic cohesion.

Observations of the facade of Aksaray Sultan Hanı reveal that the crown gate is symmetrically positioned, and the supporting walls on either side are of equal length. The central position of the crown gate and the equal distance of the buttresses to the gate and wall ends indicate that the facade was designed in a symmetrical arrangement. This structural organization gives the facade a balanced and aesthetic appearance (Table 3).

Table 3. Proportion, balance, and modulation in facade

Khan Name	Proportion in Facade	Balance in Facade	Modulation in Facade
Aksaray Sultan Hanı	Balanced and Symmetrical Facade	Balanced and Symmetrical Facade	Balanced and Symmetrical Facade
Tuzhisarı Sultan Hanı	Asymmetrical Facade	Asymmetrical Facade	Asymmetrical Facade
Alara Han	Balanced and Symmetrical Facade	Balanced and Symmetrical Facade	Balanced and Symmetrical Facade

The facade of Tuzhisarı Sultan Hanı, on the other hand, does not exhibit a symmetrical arrangement because the crown gate is not centrally located. However, the buttresses on the right and left of the crown gate are equidistant from it, and the walls are not of symmetrical lengths, but this section presents a balanced composition when this is overlooked (Table 3).

Despite the deformations on the facade of Alara Han, the symmetrical characteristics of the structure are reflected. The crown gate centers the facade, and the towers on either side of the gate are symmetrically and equally sized. The equal lengths of the walls on either side of the gate indicate strong symmetry and balance throughout the structure (Table 3).

In the crown gate of Aksaray Sultan Hanı, the repetition ratio of two units at the base transforms into a repetition of three units at the height of the crown gate. This observed 2/3 ratio is a characteristic Seljuk architecture ratio and is repeated in many structures (Table 4).

Table 4. Proportion, balance, and modulation in Ccrown gate

Khan Name	Proportion in Crown Gate	Balance in Crown Gate	Modulation in Crown Gate
Aksaray Sultan Hanı	2/3 Seljuk Ratio	2/3 Seljuk Ratio	2/3 Seljuk Ratio
Tuzhisarı Sultan Hanı	2/3 Seljuk Ratio	2/3 Seljuk Ratio	2/3 Seljuk Ratio
Alara Han	1/2 Ratio	1/2 Ratio	1/2 Ratio

Tuzhisarı Sultan Hanı shares similar features with Aksaray Sultan Hanı in many respects. This similarity is also reflected in the crown gates. The crown gate of Tuzhisarı Sultan Hanı repeats two units at the base and three units in height, representing the 2/3 Seljuk ratio (Table 4).

Alara Han exhibits a different architectural structure from other khans. The crown gate of Alara Han has a simpler design. The base ratio of two units is repeated as four units in height, indicating a 1/2 ratio. This suggests that the crown gate of Alara Han does not conform to the characteristic Seljuk ratio

of 2/3. Additionally, the equal focal plan type of Alara Han suggests that this ratio could be influenced by Byzantine proportions (Table 4).

References

Acun, H. (2007). *Anadolu Selçuklu dönemi kervansarayları*. Ankara: Kültür ve Turizm Bakanlığı Yayınları

Algan, N. (2008). *Anadolu Selçuklu dönemi mimarisi taş yüzey süslemelerinin incelemesi ve seramik yorumları*. (MSc), Dokuz Eylül Üniversitesi, Güzel Sanatlar Enstitüsü, İzmir, Türkiye.

Anadolu Agency. (2024). "Mavi Medrese" kapsamlı restorasyonun ardından yaklaşık 371 bin ziyaretçi ağırladı. https://www.aa.com.tr/tr/kultur/mavi-medrese-kapsamli-restorasyonun-ardindan-yaklasik-371-bin-ziyaretci-agirladi/3254787

Arapoğlu, M. (2024). X. ve XII. yüzyıllar Maveraünnehir ribatları. *Sanat ve İnsan Dergisi, 8*(1). https://doi.org/10.5281/zenodo.13357255

Bommelaer, J.-F. (1985). *Le dessin d'architecture dans les sociétés antiques*. Leiden: Centre de Recherche sur le Proche Orient et la Grèce antiques.

Çakmak, B. Y., & Şahin, M. (2018). Selçuklu portallerinin günümüz cephe elemanı olarak kullanılması: Konya örneği. *Artium*, *6*(2), 11-19.

Coulton, J. J. (1974). Towards understanding Doric design: The stylobate and the intercolumnations. *Annual of the British School at Athens*, *69*, 61-86.

Ching, F. D. K. (2014). *Architecture: Form, space and order* (4th ed.). John Wiley&Sons

Erdmann, K. (1961). *Das anatolische karavansaray des 13. jahrhunderts: Katalog-Abbildungen (Vol. I-III)*. Berlin: Verlag Gebr. Mann

Ersoy, M. (2021). *I. Alaeddin Keykubat'ın baniliğinde yapılan hanların orantı, denge ve modülasyon ilişkisi üzerine bir inceleme.* (MSc), Haliç Üniversitesi Lisansüstü Eğitim Enstitüsü, istanbul.

Ertug, A. (1991). *The Seljuks: A journey through Anatolian architecture*. Istanbul

Erzen, J. N. (1976). Eğitim estetik süreç olarak yorumu ve mimarlık eğitimi. *ODTÜ Mimarlık Fakültesi Dergisi*, *2*, 175-185

Ettinghausen, R., Grabar, O., & Jenkins-Madina, M. (2001). *Islamic art and architecture: 650-1250*. Yale University Press.

Gabriel, A. (1931). *Monuments Turcs d'Anatolie (Vol. I)*. Paris: Editions de Boccard.

Gençer, F. (2024). Anadolu Selçuklu mimarisinde birleşik işlevli yapılarda kütle biçimlenişinin ve oranlarının geometrik analizi. *Art-Sanat Dergisi*, *22*, 31-59. https://doi.org/10.26650/artsanat.2024.22.1483701

Goodwin, G. (1997). *A history of Ottoman architecture*. Thames & Hudson.

Hillenbrand, R. (1994). *Islamic architecture: Form, function, and meaning*. Columbia University Press.

Jones, M. W. (1989). Designing the roman corinthian order. *Journal of Roman Archaeology, 2*, 35-69

Kalaycı, L. (1994). *Sanat'ta altın oran'ın metaformoz hikayesi*. Marmara Üniversitesi, Sosyal Bilimler Enstitüsü, İstanbul, Türkiye.

Khalil, K. F., & Wahid, J. (2018). The proportional relations systems of Islamic architecture. *International Journal of Scientific and Research Publications*, 3(1).

Komaroff, L., & Yalman, S. (2001, October 1). The Art of the Seljuqs of Iran (ca. 1040–1157). The Metropolitan Museum of Art. https://www.metmuseum.org/essays/the-art-of-the-seljuqs-of-iran-ca-1040-1196

Krier, R. (1988). *Archirectural composition.* Academy Editions

Kuban, D. (1981). *100 soruda Türkiye sanat tarihi*. Gerçek Yayınevi.

Kuban, D. (2010). *Selçuklu çağında Anadolu sanatı*. Yapı Kredi Yayınları.

Kuşçu, H. M. (2020). Sivas Buruciye Medresesi (1271) ön yüz düzeninde orantı ve modüler sistem arayışı üzerine bir deneme. *Selçuk Üniversitesi Selçuklu Araştırmaları Dergisi, 13*, 27-78.

Lubicz, R. A. S. (1981). *The temple in man sacred architecture and perfect man*. Ny Inner Traditions International.

Majewski, M. (2024). Understanding geometric pattern and its geometry: Using Anatolian Seljuk architecture as a source of inspiration for students' projects in mathematics. *Electronic Journal of Mathematics & Technology*, *18*(1).

Mirzaakhmedov, S. D. (2016). The Ribat-Caravanserais from the Eastern Suburbs of Paykand, Archaeological and historical aspects. *Journal of Inner Asian Art and Archaeology*, *7*, 109-123. https://doi.org/10.1484/J.JIAAA.4.2017006

Mirzaakhmedov, D. K., & Stark, S. (2013). Archaeological investigations at the "long wall" of Bukhara. Institute for the Study of the Ancient World, NYU. https://isaw.nyu.edu/research/bukhara-project/reports/season-2013

Necipoğlu, G. (Ed.). (1994). *Muqarnas: An Annual on Islamic Art and Architecture* (Vol. 11). Brill.

Ousterhout, R. G. (2019). *Eastern medieval architecture: The building traditions of Byzantium and neighboring lands*. Oxford University Press.

Ögel, S. (1987). *Anadolu Selçuklularının taş tezyinatı. İstanbul: Türk Tarih Kurumu Yayınları.*

Özergin, M. (1965). Anadolu'da Selçuklu kervansarayları. *İstanbul Üniversitesi Edebiyat Fakültesi Tarih Dergisi*, *15*(20), 141-170.

Pinder, D. (1996). Subverting cartography: The situationists and maps of the city. *Environment and planning A, 28(3), 405-427.*

Rasmussen, S. E. (1962). *Experiencing architecture.* MIT Press.

Rice, T. T. (2015). *Anadolu Selçuklu tarihi*. Nobel Akademik Yayıncılık.

Schliephacke, H. (1968). *Abu Simbel - Eine zweimalige künstlerische und technische Leistung*. Sonderdruck der Hünnebeck

Scruton, R. (1979). The aesthetics of architecture. Princeton University Press.

Stierlin, H., & Stierlin, A. (1998). Turkey: From the Seljuks to the Ottomans. Köln, Germany: Taschen.

Şenyiğit, Ö. (2010). *Biçimsel ve anlamsal ifade aracı olan cephelerin değerlendirilmesine yönelik bir yaklaşım: İstanbul'da Meşrutiyet ve Halaskargazi caddelerindeki cephelerin incelenmesi.* Yıldız Teknik Üniversitesi Fen Bilimleri Enstitüsü, İstanbul, Türkiye.

Tuncer, O. C. (1981). Orantı ve modül üzerine Selçuklu yapılarından bazı örnekler. *Vakıflar Dergisi*, *13*, 449-456.

Tuncer, O. C. (1982). Birkaç Selçuklu taçkapısında geometrik araştırmalar. *Vakıflar Dergisi*, *16*, 61-76.

Tuncer, O. C. (2010). İstanbul Edirnekapı Mihrimah Sultan Camisi geometrik kurgusu. *Vakıflar Dergisi*, *33*, 113-124.

Tuncer, O. C. (2015). Vakıf yapılarında estetik kavramlar. *Vakıflar Dergisi*, *43*, 149-172.

Turan, R., & Kırpık, G. (2016). Selçuklu dönemi Türklerde sosyal ve ekonomik hayat. In *Selçuklu el kitabı* (pp. 479-509). Ankara: GRAFİKER.

Vitruvius. (2019). *Mimarlık üzerine 10 kitap* (pp. 230-231). Alfa Yayınları.

Yalouris, A., & Yalouris, N. (1995). *Olympia: Guide to the museum and the sanctuary*. Ekdotike Athenon S.A.

Yavaş, A. (2010). Anadolu Selçuklu banilerinin politik yaşamlarıyla mimari faaliyetleri arasındaki ilişkiler. *Türklük Bilimi Araştırmaları*, *28*, 409-417.

Yavuz, A. T. (1991). Mircinge han ve Anadolu Selçuklu dönemi eşodaklı kervansaraylar arasındaki yeri. *ODTÜ Mimarlık Fakültesi Dergisi*, *11*(1-2), 41-55.

Yavuz, A. T. (1997). The concepts that shape Anatolian Seljuq caravanserais. Muqarnas, *14*, 80-95. https://doi.org/10.2307/1523237

Yılmaz, E. M. (2017). *Selçuklu dönemi medreselerinde altın oran-estetik ilişkisi: Konya örneği*. (MSc), Selçuk Üniversitesi, Fen Bilimleri Enstitüsü, Konya, Türkiye.