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Study on the Anthropometric Data of Ergonomic On Existing Minbar Designs at Johor's Mosques

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Abstract: The minbar, which is located in the prayer hall, is one of the most prominent mosque features. Minbar is available in a variety of heights, widths, and lengths. The relation between the minbar and the volume of the prayer hall is frequently overlooked, lowering the visual aesthetics value of the interior space. The golden ratio is the gold standard in interior design when it comes to design choices and is crucial in creating the optimal product design. The effective usage of this ratio is widely thought to be an effective approach to develop amazing design. As a result, the aim of this study is to learn how to apply the Golden Ratio concept to the minbar applying mathematical ratios to represent aesthetic value and internal proportion. Future engineers and architects should be more aware of the ergonomic aspect in the design of the minbar that provide the user with comfort and safety. This study used a golden spiral template made with AutoCAD software to find the best height of the existing minbar design that is adequate for the length of the prayer hall and to calculate the appropriate ratio of anthropometric factors. The ratio is produced when a/b equals a+b/a, resulting in both equaling 1.618. Apart from that, the visual angle of congregation analysed to the mosque that implemented the ergonomic in the design of minbar. As a case study, ten existing minbars were chosen from mosques in the state of Johor. The study's findings focused on reading the width, height, and depth measurements on the minbar's front elevation. In comparison to the other ten pieces, a percentage of 30% (3 minbar) met the best proportion. As there is no tangling of lines between golden ratio influencing items on a high platform floor, width and height, the 70% pulpit does not match the correct proportions. In the pulpit design process, the golden ratio contributes in the creation of beauty and harmony. Besides, for the visual angles shows that only 10% (1 minbar) that almost achieved the comfort level of visual angle at the first saf with 32°. In light of the influence, the proportion of mathematics linked with user convenience and aesthetic appeal. The elegant and impeccable design contributes to a safe and comfortable minbar features.

Keywords: Golden Ratio, Minbar, Proportion, Ergonomics

1. Introduction

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Malaysia has more than 60,000 mosques established. A mosque is a sacred place for Muslims. From the outlook of a linguistic, Masjid refers to a place of worship. Many mosques in Malaysia are built with unique features and attractive designs which implement the Islamic characteristic. Nevertheless, does the mosque build fulfil the requirements and the human needs? Muslims obliged the men to visit the mosque every Friday to listen to the khutba' before perform the Friday prayer. Thus, since the khutba' takes a long time around 20 minutes, listening to the khutba' required the comfort position for congregations. The situation is the position of the minbar somehow too low or too high, thus the congregations need to head up while listening to the khutba'. The congregations experienced uncomfortable condition such as back pain, neck pain or fatigue that can affect their attention .

Somehow, apart from the ergonomic aspect design, the geometrical design of minbar should be aware of the design of the building or product. The anthropometrics data on ergonomics of existing minbars form should be mindful of the aspect. By applying the principles of proportion and geometry in the system of design, the product to be created can achieve human demands, which will meet the aesthetic value, high standard, and fulfil the criteria for a good design. This study aims to investigate the geometrical shapes of existing minbar designs at Johor's Mosques.

1.1 Minbar

Minbar is located at the front of the praying hall used by Khatib preaching the khutba'. The height of the minbar floor usually is in the range of one to three meters above the mosque floor to allow imam to see the congregations [1]. Figure 1 shows that the congregations listen to Friday speech and perform the daily individual or group prayers. Hence, the architect and designer should focus on minbar design by considering the specification and the material used. Minbar design should impact Khatib who used it and the other user of the mosque because they have to head up while Khatib preaching. So, the determination of geometrical shape, appropriate design size, and the minbar's suitability to be placed at the particular mosque must be taken as a serious consideration.

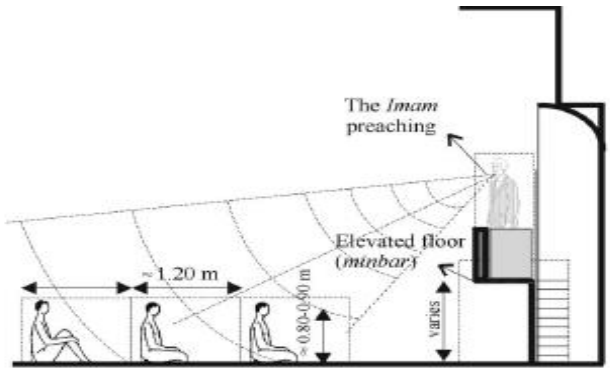

Figure 1: Congregations are listening to Friday speech

1.2 Golden Ratio

The function of mathematical geometry is to analyze paintings (figurative and abstract) and for architecture is in terms of shapes, for example, lines, points, circles, cube etc. The Golden Ratio is an irrational number that equivalent to 1.618, which is the symbol known as phi (ϕ) represented by the Greek symbol. The digit after the decimal in the Golden ratio just keep going on and never end as such 1.61803398874989484820 ... … [2]. In addition, the idea behind the Golden ratio is a unique ratio described by dividing a line into parts where the whole length will divide by the long part to produce the ratio of the long part and short part as shown in Figure 2.

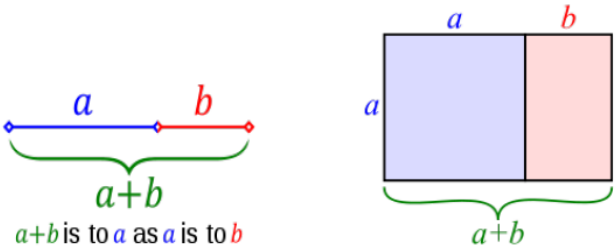

Figure 2: Golden Ratio

1.3 Application of Golden Ratio

Most designers and architects have used the concept of the golden section as the main principle of proportions in their work. The concept was also used by designer Charles Eames in his famous and known Plywood Chair design [3]. The back of the chair fits perfectly on the golden rectangle as shown in Figure 3.

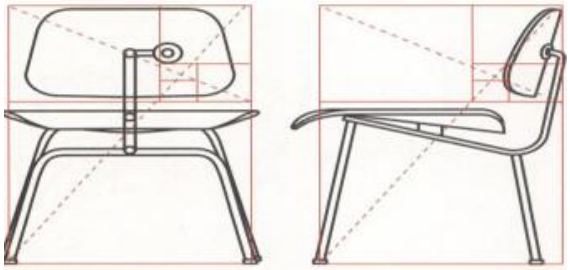

Figure 3: Plywood Chair by Charles Eames

1.4 Geometry for Strength

Birgi grand mosque was built in 1312 by Karamanoglu Mehmet. However, the minbar constructed in 1322 after 10 years [4]. The minbar of the mosque was made from walnut timber and with kundekari technique. Besides, the side panels of minbar construct with different geometrical shapes such as rectangles, triangles, pentagons, octagons and 10 sleeves star as shown in Figure 4.

Figure 4: Minbar of the mosque

2. Methodology

The selection of locations were an influential part of the research.There are ten (10) selected mosques around Johor area in this research. All the mosques that have been selected have a differences in the design of drawing layout and minbar design. The mosques that selected are, Masjid Teluk Belangah, Johor Bahru-Singapura **(MTB)**, Masjid Sultan Abu Bakar, Johor Bahru **(MSAB)**, Masjid Taman Pasir Pelangi, Johor Bahru **(MTPP)**, Masjid Kampung Melayu Majidee, Johor Bahru **(MKMM)**, Masjid Kota Iskandar, Nusajaya, Johor Bahru **(MKI)**, Masjid Sultan Ibrahim, Muar **(MSIM)**, Masjid Sultan Ibrahim, Ayer Hitam, Batu Pahat **(MSIBP)**, Masjid Sultan Ismail, Jalan Bakau

Condong, Batu Pahat **(MSISBP)**, Masjid Bandar Pontian, Pontian **(MBP)** and Masjid Temenggong Daeng Abd Rahman, Pontian **(MTDAR)**.

2.1 Measurement

The measurement method is an important part of the fieldwork. These measurement can be obtained for the research work incline the length and height of the minbar design and the praying area. Besides that, the measurement work was carried out at every selected mosque around the Johor area. Figure 3.4 shows the illustration obtained from the literature review that shows the elevation between the congregation and the minbar during the khutba'.

The distance between safs as shown in the previous study in Figure 5 is 1.20 m and it is a really important parameter. Furthermore, the height of the minbar platform should not be neglected where the preacher needs to stand to deliver the khutba' is also taken and recorded. The important parameter involved in the measurement work is the height of the congregation in standing and sitting position.

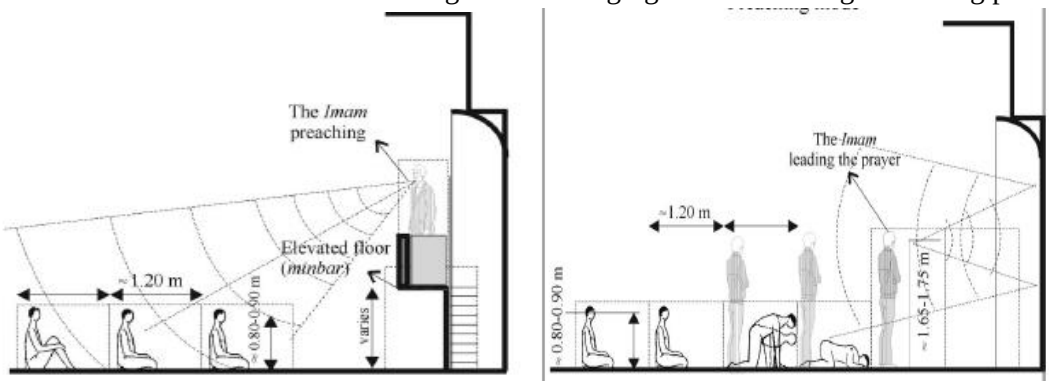

Figure 5: Congregations are listening to Friday speech and another one a performing the daily individual or group prayers

2.2 Golden Spiral Template

A template of the golden spiral is based on the concept of Fibonacci Numbers[3]. The minbar design was fitted into this template to determine its suitable balance, aesthetic relationship between the minbar's height and width, and its geometrical shape to get the appropriate size of the minbar based on its scale.

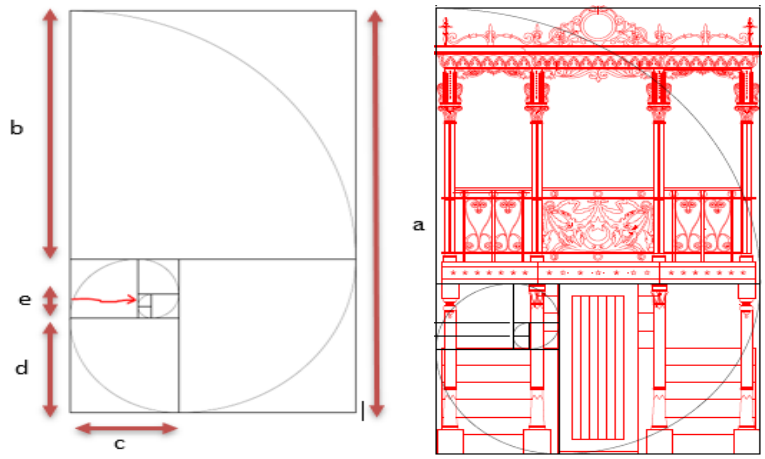

Figure 6: Golden Spiral Template

2.3 Data analysis

The first analysis involves the calculation of the data obtained from the measurement that has been done by using the laser distance meter. The measurement data such as the height of the minbar, distance of the congregation from the minbar are calculated to determine the visual angle faced by the congregation during listening to the khutba and also the geometrical shape design of the minbar by using the golden spiral template. Besides that, the results of the analysis were compared to the comfortable posture of the human body which is already explained in the literature review. All the data were performed in figures derived from the AutoCAD software.

3. Results and Discussion

This study analyses the altitude of minbar height and visual distance of congregations during the khutba'. In addition, this study uses a golden spiral template to determine the appropriate size of the minbar on the selected mosque. Aside from that, the results were obtained using AutoCAD software and are presented in table form.

3.1 Analysis of Size on Minbar Throughout Anthropometric Data

A golden spiral template was included in the design of each pulpit to get the right size for the pulpit. The results of this study shown in Table 1 are the actual measurements of the minbar for the selected mosques. Meanwhile, Table 2 shows the appropriate size of minbar by using the golden spiral template.

Table 1: Actual Size of Minbar According to Selected Mosque

No.	Mosque Name	Actual Size of Minbar (inch)				
		Minbar Height (a)	Height of minbar platform to top (b)	Height of minbar platform to botttom (c)	Width of minbar platform (d)	Width of minbar (e)
1	MTB	130.88	78.49	52.38	38.85	75.5
2	MSAB	213.05	116.83	96.22	87.61	87.61
3	MTPP	210.9	121.59	89.32	101.13	101.13
4	MKMM	202.46	158.71	43.75	78.75	78.75
5	MKI	299.21	184.21	115	100.97	202.04
6	MSIM	235.29	137.79	97.5	138.75	138.75
7	MSIBP	217.5	117.5	100	67.5	130
8	MSISBP	232.21	154.56	77.64	48.75	285
9	MBP	201.85	109.16	92.69	64.06	78.44
10	MTDAR	222.79	126.54	96.25	75	113.75

Table 2: Appropriate size of minbar by using golden spiral template

No.	Mosque Name	Appropriate Size of Minbar (inch)				
		Minbar Height (a)	Height of Minbar Platform (b)	Width of Minbar Staircase (c)	Height of Minbar Staircase (d)	Height of Staircase Riser (e)
1	MTB	124.17	76.67	29.22	29.22	3.65
2	MSAB	203.28	125.49	47.81	47.81	5.99
3	MTPP	203.18	125.5	47.81	47.81	5.96
4	MKMM	203.2	125.49	47.81	47.81	5.96
5	MKI	293.49	181.28	69.06	69.06	8.64
6	MSIM	225.76	139.45	53.12	53.12	6.63
7	MSIBP	214.47	132.48	50.47	50.47	6.32
8	MSISBP	237.05	146.37	55.78	55.78	6.97
9	MBP	203.18	125.5	47.81	47.81	5.98
10	MTDAR	203.2	125.5	47.81	47.81	5.97

In comparison to the other ten pieces, a percentage of 30% (3 minbar) met the best proportion. As there is no tangling of lines between golden ratio influencing items on a high platform floor, width and height, the 70% pulpit does not match the correct proportions. According to the golden ratio concept by [2]the calculation below has proven that the appropriate size of minbar has been fulfilled the golden ratio concept.

Table 3: Golden Ratio concept value based on appropriate size of minbar

No.	Mosque Name	Minbar Height (inch) (a)	Height of Minbar Platform (inch) (b)	$\frac{\mathbf{a}}{\mathbf{b}} = \frac{\mathbf{a+b}}{\mathbf{a}}$
1	MTB	124.18	76.67	1.618
2	MSAB	203.29	125.49	1.618
3	MTPP	203.18	125.5	1.618
4	MKMM	203.2	125.49	1.618
5	MKI	293.49	181.28	1.618
6	MSIM	225.76	139.45	1.618
7	MSIBP	214.47	132.48	1.618
8	MSISBP	237.05	146.37	1.618
9	MBP	203.18	125.5	1.618
10	MTDAR	203.2	125.5	1.618

3.2 Analysis of Visual Angle of Congregation At The Selected Mosques

The measurement work was done on each saf, and the number of saf varies by the mosque. Furthermore, analysing this study must emphasise several factors such as standing human height, sitting human height, and distance between safs. Besides, the platform height of the minbar was one of the significant factors that served as a point for the preacher to stand when delivering the khutba'.

This study's findings decrease or reduce the visual angle among the congregation when the number of safs increased. This scenario always happen for the congregation is in the back row. They should look at the minbar at a lower point of view than the congregation in the front row during the sermon's session. Moreover, its clearly defined that the height of the minbar (small) platform is influenced by the number of rows or the distance between the rows and the minbar.

The visual angle at the same saf was different for each mosque due to the different distance from minbar to saf as shown in Table 4. The distance between safs, however, was the same for each mosque, which was 60 inches (1.5m). According to the study's findings, the visual angle of the congregation at Masjid Kampung Melayu Majidee, Johor Bahru (MKMM) was the most comfortable where the congregation should lookup at a low angle which was maximum angle of 32˚ at the front saf with the total 27 saf in the praying hall.

Table 4: Measurement Data In Prayer Hall At The Selected Mosques

Mosque	Distance of Front Saf To Minbar (inch)	Distance Between Saf (inch)	Number of Saf
MTB	36.13	60	26
MSAB	186.92	60	29
MTPP	56.81	60	18
MKMM	124.14	60	27
MKI	24.8	60	25
MSIM	94.27	60	25
MSIBP	152.32	60	25
MSISBP	125.41	60	34
MBP	90	60	42
MTDAR	48.13	60	25

Table 5: Visual Angle of Congregation According to the Saf Number and Selected Mosque

Saf No.	Visual Angle of Congregation, Θ									
	MTB	MSAB	MTPP	MKMM	MKI	MSIM	MSIBP	MSISBP	MBP	MTDAR
1	67°	35°	65°	32°	81°	54°	41°	42°	55°	69°
2	42°	28°	46°	23°	60°	40°	32°	31°	40°	49°
3	29°	23°	35°	18°	46°	31°	26°	24°	31°	37°
4	17°	19°	27°	14°	36°	26°	22°	20°	25°	29°
5	14°	17°	22°	12°	29°	21°	19°	17°	21°	24°
6	12°	15°	19°	10°	25°	18°	16°	15°	18°	20°
7	11°	13°	16°	9°	21°	16°	15°	13°	16°	17°
8	10°	12°	14°	8°	18°	14°	13°	12°	14°	15°
9	8°	11°	13°	7°	16°	13°	12°	10°	13°	13°
10	8°	10°	12°	7°	15°	12°	11°	10°	11°	12°
11	7°	9°	11°	6°	13°	11°	10°	9°	10°	11°
12	6°	9°	10°	6°	12°	10°	9°	8°	10°	10°
13	6°	8°	9°	5°	11°	9°	9°	8°	9°	9°

14	6°	8°	8°	5°	10°	9°	8°	7°	8°	9°
15	6°	7°	9°	5°	10°	8°	8°	7°	8°	8°
16	5°	7°	7°	4°	9°	8°	7°	6°	7°	8°
17	5°	6°	7°	4°	9°	7°	7°	6°	7°	7°
18	5°	6°	7°	4°	8°	7°	7°	6°	7°	7°
19	4°	6°		4°	8°	6°	6°	5°	6°	6°
20	4°	6°		4°	7°	6°	6°	5°	6°	6°
21	4°	5°		3°	7°	6°	6°	5°	6°	6°
22	4°	5°		3°	7°	6°	5°	5°	5°	5°
23	4°	5°		3°	6°	5°	5°	4°	5°	5°
24	3°	5°		3°	6°	5°	5°	4°	5°	5°
25	3°	5°		3°	6°	5°	5°	4°	5°	5°
26	3°	4°		3°				4°	5°	
27		4°		3°				4°	4°	
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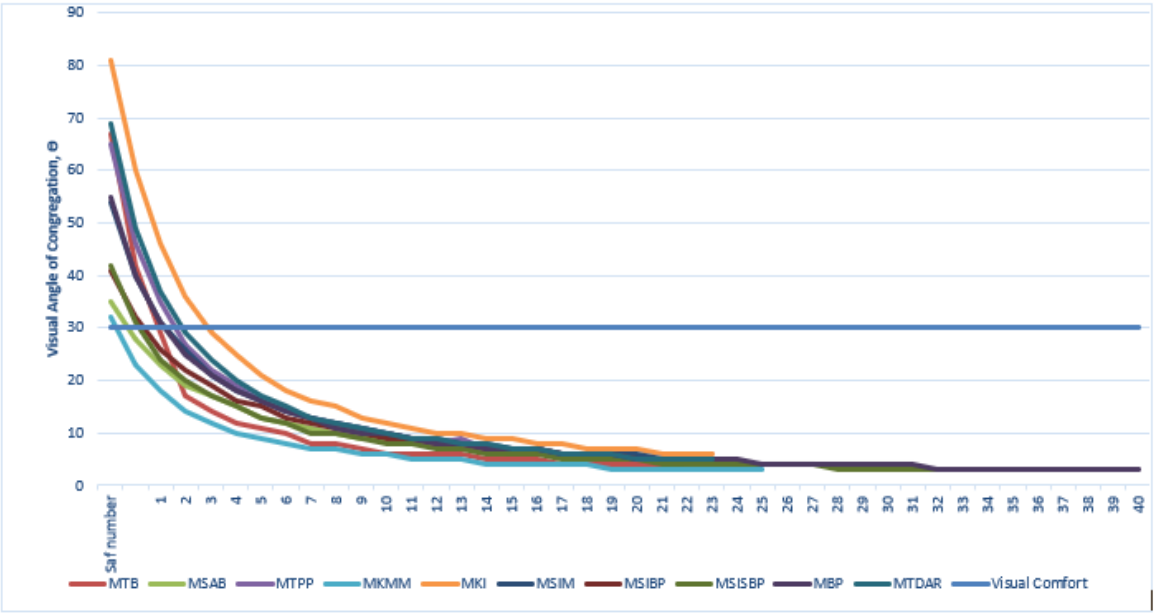

Figure 7: Graph of Visual Angle of Congregation According to the Saf Number and Selected Mosque

The graph above also shows the visual comfort achieved by the congregation at each mosque on different saf. This is because the height of the minbar platform was different for each mosque. The Figure 7, on the first saf of MKMM mosque shows that the visual angle at the first saf (1st saf) almost achieve 32° visual comfort. On the other hand, the congregation at MSAB achieved visual comfort with 29° on the second saf (2nd saf) while MTB on the third saf (3rd saf). Besides, MTDAR mosque achieved a level of visual comfort at the fourth saf (4th saf) and MKI achieved the visual comfort at the fifth saf (5th saf). The result shows that the first row (saf) until the fifth row at the all selected mosque almost and were achieved the visual comfort.

As shown in the graph above, only one mosque meets the comfort criteria with the visual angle at less than 30 degrees ($\leq 30^{\circ}$), MSAB at the second saf (2rd saf) with 28°. This mosque has a total number of 29 safs. Other than that, the largest visual angle faced by the congregation was 35 degrees (35˚) on the first saf (1st saf) while the smallest visual angle was 4 degrees (4˚) on the 29th saf. Besides, comfort level of the congregation at this mosque due to one of the highest distance from the first saf towards the minbar with 186.92 inches.

4. Conclusion

Architects nowadays are more concerned with the shape of a design than with aesthetic values achieved through proportion. This is due to the desire to achieve a perfect or idealised result as well as design balance. However, this study demonstrated that proportions can also be used in minbar design. The minbar sizes based on the golden spiral template were nearly identical to the actual sizes for each mosque.

However, some minbars in specific mosques produce results that are very similar to or nearly identical to the golden spiral analysis. These minbar were located at MTB, MSIM, and MSISBP. The minbar design at these mosques shows the perfection in minbar design where the width and the height of the minbar were almost the same for both measurements as the golden spiral template was fitted in minbar design.

According to the first objective of this study,the ergonomics features were determined and proven by the congregation through the visual angle. The visual angle was calculated using the congregation's position sitting on the saf in each mosque while listening to the khutba'. This study demonstrates the differences in visual angle among the congregation, which depended on the saf number seated by the congregation. It is possible to conclude that as the number of saf in the prayer hall increased, the less visual angle faced by the congregation.

However, visual angles shows that only 10% (1 minbar) that almost achieved the comfort level of visual angle at the first saf with 32°. Meanwhile,the visual angle for the congregation at the selected mosques, the highest visual angle faced by the congregation at the front saf is the MKI mosque with 81°. This is because the distance between the front saf towards the minbar has a nearest distance than the other selected mosques with 24.8 inch. The effect of the visual angle of the congregation above 30° can cause back pain, fatigue, and other related issues.

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References

[1] A. A. Abdou, "Measurement of acoustical characteristics of mosques in Saudi Arabia," *J. Acoust. Soc. Am.*, vol. 113, no. 3, pp. 1505–1517, 2003, doi: 10.1121/1.1531982.

[2] G. B. Thapa and R. Thapa, "The Relation of Golden Ratio, Mathematics and Aesthetics," *J. Inst. Eng.*, vol. 14, no. 1, pp. 188–199, 2018, doi: 10.3126/jie.v14i1.20084.

[3] T. O. Omotehinwa, "Fibonacci Numbers and Golden Ratio in Mathematics and Science," *Int. J. Comput. Inf. Technol.*, vol. 2, no. 4, pp. 630–638, 2013, [Online]. Available: https://www.researchgate.net/publication/334015286_Fibonacci_Numbers_and_Golden_Ratio_in_Mathematics_and_Science.

[4] A. Kasal, Y. Z. Erdil, M. Acar, H. Centered, and P. Engineering, "A review of basic interior design elements in mosques," January 2019, 2014.