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Comparison of Geometrical Proportions in the Tomb Monuments of the Contemporary Period with an Emphasis on Various Systems of Global Proportions

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Research Article

Abstract

Throughout history, in order to honor and record valuable events such as themes, conquests, events and personalities, monuments were formed that have a meaning in their heart. These buildings have been influenced by various factors. Paying attention to the body and also the physical form to engage the senses of the visitors has been a main pillar in the design of such buildings. One of the ways to create brevity in such buildings is the use of geometry and the use of proportional systems to create pleasure and a pleasant feeling in the audience. This research, using causal-comparison method and using the tool of collecting questionnaires, seeks to see how much proportional systems have been used in the design of the overall form and its components from each of the mentioned and selected monuments. have used, the range of measurement is selected with the preference system and with the opinions of thinkers, and the people to be measured include space users and users who are selected by random sampling with a number of 384 people according to Morgan's table. JMPSAS16 software is used for ease of numerical and graphical analysis. The results show that the largest factor contribution in the application of geometric proportions in the components and overall design is related to radical ratios with the value of (1.000) for the components and (0.905) for the overall design, and the lowest is related to Ken and Shako with the

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value (0.167) for components and (0.195) for the overall plan. The important point is that the platonic rectangle with the value of (0.915) for the components and (0.914) for the general plan has a high factor share, but due to the lack of significance for both parts, the results of attention to it are not reliable.

Keywords: Geometric Proportion; Tomb Monuments; Contemporary Period; Systems of Global Proportions

1. Introduction

Different views of architecture have existed as long as humans have existed and even before that, which has seen many imaginations. In this process of transformation and smooth evolution, the presence of some metamaterials has made them eternal and divine in the valley of architecture. Since the birth of architecture, geometry has been, is and will be. The knowledge of geometry, like many human sciences, has a long history, which has always been used in architecture to enhance the material and convey the spirit, meaning and special effect. This type of use for creation by mankind can be influenced by the thoughts and ideas of philosophers and great thinkers, as Plato says that God is an "engineer" and before him Pythagoras and after him Plotinus also believed that mathematics is because of its sensible area (and not Perceptible) has a theological aspect and the principles of God created the world based on an amazing mathematical order based on two right triangles (Saki, and Pakzad, 2014: 399). The issue of using proportions has been discussed since the beginning of human creation and his awareness of the issues and environment around him and has been researched and examined by various artists and scientists since the beginning of time. The purpose of all theories of proportions is to create a sense of order between the components of a visual composition. (Grotter, 2004: 103) Architects have succeeded in creating order, harmony, compliance with the principles of hierarchy and beauty in a set of buildings with different uses in the vicinity of each other by using good proportions and geometry throughout the ages. Systems of mathematical proportions originate from the Pythagorean hypothesis which says: everything is a number and from the belief that some numerical ratios show the harmonious structure of the universe (Dick Ching, 1998:106).

The system of proportions creates a set of visual constant ratios between the components and the whole of a set. In the past, the design of different components of buildings was done by looking at proportional rules and balanced proportions, and it seems that the building has a part of its beauty. It owes to these rules and the skill of using these rules. But nowadays, such skills are not taught separately in architecture schools. The design does not limit itself to the use of geometric proportions. Monuments are built to honor and remember various issues such as a character, an event with a meaning, these monuments are influenced by factors such as the importance of the subject or character, density of the site, visual obstacles, political, economic power, etc., they can have different scale and architecture, memorial architecture can be divided into two categories, burial and non-burial. The importance of these buildings is their fundamental impact on the development and identity of many cities in Iran, which strengthens the sense of place, meaning and personality in today's cities, and they can be a symbol of identity. become that city. Geometry is one of the important elements in the design and general plans of these buildings.

Architects of the contemporary era always try to use proportional systems known at the world level in the design of such buildings, which can make these buildings attractive in the overall scheme and components. This research aims to investigate the contribution of each of the systems of geometric proportions in the formation of the contemporary period tomb monuments and tries to answer the question of how much each of the proportional systems plays a role in the formation of the contemporary period tomb monuments.

2. Theoretical Foundations

2.1. Proportions

Proportion, which in Euclid's view refers to the quantitative comparison of two similar things, has been the basis of the creation of the whole nature, including the heavens and the earth, and especially humans. Proportions have always been used in the design of buildings in different periods and ancient civilizations. Proportion in the object always makes the object look more balanced. Proportions have been used in architecture from materials and materials, climatic conditions, technical and executive factors to the thoughts governing people's lives, and space has been designed as a suitable background for human growth and excellence. Proportion is one of the basic principles of an artwork that expresses the harmonious relationship between its components (Ansari, Okhot, and Taghvaei, 2011: 46). In another definition, proportionality is: the relative and analogical relationship between different parts and the whole of an element. Proportion, while being a determining factor for harmony, is one of the issues that has always been discussed in architecture. Proportion is a subjective value and can only be checked in relation to the shape. Proportion in architecture means a ratio that expresses the relationship between two or more sizes (Grotter, 2004: 360). Measuring the size of two things produces a ratio. According to Euclid's theory: Quantitative comparison refers to two similar things. While proportion is said to be the equality of proportions. Proportions are a set of ratios, the ratio is a comparison of two qualities or quantities, such as size or amount, and therefore ratios are considered to represent a unit of a difference or difference (Carrier, 2005: 7). In the field of architecture, proportions include the comparative ratios of various quantities and qualities of heterogeneity, and hence its understanding is more complicated. If we put proportionality as an example of perception activity based on the recognition of difference (Carrier, 2005: 9).

3. Theories Related to Proportional Systems and Measurement Units

All theories of proportions aim to create a sense of order between the components of a visual composition. The proportional adjustment system creates a set of visual fixed ratios between the components of a building and also between the components and the whole. Proportion regulation systems go beyond functional and technical determinants of architectural form and space, and present aesthetic arguments about themselves (Dick Ching, 1998: 298). The proportions in the world thought can be divided into 4 categories: 1- Golden proportions 2- Renaissance theories 3- Le Corbusier's modular 4- Human proportions

3.1. Golden Proportions

The ancient Egyptians used proportions that they called theological proportions. Later, these proportions were called the divine proportion by Vitruvius, an Italian architect of the second century. But at the end of the 19th century and the beginning of the 20th century, when gold became the standard of economic measurement, these proportions became popular with the term golden proportions (Lasayi, and Mparma, 1984; Ayat Elahi, 1998). The law of golden divisions of line segment by Euclid, a prominent Greek philosopher and mathematician, in the third century BC.

It was discovered (Haji Ghasemi, Navai, and Rasouli, 2012). Also, after some time, the Greeks realized the dominant role that the golden ratio played in the proportions of the human body. Therefore, they reflected these proportions in the building of their temples. In this ratio, a line is divided into two unequal parts, where the ratio of the length of the smaller part to the larger part is equal to the ratio of the length of the larger part to the whole line (Haji Ghasemi, Navai, and Rasouli, 2012: 93). The golden ratio is the ratio of 1 to 61803.1. Whenever a shape or volume has allegorical or accepted dimensions and sizes, it is called proportional or having golden sizes (Carrier, 2005: 71). Sublime and golden proportions have become common in every culture according to the beliefs and likes of that culture and thought, and it has proven its beauty as a result of its many uses. Be considered. In the Bible, there is also a reference to the golden ratio, for this reason, this ratio has been called the "divine ratio" since ancient times, and there is a group of people who believe that this ratio has a special role in the creation of the universe. Proportions in their general form rely on the science of geometry and mathematics in their place and in their specialized form have an undeniable value in the basics of understanding art and are considered as fundamental considerations (Carrier, 2005: 9). Among the golden measures, we can mention the rectangle 2√, 3√, 4√ and... and Fibonacci numbers (Carrier, 2005: 71). Architects also used this law during the Renaissance period. Le Corbusier set his modular system based on golden proportions. The golden ratio, which has been widely used in Islamic architecture, is the ratio obtained from pentagonal dimensions (Ansari, Okhot, and Taghvaei, 2011: 71). If three points are on a straight line, the ratio of the large segment to the small segment is equal to the ratio of the length of the entire line segment to the length of the large segment. In the second century AD, Vitruvius called this geometric ratio (golden ratio) theological ratio. Lahoti ratio: It is a ratio that divides a line segment into two proportional parts so that the ratio of the smaller part to the larger part is equal to the ratio of the larger part to the whole line segment.

Consider a square ABCD with a side length of one unit (Figure 2). Point O is the middle of side CB. Draw an arc to the center of this point and to the radius OA to cut CB at point Q. The rectangular square PQCD is a "golden rectangle" and its length-to-width ratio is 1/618.

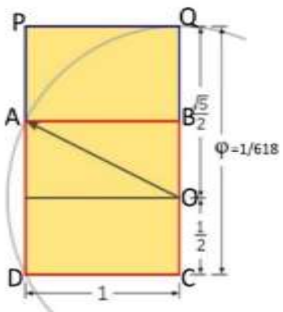


Fig 1 How to geometrically draw a golden rectangle with the help of a square

It has been said that such a rectangle is more beautiful to the human eye than other rectangles. For this reason, it has been widely used in architecture from ancient times until today, and even today, when they want to make something rectangular that is eye-catching, they make it in the shape of a golden rectangle, that is, if we divide its length by its width, a number close It is obtained as 1/6.

The golden ratio of the line segment is represented by the 21st letter of the Greek alphabet, T (Lawlor, 1989). Phi Dias, a Greek sculptor, studied the golden ratio in detail, and for this reason, this ratio is also known as Phi (Φ) (Kashifpour, 2009). Dividing the line segment into two proportional parts can be used to make: 1) golden rectangle and spiral, 2) golden pentagon, 3) golden triangle.

1. Golden rectangle and spiral:

In making the golden rectangle, like 2√, the index square of image 3 is used. With the difference that to draw a golden rectangle, we make an arc equal to the diameter of the square from the diameter of half the index square, the obtained point shows the place of formation of the golden rectangle, which points (c, e, f) are the same as points A, B, C on the segment they are the golden line. The golden ratio can be used in different ways. For example, by multiplying one of the sides of a square by the number 1.618, we get a rectangle with harmonic proportions.

Fig 2 Rectangle with harmonic fit

If we continue to use the golden ratio formula on this new rectangle, we will eventually get a diagram with progressively smaller squares like the one below.

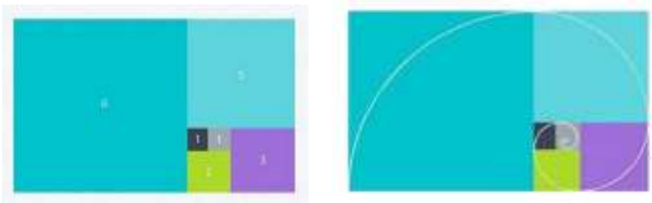


Fig 3 How to form the squares forming the golden spiral

If we draw an arc from one corner to the opposite corner in the golden ratio diagram above, we have drawn the first golden spiral curve or Fibonacci sequence. The Fibonacci sequence is actually a series in which each number is equal to the sum of the two previous numbers. Starting from zero, this sequence is: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, ... by adding an arc to each square, finally to the golden spiral diagram. The attractive feature of the Fibonacci sequence or the golden spiral is that when we divide each of its numbers by the number before it, we reach a number close to 1.618, which is known as the "golden ratio". The Greeks represent this ratio with the letter "phi" and know it as "divine ratio". The Fibonacci pattern, or characteristic description of the golden ratio, can be seen anywhere in the forms of nature, music, and art. One of the mathematical products is the sacred spiral ratio, which is commonly found in nature (Rawles, 1997). In other words, Phi shines in the natural world like bright streaks of an invisible signature from God.

From the summation of the material presented about proportional systems, it can be concluded that the proportional adjustment systems can be examined on two scales in Iran and the world, and it can be concluded that the Iranian-Islamic proportions can be called balanced proportions 2√ And 3√ and 5√ introduced that among these 5√ is introduced under the title of golden ratio and proportions on a global scale include two divisions of golden proportions and human proportions, which renaissance theories are based on golden proportions and the modular system Le Corbusier deals with both the golden ratio and the human ratio, and in general with the golden number Φ, which is equal to (√5+1/2), and it can finally be claimed that all proportional systems with one of the 4 √2 criteria and √3 and √5 and the golden number Φ can be analyzed. Therefore, this result can be seen in the diagram below. In summing up the material presented in this section, it can be claimed that according to the science of geometry and proportions that were expressed and identified in this section, due to the close relationship between these Science exists with nature (5√, golden ratio) and from another point of view, nature has always been praised by humans, so one of the criteria that helps the designer to arouse the viewer's sense of pleasure (meaning the sense of visual pleasure) is to watch an architectural body. It is slow to design.

2. Golden Pentagon:

As mentioned earlier, the number √5 represents the pentagonal geometric shape. Now, a regular pentagon surrounded by a circle is a golden pentagon, which with another pentagon, upside down, makes a regular golden decagon (Ayat Elahi, 1998; Nikghadam, Niloufar, 2012). In a pentagon, the diameters are divided into two proportional parts like a golden line segment (Nikghadam, Niloufar, 2012).

3. Golden Triangle:

As it was said, the 3√ rectangle is called the Platonic rectangle that forms an equilateral triangle (Barratt, 2005). It is divided again into two other golden triangles (Saki, and Pakzad, 2014). In other words, the isosceles triangle in the picture related to the golden pentagon in the picture is the same golden triangle seen in picture 16-2, which can be divided into two other golden triangles.

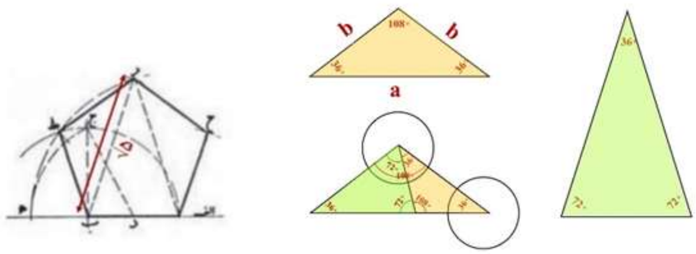


Fig 4 Golden triangle and golden pentagon (Source. Saki, and Pakzad, 2014)

3.2. Renaissance Theories

Pythagoras realized that the sound harmony of the Greek music system can be expressed by the following simple expansion: 1, 2, 3, and 4 and their ratios as 1:2, 1:3, 2:3, and 3:4. This ratio led the Greeks to believe that they had found the key to the mysterious harmony that pervaded the universe. Pythagorean believed that everything is arranged according to numbers. Later, Plato completed the science of calculating Pythagorean numbers as the science of proportion. He squared and cubed this simple numerical expansion to obtain double and triple expansion. According to Plato, these numbers and their ratios not only understood the harmony of sounds in Greek music, but also showed the harmonious structure of the world. Renaissance architects, believing that their buildings should belong to a higher order, referred to the Greek system of mathematical proportions. The Greeks believed that music is geometry translated into sound, Renaissance architects believed that architecture is mathematics translated into spatial units. By applying the Pythagorean theory about the intermediate ratios of intervals in the steps of Greek music, they completed the infinite progression of ratios that formed the basis for the infinite ratios of their architecture. These sets of ratios did not only show themselves in the dimensions of a room or a view, but also appeared in the connected proportions of a string of space or the whole plan (Dick Ching, 1998: 312). As can be seen in the figure below, using the golden ratio and √2, this set of ratios can be seen in the dimensions of a room, facade, and in the interconnected proportions of the space or the whole plan, which Palladio 7 types of the most proportional suggested the rooms in 4 books on architecture (Bemanian et al., 2012: 50). It should be noted that the rectangle is the most common shape in design, which is expressed by the ratio of width to length, for example: 3:2, 5:3, 8:5 and so on (Lasayi, and Mparma, 1984).

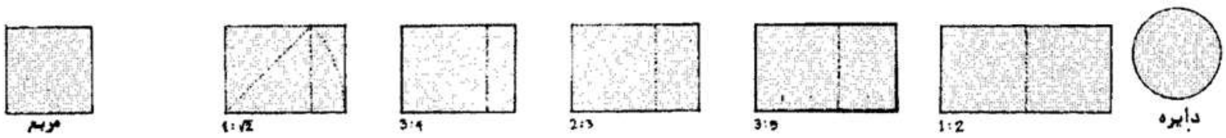


Fig 5 Palladio's theory about seven types of the most appropriate rooms (Mays, 2008)

3.3. Le Corbusier’s Modular System

Le Corbusier considered the measurement tools of Greece and Egypt, which were part of the mathematics of the human body and were the source of harmony governing human life, very rich, for this reason, his measurement tool, the modular system, is based on mathematics (golden ratio and Fibonacci series) and completed the proportions of the human body (functional dimensions of the building). Le Corbusier began his studies in 1942, and in 1948 he published a book called Modular, a Human-Scale Pion of General Application in Architecture and Mechanics. The second volume, Modular 2, was published in 1954 (Dick Ching, 1998: 316). Le Corbusier saw the modular not only as a set of numbers with fixed agreement, but as a system of measurement to which lengths, sides, and volumes were subservient, and which could establish proportion and human scale everywhere. The main grid consisted of three sizes: 43, 70, and 113. (Their ratio was adjusted according to the golden ratio) (Ansari, Okhot, and Taghvaei, 2011:50). Le Corbusier calculated the length of an average human, which was equal to 183 hundred meters, to get his proportions. These ratios are on the one hand: 86, 140, 226 (with raised hand) and on the other hand, 70, 113, 183 (up to the top of the head) (Dick Ching, 1998: 351).

113=70+43 183=70+113 226(113*2) =43+113+70

3.4. Human Proportions

The system of adjusting proportions according to human proportions is based on the dimensions and proportions of the human body. In this system, they use the theory that the form and spaces in architecture include and occupy the human body and therefore should be determined by its dimensions (Dick Ching, 1998: 351). If the size of the middle part of the body to the sole of the foot is considered as one unit, the height of the stature is equal to 1.618, which is the same number as Φ (Kashifpour, 2009). According to the Holy Qur'an, man has within himself all that is reflected in the world "the best proportion". Man is the core of God's creations; He has the most harmonious proportions, reflecting the harmony of the divine (Guenon, 1995). "Indeed, we created man in the best form" (proportion) (Holy Qur'an, Surah 95, Verse 4). Leonardo da Vinci depicted the geometric dimensions of the human body by showing that humans clearly display the dimensions of the golden ratio in their bodies based on the ratio of 1/618. The Vitruvian Man (Fig. 6) painted by Da Vinci based on Vitruvius, who wrote that human dimensions should be related to architecture. Vitruvius believed that if human dimensions could be joined with buildings, they would be complete in their geometry (Guenon, 1995).

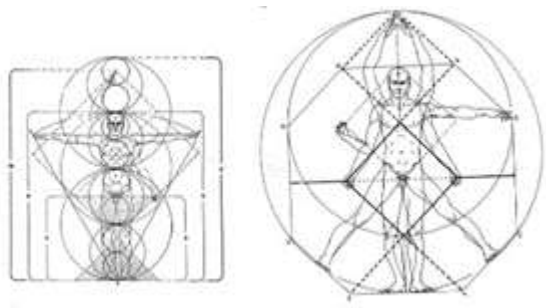


Fig 6 Vitruvian Man (Source, Dabbour, 2012)

According to Robert Lawler; "The human body includes its dimensions in all important geometric geodesic sizes and functions. The dimensions of the ideal human are at the center of a circle of constant cosmic relations" (Lawlor, 1989). Leonardo da Vinci in his famous drawing of the human body from the ratio Golden has benefited. For example, points of the body that have the golden ratio: the ratio of human height to the distance from the navel to the heel, the ratio of the distance from the fingertips to the elbow to the distance from the wrist to the elbow, the ratio of the distance from the shoulder to the top of the head to the size of the head, the ratio of the distance from the navel to the top of the head To the distance from the shoulder to the top of the head, the ratio of the distance from the navel to the knee to the distance from the knee to the heel. From the comparison of Le Corbusier's modular proportional system and human proportions, it can be seen that from dividing Le Corbusier's numbers to each other using the golden ratio of the line segment (BC/AB = AC/BC), that is, 2.52 = 113.70 = 43.70, which is approximately It is equal to $\sqrt{5} = 2.23$, and in the system of human proportions, human height is considered as the golden number Φ, which is equal to $\sqrt{5}+1/2$ or $\Phi = 1.6180339000$.

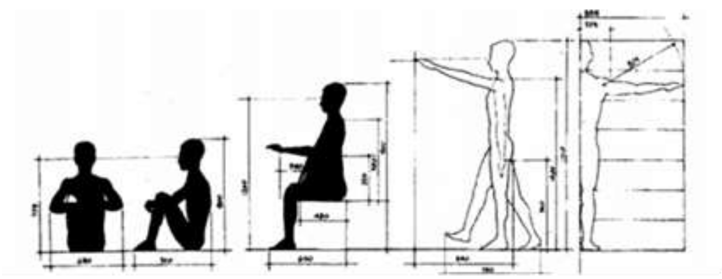


Fig 7 Human proportions and sizes determined by the human body (Neufert, 2018)

From the summary of the material presented in this section, it can be concluded that the unit of measurement of proportions can be divided into four categories of column construction, Ken and

Shako, modular and pimon, which in the column construction method, proportional criteria are based on the diameter of the column and It has different proportions in different ways as mentioned, and in Ken and Shako, it is a single Ken, and the division criterion is based on squares with a diameter of one Ken, used to identify the proportions, and in the modular system, basic and multiple modules are used, and the small pimon and large is also measured based on nodes. Also, it is concluded that the Ken unit is approximately 1.5 times the size of the large pimon.

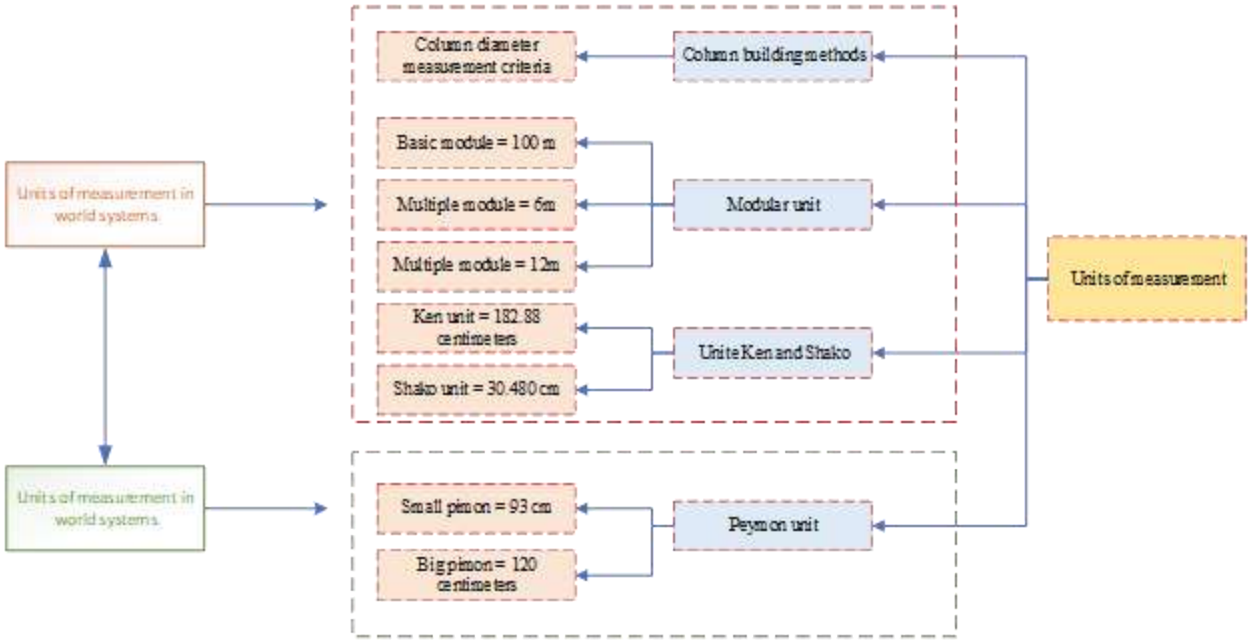


Fig 8 Diagram of measurement systems (author)

4. Research Methodology

The research method of the thesis is of a developmental-applicative type, and with a comparative causal method, it seeks to extract the difference in the intensity of the effect of the factorial contribution of these geometric proportions in the formation of contemporary period tomb monuments. For this purpose, the introduction and definition of geometric proportions are introduced and defined in the theoretical basics section, then a questionnaire with a Likert scale is used for the degree of application of each of the proportions. Random sampling and using Cochran's formula, the sample size in the population was calculated, which was 324 people. The results are entered into the ORIGINPRO2022 software for convenience in numerical and graphic sections. Descriptive and inferential statistics are reported. For validity, the CVR formula is used, the value of which is 0.742 for 20 experts.

5. Study Area

In this research, due to the vastness of the monuments, it is the Delphi system with three phases of brainstorming, limitation and selection. In the selection stage, the panel of experts is asked to rate the introduced buildings. The selected buildings are shown in Table 1.

Table 1 Introduction and explanation of the Kendall coefficient of selected monuments

Building name	Kendall Coefficient	Description	Images
Tomb of Saeb Tabrizi	0.788	Professor Hossein Maarif Isfahani designed the building plan and sent it to Tehran. That plan was completed with the opinion of engineer Mohsen Foroughi, the son of Zakal Molek, and after four years, the building of the tomb was completed in 1346. About seven hundred thousand Tomans were spent for this magnificent building, one eighth of which was donated by the interested people of Isfahan and the rest was paid by the National Association. It was decided that the opening of Makarn tomb will be done with the formation of the Congress of Archeology (May 1347); But it was postponed until the middle of Mehr 1347 without a specific reason	
Tomb of Kamal al-Mulk	0.762	The tomb of Kamal al-Molk is a building in the city of Neyshabur, Iran, which is the burial place of Kamal al-Molk. This building is located near the tomb of Atar Nishaburi in Shadiyah neighborhood. The designer of this monument is Hoshang Sihoun and it was unveiled in a ceremony on April 1, 1963-12 April 1342 in the presence of Farah Pahlavi. The builders of this tomb were some Nishabori workers who were appreciated by the then government at the unveiling ceremony.	

Tomb of Nader Shah	0.786	It is a building in the garden complex of the Naderi Museum in Mashhad, which was designed and built by Hoshang Sihon in 1342 in memory of Nader Shah Afshar. The building of Nader Shah Mausoleum consists of the central part, which is Nader Shah's burial place, and two museum halls, one of which displays the weapons museum of different periods of Iranian history, and the other displays the weapons museum and artifacts related to Nader Shah's era.	
Abu Ali Sina tomb	0.781	The design of the mausoleum was adapted by the engineer Hoshang Sihon in the architectural style of the period and century in which Bu Ali Sina lived, based on the oldest historical Islamic building, Qaboos Dome Tower in the city of Kavus Dome. The National Artifacts Association then collected the rest of the cost by selling stamps and collecting other donations and started building the tomb. On March 22, 1326, at the suggestion of the Ministry of Culture (during the ministry of Dr. Ali Akbar Siasi), the Board of Ministers allowed three hundred thousand lottery tickets to be sold at the price of two tomans each time, for the construction of the tomb, in three occasions with an interval of three months, and two thirds of the income obtained the cost of Abu Ali Sina's millennium celebration and the construction of his mausoleum. The construction of the new cemetery was completed in 1333.	

Ferdowsi Mausoleum of Mashhad	0.706	Ferdowsi tomb has been built and destroyed many times. In the reports made by Iranian and foreign researchers in the last two centuries, a humble building covered with wheat fields has been seen. Finally, at the beginning of the 14th solar century and at the same time as Iran's new nationalism, efforts were resumed to build a tomb worthy of Ferdowsi. The current area of the tomb complex is nearly six hectares and includes the tomb garden, a pool and a statue of Ferdowsi by Abolhasan Sediqi in front of it, a monument, office buildings, a library, a museum, the tomb of Mahdi Akhwan the Third and the tomb of Mohammad Reza Shajarian. The interior architecture of the building also includes tiling, prominent stone motifs from Shahnameh stories and stone inscriptions from Ferdowsi's poems and others.	

In this research, it was found that the most valuable monuments in the monuments are related to the tomb monuments. that examining the geometry and proportions of Hessian in its components and in its general plan can be helpful.

6. Research Findings

6.1. Descriptive Statistics

According to the results obtained from the descriptive statistics, 239 people (73.76%) of the sample are men and 85 people (26.24%) are women in the age group of 20-30, 30-40, 40-50, 50-60. have been years The working method is such that a question is formulated and provided to spatial users for the effect of each geometrical proportion. Each question has an answer between 1 and 5 (very little to very much). The sum of the scores of indicators of a component means the score given by each person to the desired quality, so the score that can be obtained for each quality is between 1 and 5. The results of descriptive statistics and data distribution show that the highest frequency is related to the radical ratio with a value of 1916 in the components in Bu Ali Sina tomb, and the highest frequency is related to radical ratios with a frequency of 1901 in the Bu Ali Sina tomb. The lowest amount of use of Ken and Shako proportions in components with a value of 324 is in Bo Ali Sina's tomb and the lowest in the overall design is related to Ferdowsi's tomb. The largest range of changes is related to general plans and the least is related to components. The most attention in the application method is related to radical correlation and golden ratio, and the lowest range is related to basic rand coefficients. The support of the moving average of the data distribution shows the high accuracy of the tool and the correct measurement of proportions.

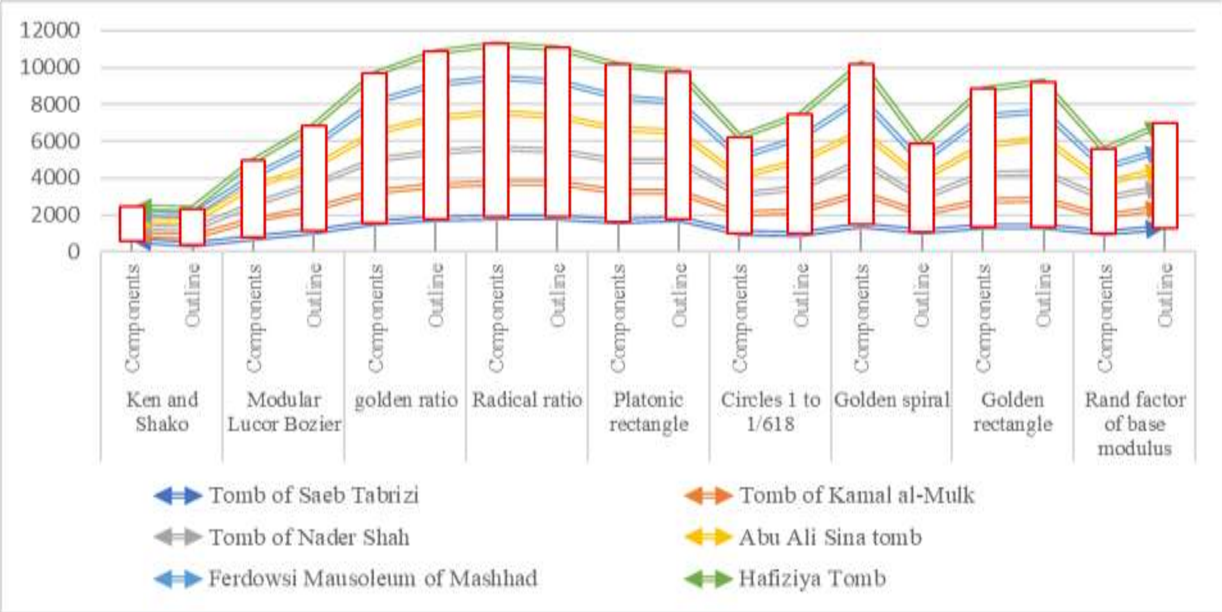


Fig 9 Distribution of the use of geometric proportions in tomb monuments

6.2. Inferential

Pearson Correlation

At this stage, after extracting the selected geometric proportions with the Delphi method, a questionnaire is compiled and randomly distributed among space users, architects and experts. It should be noted that the relevant documents from the monument are shown to the people filling the questionnaire. The results are entered into the ORIGINPRO software, predictive relationships (regression) and correlation relationships are used for analysis. Two-Sample Kolmogorov-Smirnov Test is used to check the parametric and non-parametric type of data.

Table 2 Kolmogorov-Smirnov test to check the normality of the variables of proportions in tomb monuments.

Variable	Average	Standard deviation	Z Kolmogorov Smirnov	p
Geometric proportions	28.21	5.5	0.708	0.004

As can be seen in the above table, the Kolmogorov-Smirnov test is significant for the score of geometric proportions (p=0.004) and therefore their internal and external output has a normal distribution and parametric analysis should be used for it.

Table 3 Pearson's correlation of types of geometric ratios to each other

		Ken and Shako		Modular Lucor Bozier		golden ratio		Radical ratio		Platonic rectangle		Circles 1 to 1/618		Golden spiral		Golden rectangle		Rand factor of base modulu	
		X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2
Ken and Shako	X_1	1																	
	X_2	0.362	1																
Modular Lucor Bozier	X_1	0.372	0.424	1				$X_{1=}$ Components											
	X_2	0.872	0.423	0.781	1						$X_{2=}$ Outline								
golden ratio	X_1	0.685	0.454	0.732	0.411	1													
	X_2	0.597	0.341	0.662	0.421	0.741	1												
Radical ratio	X_1	0.436	0.578	0.748	0.789	0.923	0.831	1											
	X_2	0.852	0.514	0.864	0.521	0.929	0.124	0.741	1										
Platonic rectangle	X_1	0.665	0.542	0.662	0.542	0.685	0.311	0.429	0.872	1									
	X_2	0.213	0.541	0.652	0.545	0.621	0.325	0.623	0.685	0.424	1								
Circles 1 to 1/618	X_1	0.425	0.654	0.665	0.411	0.652	0.425	0.685	0.597	0.423	0.424	1							
	X_2	0.414	0.221	0.483	0.309	0.612	0.223	0.621	0.436	0.454	0.423	0.714	1						
Golden spiral	X_1	0.101	0.121	0.464	0.517	0.381	0.529	0.652	0.852	0.521	0.454	0.883	0.755	1					
	X_2	0.421	0.522	0.452	0.517	0.484	0.679	0.612	0.665	0.542	0.521	0.619	0.842	0.235	1				
Golden rectangle	X_1	0.615	0.524	0.463	0.607	0.464	0.628	0.381	0.213	0.545	0.542	0.836	0.518	0.211	0.716	1			
	X_2	0.762	0.619	0.472	0.619	0.421	0.542	0.484	0.425	0.411	0.545	0.920	0.345	0.744	0.985	0.162	1		
Rand factor of base modulus	X_1	0.372	0.162	0.661	0.562	0.741	0.574	0.464	0.414	0.309	0.411	0.654	0.583	0.821	0.326	0.902	0.919	1	
	X_2	0.872	0.902	0.452	0.823	0.429	0.456	0.372	0.421	0.517	0.309	0.625	0.919	0.947	0.218	0.532	0.765	0.162	1

The results show that there are correlations, both in the form of a general plan and in the form of components, between all types of proportions in tomb monuments, and almost all of their values are positive. The highest amount is related to Radical ratios with other ratios, the highest of which is between the Radical ratio with the value (0.929) and the Golden ratio and in general between the Golden ratio with the Radical ratio with the value (0.923) and the lowest is related to the ratio Zarin is with Ken and Shako in components with the value of (0.121) and (0.101) in components.

Multivariate Regression and Factor Share Growth Chart

To use the type of linear or multivariate regression, the internal correlation matrix diagram of the variables is used. After drawing the correlation matrix diagram, it was determined that the factors have no linear relationship, so it is correct to use multivariate regression.

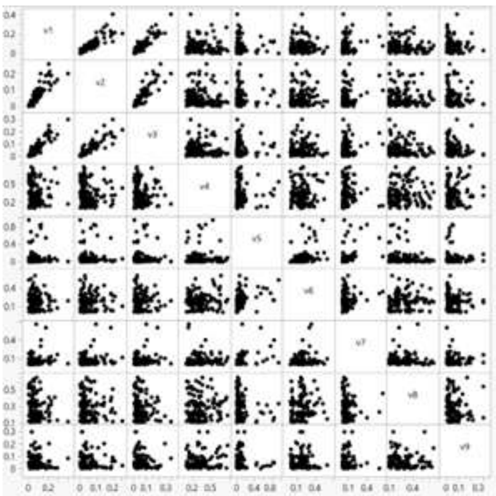


Fig 10 Correlation distribution matrix diagram among types of proportions

At this stage, after extracting all kinds of geometric proportions, the monuments are evaluated. The results show that the largest factor contribution in the application of geometric proportions in the components and overall design is related to radical ratios with a value of (1.000) for the components and (0.905) for the overall design, and the lowest is related to Ken and Shako with a value of (0.167) for components and (0.195) for the overall plan. The important point is that the platonic rectangle with the value of (0.915) for the components and (0.914) for the general plan has a high factor share, but due to the lack of significance for both parts, the results of attention to it are not reliable.

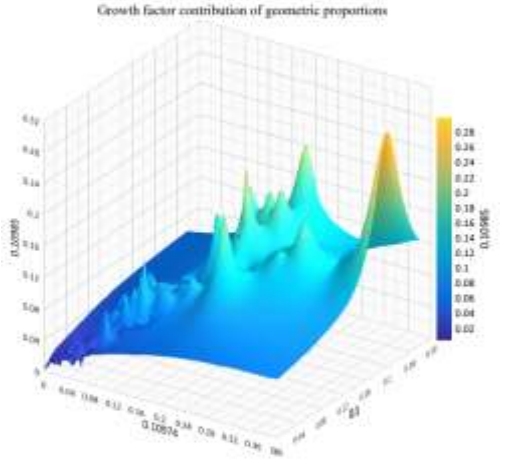
Table 4 Multivariate regression of geometric proportions in tomb monuments

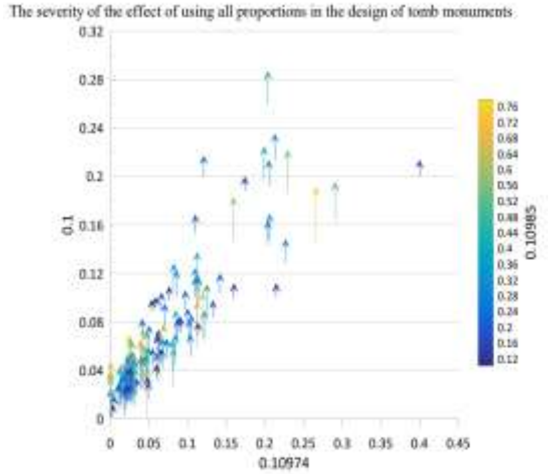
		Coefficient of determination	F	β	t	(p-Value)	Degrees of freedom
Ken and Shako	Components	0.167	217/314	0.762	451/39	0.001	383
	Outline	0.195	147/523	0.372	328/44	0.002	383
Modular Lucor Bozier	Components	0.653	381/852	0.872	823/36	0.003	383
	Outline	0.680	921/298	0.685	362/39	0.004	383
golden ratio	Components	0.612	257/247	0.597	958/18	0.008	383
	Outline	0.656	321/644	0.436	644/16	0.009	383
Radical ratio	Components	1.000	523/845	0.852	422/21	0.001	383
	Outline	0.905	254/754	0.665	144/19	0.001	383
Platonic rectangle	Components	0.915	541/124	0.213	231/39	0.641	383
	Outline	0.914	241/232	0.425	914/29	0.591	383
Circles 1 to 1/618	Components	0.411	321/201	0.414	221/24	0.011	383
	Outline	0.323	124/443	0.421	248/48	0.021	383
Golden spiral	Components	0.712	134/522	0.421	288/25	0.009	383
	Outline	0.621	265/229	0.615	254/65	0.016	383
Golden rectangle	Components	0.421	412/323	0.424	517/49	0.021	383
	Outline	0.246	211/441	0.423	326/25	0.011	383
Rand factor of base modulus	Components	0.821	541/321	0.454	351/58	0.022	383
	Outline	0.285	991/621	0.341	324/29	0.011	383

In the next step, the factorial growth chart is used for the efficiency of the ratios and to compare the minimum and maximum of the ratios and to determine the accumulation of coefficients for determining the answer letter. The results show that the tendency to use proportions in selected buildings has increased based on cases. The usage trend is increasing, also the distribution of the factor share is close to the average and most of the data follow the fashion. Also, the following diagrams emphasize that there are many parts of these buildings that do not use certain proportions. Therefore, they have a low range and its cumulative percentage is higher in this range.

Table 5 Growth chart of the application of geometric proportions in tomb monuments

Chart of growth and accumulation of factor share





In the next step, PN modeling is used to improve and increase the contribution of each proportion in creating beauty through design. In this step, the responses of users and designers are collected together, and the results are extracted from the numerical average between these two groups and entered into the modeling. The results indicate that if proportions are used together as follows, their effectiveness can be improved to a high extent in order to achieve beauty;

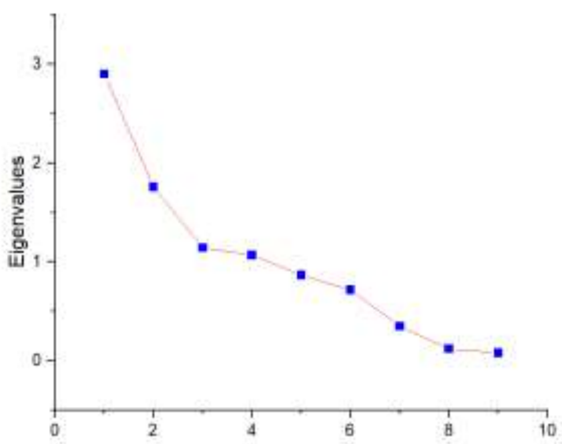
1- Radical coefficients, golden rectangle, golden ratio

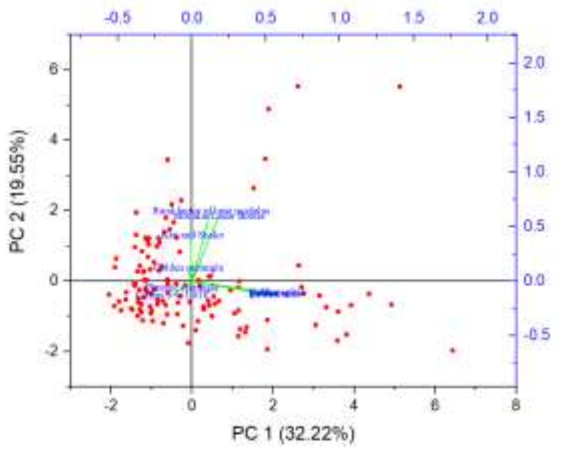
2- Base modulus coefficient, Ken and Shako

3- Circles 1 to 618/1, Platonic rectangle, golden curve

Also, in PN modeling, it is clear that the radical coefficients and the golden ratio have a greater contribution to the responses individually, and these two are used with a large difference compared to other ratios.

Table 6 PN modeling of geometric proportions used in tomb monuments





7. Discussions

Based on the results obtained from the analysis of the geometric proportions of the selected buildings, it is clear that native proportions such as radical ratios and nominal numbers are more popular among architects for use in tomb monuments, both in components and in Lee's design. Also, the number of proportions used both in the components and in the overall design is the same, but this value is different in the golden curve. The important point in Pearson's correlation is the positive and significant relationship of proportions both in the components and in the overall plan, but this value is different in the golden curve. The important point in Pearson's correlation is the positive and meaningful relationship between the proportions, both in the components and in the overall plan, that the application of one item promotes the other and there is no inverse relationship at this stage. Also, Iranian proportions have more correlation with each other than international geometric proportions. One of the reasons that can increase the factor share of radical ratios in ratios is the existence of three types of ratios including radical 3, radical 2 and radical 5. It seems that Ken and Sheko have been used very little, and by evaluating them in some parts, it overlaps with other proportions, but the Platonic rectangle has a high and insignificant relationship, which indicates the involvement of conditions or other variables. Based on the growth chart, it can be understood that various proportions have been used in these monuments, which do not have a place in any of the known proportions, and for this reason, the application of proportions is low compared to the total proportions, but the desire to use proportions It is incremental. It is also better to use the mentioned triple compounds to achieve a better proportional composition.

8. Conclusion

Mausoleum buildings are among the most common after mosques. The architecture of contemporary tombs in Iran has a special place. The architects of these buildings, by approaching modern architecture and authenticating ancient Iranian architecture in the design of these buildings, have created valuable works that can be studied and examined in different dimensions. The majority of contemporary tomb buildings were created with the activities of the National Artifacts Association. One of the ways to communicate between native architecture and monuments is to use geometric proportions in the body. The buildings of Yamani, a contemporary tomb, with a combination of materials and looking at the concepts of modern architecture, try to revive the tradition by dealing with physical indicators. This research showed that although some universal geometries are used in these buildings, but these buildings are often They have applied Iranian geometries to revive Iranian culture and identity. This research showed that the application of geometric proportions in the components is much more important than the overall design, and to achieve the desired result, they should be used together in the mentioned manner.

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