



STUDYING THE HUMAN SCALE AND PROPORTIONALITY OF GREAT MOSQUE IN JAWA TIMUR, INDONESIA

Received August 24th, 2022 | Accepted May 4th, 2023 | Available online June 20th, 2023 |
DOI <http://dx.doi.org/10.18860/jia.v7i3.17382> |

Hamam Rofiqi Agustapraja

Universitas Islam Lamongan
Indonesia
e-mail: hammamrofiqi@unisla.ac.id
University Tun Hussein Onn
Parit Raja, Malaysia

Corresponding Author:

gf210084@siswa.uthm.edu.my

Izudinshah Bin Abd Wahab

University Tun Hussein Onn
Parit Raja, Malaysia
Izudin@uthm.edu.my

ABSTRACT

The proportion and scale of humans in the building are one of the invoices in shaping the beauty and effectiveness of the function of the building. In architecture, there is a golden ratio as a reference for calculating the proportions of a shape. While in Indonesia, especially in Java and Bali, there is a traditional measurement method for developing a building, using body anatomy measurements. This study uses the Golden Ratio and Traditional Measurement methods to analyze the dimensions of the prayer room at the Great Mosque in East Java with case studies of the Lamongan Great Mosque, Tuban Great Mosque, and Gresik Jamee Mosque. The results obtained from this study for the dimensions of the existing prayer room with the largest percentage approaching the golden ratio are the prayer room of the Great Mosque of Lamongan (82%) and the smallest is the Jami Gresik Mosque (61.8%). While the dimensions of the prayer room need adjustments to be more effective in meeting the human scale in performing prayers, traditional measurement methods that approach modern measurements use "kilan" and "hasta." From these results, it is hoped that in the future, mosque planning can pay attention to the proportions and dimensions of the human scale, both with modern and traditional measurements, which are the local wisdom of the local culture.

KEYWORDS:

Proportion, Human scale, Great Mosque of East Java, Golden Ratio, Traditional Measurement.

INTRODUCTION

In architecture, the size of a building is very important, especially related to the proportion of humans as residents and users of the building [1]. Humans instinctively follow and imitate the natural surroundings as a reference in developing a building. The proportion of good and correct sizes in buildings is important for comfort in carrying out activities [2]. A good proportion may also enhance the beauty of the facade in terms of building visualization [3].

The theory about the size of a building can be referred to as the Golden Ratio, which was applied to classical buildings during the Renaissance era and is very much related to ergonomics [4] and anthropometry [5] of the perpetrators of these building activities [6].

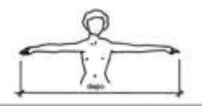

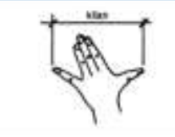

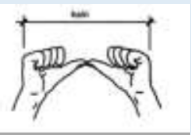

In architecture, scale and proportion are very important. Proportion refers to the harmonious relationship between one part and another, while scale refers to the size of one with the other [7].

Previous researches in the field of human

proportion and scale are commonly using qualitative and quantitative methods. The differences between architectural research and other fields lie in the desired method and purpose related to the field of mathematics [8]. The quantitative method is used to find the "proportion of ratio." In contrast, the architecture uses qualitative methods to focus on the quality of the scale proportion to the function of the building and the beauty it produces, where the goal is to find a "proportion of beauty" [9].

In traditional Javanese and Balinese architecture [10], [11] there are measurement methods with limbs as a determinant of the dimensions of their buildings that use body anatomy, including; *Depa* (a unit of length based on the length of the hand from the tip of the finger), *Hasta* (a unit of length based on the tip of the finger to the tip of the elbow), *Kilan* (a unit of length based on the length of the little finger to the thumb when stretched), *Tapak* (a unit of length based on the sole from heel to toe), *Kaki* (Unit of measure based on two fists with the junction of the two thumbs extending) [12], which is explained in Table 1.

These Javanese Traditional units of measure, when synchronized with modern anthropometry in literature [14], identify that the activities of praying may be translated into traditional measurements. For example, the type of activity carried out in the prayer room, such as performing prayers, is done by its standard, among others: for an adult human standing 87.5 cm, bowing 87.5 cm, sitting cross-legged + 75 cm, and prostrating 120 cm. The dimensions are shown in Figure 1, Figure 2, and Figure 3.

Unit Name	Figure	Description
Depo		Unit of Length based on the length of the hand from the tip of the finger (+170 cm)
Hasta		Length unit based on the fingertip to elbow (+ 35-40 cm)
kilan		Unit of length based on the distance from the little finger to the outstretched thumb (+16-20 cm)
Pecak / tapak		Based on the length of the sole from heel to toe (+22-28 cm)
kaki		Based on two fists with the junction of the two thumbs span (+31.4 cm)
nyari		Based on the width of the thumb (+ 2.6 cm)

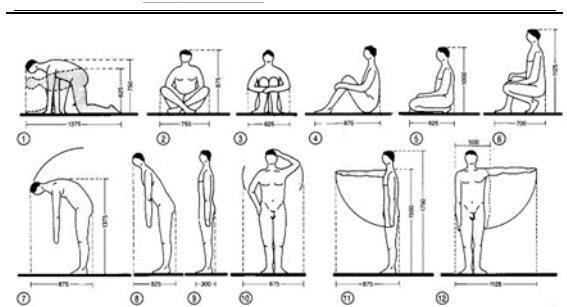


Figure 1. Anthropometric units [15]

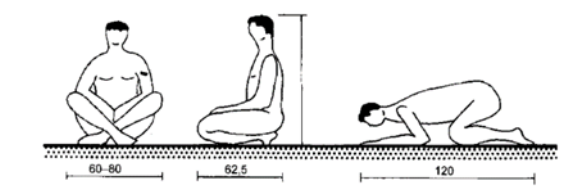


Figure 2. Dimensions of sitting and prostration [14]

The dimensions of people standing praying who can close the shaf or line of prayer are 55-60 cm, with a prostration room of 120-130 cm [16]. It can be concluded that to make the activity of standing in prayer can form a tight line.

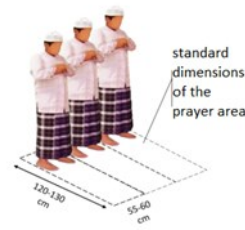


Figure 3. Standard Dimensions of the prayer area, [16]

The Great Mosque is a relic of local wisdom in the field of architecture in Indonesia, especially in Java [17]. The Great Mosque and 3 other elements, namely Alun-Alun [18], Pendhopo, and the Market, are one unit in the "Catur Gatra Tunggal" [19]. The Great Mosque itself has the characteristics of traditional Javanese architecture, which uses the "Soko Guru" wood structure building technology as the main structure [20]. The typology of the location is shown in Figure 4.

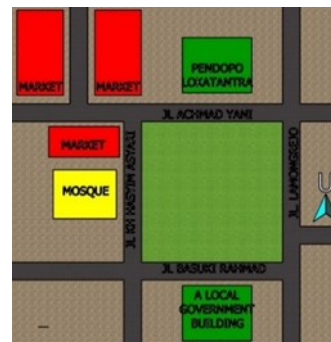


Figure 4. Illustration of the typology of the location of the Great Mosque in Java

From the narrative above, we get a research gap to analyze the dimensions of space with references from the West, namely the golden section and traditional Javanese measurement units that use body measurements so that an ideal proportion can be produced according to the human scale.

The purpose of this research is to study whether the application of the concept of the golden ratio and the use of the human scale; in this case, the method used is the traditional measurement which is applied to the size of the room, shape, and proportion, especially in the prayer room.

METHODS

This research covers the Great Mosque of Tuban, the Great Mosque of Lamongan, and the Jamee Mosque of Gresik, the three local great mosques. The method for determining the human scale and proportions in this study is based on the golden ratio method and traditional Javanese unit measurements. Figure 5 shows the location of the districts of

Lamongan, Tuban, and Gresik on the island of Java, Indonesia.

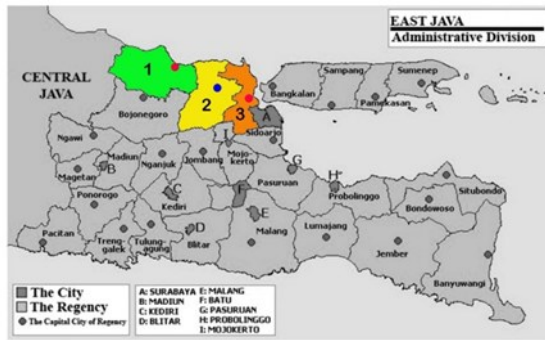


Figure 5. East Java Administrative Division. 1. The Regency of Tuban, 2. The Regency of Lamongan, 3. The Regency of Gresik

This method focuses on the plan of the mosque, especially in the main prayer room, which emphasizes the dimensions of the prayer room.

There are several ways to measure the golden ratio; the first is by comparing two sizes, a and b. The two sizes of a and b (with conditions a is bigger than b) are said to have a golden ratio if the comparison between the two quantities is the same as the total ratio of the two (a+b).

The golden ratio will be obtained if the long part divided by the short part equals the length of the original line divided by the long part, as shown in Figure 6. A golden ratio is an irrational number with a value of 1.61803398874989484820... whose digits continue to increase without a certain pattern [21]. However, the equation $a/b = (a + b) / a$, as in the example of dividing the line above, must always be fulfilled.

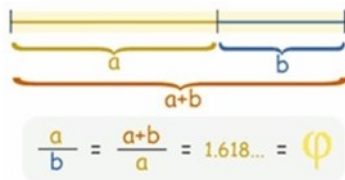


Figure 6. Golden ratio formula that can produce irrational numbers [22]

The second way is by simulating a rectangular line shown in Figure 7.

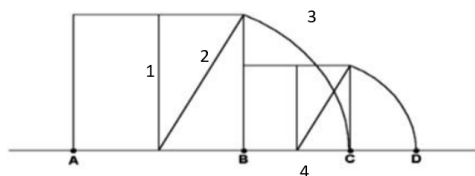


Figure 7. Square line simulation method to find the golden ratio [22]

An ideal width of an area can be determined based on the square line simulation method of the golden ratio. Assuming lines A to B is the longest line in a certain area, the ideal width is determined by:

1. Dividing line A-B in half,
2. Making a diagonal from the midpoint to the outermost corner on side B,
3. The resulting line is rotated in the direction of line A-B and is marked with point C,
4. The intersection of line B-C is the ideal width according to the calculation of the golden section.

While the third method uses traditional Javanese measurement units based on the anthropometry of certain body parts (anatomy) and has the following units [12]:

1. Depa = ± 1,70 m
2. Hasta = ± 0,4 m
3. Kilan = ± 0,2 m
4. Tapak = ± 0,28 m
5. Kaki = ± 0,3 m

The traditional dimensions are used in analyzing the prayer rooms in the Lamongan Great Mosque, Tuban Great Mosque, and Gresik Jamee Mosque. The conversion of the anthropometric human body measurements, as shown in Figures 1 and 2, to Traditional Size units is shown in Table 2.

Table 2. Size List according to literature

activity	literature	depo	hasta	kilan	pecak	kaki
Stand up	60	0,35	1,50	3,00	2,14	1,94
Bow down	87,5	0,51	2,19	4,38	3,13	2,82
prostration	120	0,71	3,00	6,00	4,29	3,87
sit	80	0,47	2,00	4,00	2,86	2,58

Therefore, the next step is the comparison of the body size of the activities in the prayer (Figures 1 and Figure 2) are then compared with the existing dimensions of the prayer room, intending to know the ideal dimensions that can be suggested in the prayer room at the Great Mosque so that the main activities in the prayer room are more effective and appropriate with need.

DISCUSSION

CASE STUDY THE GREAT MOSQUE OF LAMONGAN

The Great Mosque of Lamongan was built around 1908 AD [23]. The initial building of the mosque is in the middle, with a size of 18.5 x 21 m, then a prayer room expansion building in the west with a size of 15.8 x 21 m, and a new building in the south. 47 x 18 m. The tower's location is in the east, with a main door on the east side as the main door for male and female worshippers, while on the south side, the entrance is for male worshippers.



Figure 8. Façade the Great Lamongan mosque [24]

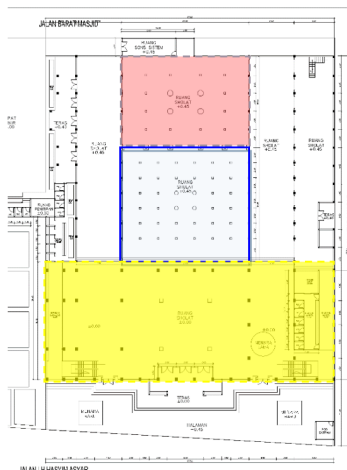


Figure 9. shows the floor plan of the Great Lamongan mosque, the main prayer room (blue) is 18,5 x 21 m, the additional prayer room (red) is 15.8 x 21 m, and the new building (yellow) is 47 x 18 m.

THE GREAT MOSQUE OF TUBAN

The Great Mosque of Tuban was built in 1894 [25]. The first renovation was carried out using the services of a Dutch architect, B.O.W.H.M. Toxopeus [26]. The initial building is in the center with a European architectural style, with the dimensions of the prayer room 23.1 x 20.9 m. Then the prayer area is added to the left and right sides of the initial prayer room so that it has dimensions of 47.85 x 23.1 m. In the east, there are 4 towers and an expansion of the mosque in the form of a porch with a membrane umbrella roof covering.



Figure 10. Façade The Great Mosque of Tuban [25]

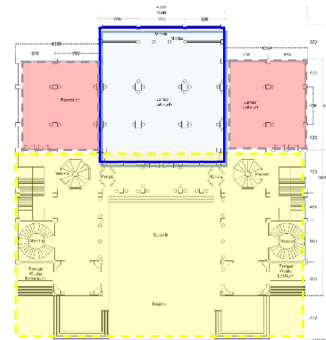


Figure 11. shows the floor plan of the Great Mosque of Tuban with the initial plan (blue), the addition of the prayer room area (red), and the porch (yellow)

THE JAMEE MOSQUE OF GRESIK

The Jamee Mosque of Gresik, built-in 1756 [27], has the dimensions of the main prayer room 20x20 m and a floor height of 3,3 m, with the addition of the building on the porch on the mezzanine floor with a height of 4,5 m from street level.



Figure 12. Façade The Jamee Mosque of Gresik [27]

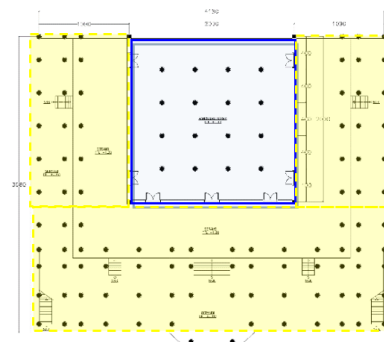


Figure 13. The floor plan of The Jamee Mosque of Gresik, with the dimensions of the main prayer room 20 x 20 m, and the addition is in the foyer.

FLOOR PLAN ANALYSIS TROUGH HUMAN SCALE STUDY WITH GOLDEN RATIO

THE GREAT MOSQUE OF LAMONGAN

According to the golden section analysis, the Lamongan Great Mosque has a main prayer room in

the initial building with 18.5 x 21 m dimensions.

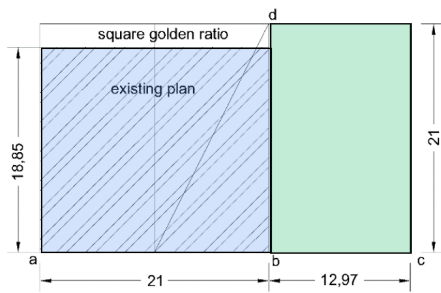


Figure 14. Golden ratio analysis of the Lamongan Grand Mosque floor plan using lines, the original plan (blue), and the plan that matches the golden ratio (green) 21 x 12.97 m

The plan of the Great Mosque has the longest side of 21 m. If using line analysis, it is found that the appropriate dimension of the golden section is 12.97 m. If using the ratio, then $21/12.97 = 1.619$, close to the value of the golden section ratio. This is also by the additional prayer room because it has the same dimensions as the long side, which is 21 m.

THE GREAT MOSQUE OF TUBAN

In the plan of the main prayer room of the Great Mosque of Tuban with the longest side of 23.1 m, if analyzed using the intersection of the golden section, the ideal dimension is 23.1×14.25 , which is found in Figure 15, green.

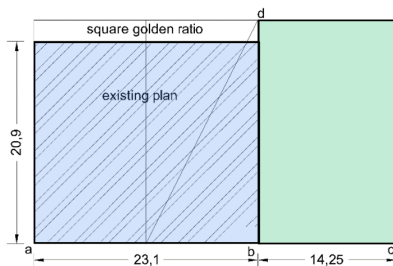


Figure 15. The main prayer room. The existing dimensions (blue) are 23.1 m x 20.9 m, and the golden section analysis (green) dimensions are 23.1 m x 14.25 m.

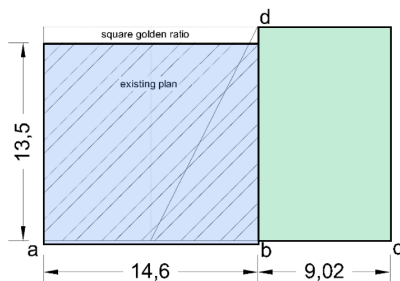


Figure 16. Additional prayer room. The existing dimensions (blue) are 14.6 m x 13.5 m, and the golden section (green) analysis dimensions are 14.6 m x 9.02 m.

In an additional prayer room with the longest side being 14.6 m, the ideal dimensions for the floor plan

are 14.6 m x 9.02, as shown in Figure 16 green squares.

The ratio between the main prayer room plan calculated based on the golden section is $23.1/14.25 = 1.621$ and that of the additional prayer room $14.6/9.02 = 1.618$. The result of the division is close to the golden ratio of 1.618.

THE JAMEE MOSQUE OF GRESIK

The Jamee Mosque of Gresik has a square plan shape, with dimensions of 20 x 20 m. Using a square side that has a length of 20 m, the following analysis is obtained:

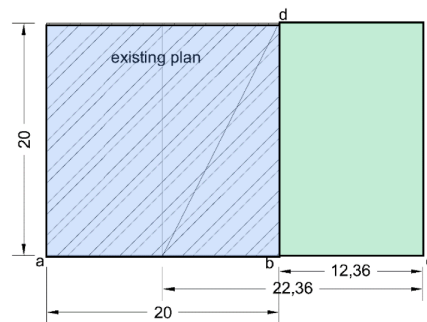


Figure 17. The main prayer room. The existing dimensions (blue) are 20 m x 20 m, and the dimensions of the analysis of the golden section (green) are 20 m x 12.36 m

The results of the intersection of the analysis lines of the golden section found that the ideal dimension for the 20 m long side is 12.36 m. In other words, the ratio between $20/12.36$ is 1.618, close to the golden ratio.

FLOOR PLAN ANALYSIS TROUGH HUMAN SCALE STUDY WITH ANTHROPOMETRY AND TRADITIONAL

Analysis using anthropometrics is used to find the ideal dimensions based on the size of the human body. For example, it is known from the literature study above that the needs of individuals in the prayer room for their activities require dimensions of 80 cm x 120 cm, as shown in Table 3.

Table 3. Conversion of modern anthropometric measurements to traditional measurements

activity	liter-ature	depo	hasta	kilan	pecak	kaki
Stand up	60	0,35	1,50	3,00	2,14	1,94
prostra-tion	120	0,71	3,00	6,00	4,29	3,87
sit	80	0,47	2,00	4,00	2,86	2,58

The size converted in traditional depot units is rounded up. After all, in traditional units, it cannot be

divided into more detailed measurements because it only relies on body parts so that the size becomes simpler, as in Table 4.

Table 4. Conversion of existing dimensions and Traditional Units

activity	literature	depo	hasta	kilan	pecak	kaki
Stand up	60	0,5	1,5	3	2	2
prostration	120	1	3	6	4	4
sit	80	0,5	2	4	3	3

THE GREAT MOSQUE OF LAMONGAN

The Great Mosque of Lamongan has dimensions of a prayer room with dimensions of 21 m and 18.85 m for the prayer room in the middle and 21 m x 15.8 m for the prayer room on the west side, meaning that 21 m dimensions are used to count the number of people in a row (shaf). While at 18.85 m and 15.8 m, it is used to calculate the number of rows (shafs). So it can be concluded in Table 5 below:

Table 5. Conversion of existing dimensions and activity requirements

dimension	activity	literature
2100	Stand up	35,00
1885	prostration	15,71
	sit	26,25
2100	Stand up	35,00
1580	prostration	13,17
	sit	26,25

Table 6. Conversion of existing dimensions and Traditional Units

Dimension and activity	Depo	Hasta	Kilan	Pecak	Kaki
2100 Stand up	24.71	35.00	35.00	37.50	33.87
1885 Prostration	11.09	15.71	15.71	16.83	15.20
	Sit	24.71	26.25	26.25	25.00
2100 Stand up	24.71	35.00	25.00	37.50	33.87
1580 Prostration	9.29	13.17	13.17	14.11	12.74
	Sit	24.71	26.25	26.25	25.00

From Table 5, it can be calculated that the long side of the central prayer room of the Great Lamongan

mosque has dimensions of 18.85 m, it is obtained 15.71 rows (shafs) with 35 people to be able to stand and 26.25 people in a sitting position in each row (shaf). If to be able to complete the number of rows, it can be recommended dimensions from 18.85 to 19.20 so that the dimensions of the prayer room become 21 m x 19.20 m. which can accommodate 16 rows (shafs) and 35 people for each row (shaf) (Figure 18).

As for the western prayer room, which has dimensions of 15.8 m, there are 13.17 rows (shafs) with 35 people standing and 26.25 people sitting in each row (shaf). Therefore, to complete the line, the recommended prayer room dimensions are 21 m x 15.6 m.

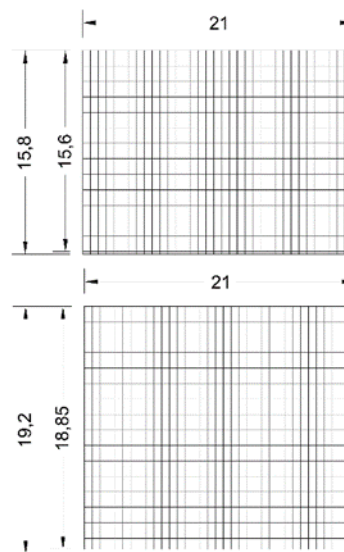


Figure 18. Anthropometric simulation on the floor plan of the Great Mosque of Lamongan

While in Table 6. It is explained that the conversion of the dimensions of the prayer room to traditional units that are close to the size according to the literature is to use the measurement method with cubits and kilns, which can get 35 people in one row (shaf) in both the central and western prayer rooms, 13, 17 rows (shafs) for the west prayer room and 15.71 rows (shafs) in the central prayer room.

THE GREAT MOSQUE OF TUBAN

At the Great Mosque of Tuban, the dimensions of the prayer room are 23.1 m x 20.9 m with the sense that 20.9 m is used to calculate the number of rows (shafs), while on the side, the dimension 23.1 m is used to count people in a row (shafs). And the additional prayer room has dimensions of 13.5 m x 14.6 m, with a side of 14.6 m to determine the number of people in each row and 13.5 m to determine the number of rows. The calculation of the number of rows and the number

of people in each row can be concluded from Table 7 below.

Table 7. Conversion of existing dimensions and activity requirements

dimension	activity	literature
2310	Stand up	38,35
2090	prostration	17,42
	sit	28,76
1460	Stand up	24,33
1350	prostration	11,25
	sit	18,25

Table 8. Conversion of existing dimensions and Traditional Units

Dimension and activity	Depo	Hasta	Kilan	Pecak	Kaki
2310 Stand up	27.07	38.35	38.35	41.09	37.11
2090 Prostration	12.29	17.42	17.42	18.66	16.85
	27.07	28.76	28.76	27.39	24.74
1460 Stand up	17.18	24.33	24.33	26.07	23.55
1350 Prostration	7.94	11.25	11.25	12.05	10.89
	17.18	18.25	18.25	17.38	15.70

Table 7 shows that the main prayer room can accommodate 38.35 people in each row and make 17.42 rows, while the additional room can accommodate 24.33 people in each row and make 11.25 rows. The above analysis results can produce recommendations for effective dimensions for the prayer room. The main prayer room is 23.4 m x 21.6 m, accommodating 39 people in each row (shaf) and 17 rows (shafs). At the same time, the additional prayer room on the right and left sides of the ideal dimension is 15 m x 14.4 m, which can accommodate 25 people in each row and 12 rows (shafs), which can be simulated in Figure 19.

In Table 8, it is known that the traditional measurement method that is close to the dimensions of activity needs is using cubits and kilns, in the main prayer room makes 38.5 people in one row (shaf) and makes 17.42 rows. The additional prayer room makes 24.33 people in each row (shaf) and 11.25 rows (shafs) in the room.

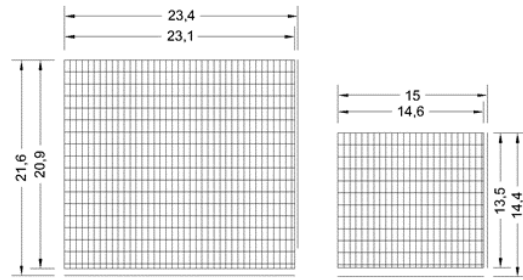


Figure 19. Anthropometric analysis of the prayer room of The Great Mosque of Tuban.

THE JAMEE MOSQUE OF GRESIK

The Jamee Mosque of Gresik has the dimensions of a prayer room with dimensions of 20 m and 20 m, meaning that 20 m has the same dimensions to calculate the number of rows (shafs) and the number of people in each row.

Table 9. Conversion of existing dimensions and activity requirements

dimension	activity	literature
2000	Stand up	33,33
2000	prostration	16,67
	sit	25,00

Table 10. Conversion of existing dimensions and Traditional Units

Dimension and activity	Depo	Hasta	Kilan	Pecak	Kaki
2000 Stand up	23.53	33.33	33.33	35.71	32.26
2000 Prostration	11.76	16.67	16.67	17.86	16.13
	23.53	25.00	25.00	23.81	21.51

The analysis in Table 9 shows that the prayer room can accommodate 33.33 people in each row (shaf) and form 16.67 rows (shafs).

The recommended dimensions for the room to be effective are 20.4 m x 20.4 m so that it can accommodate 34 people and make 17 rows (Figure 17).

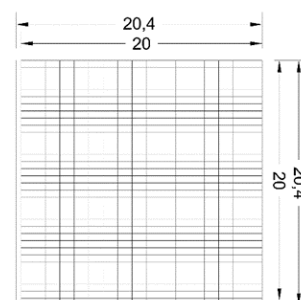


Figure 20. Anthropometric analysis in the prayer room of The Jamee Mosque of Gresik.

Table 10 shows that the traditional measurement method is the same as the previous mosque, namely using cubits and kilns, in the main prayer room produces 33.33 people in one row (shaf) and 16.67 rows.

CONCLUSION

From the research above, in addition to being adapted to the function of the activity in the mosque, the beauty of the design, the human scale, and the proportions greatly affect the size of the prayer room.

The results of this study are summarized in Table 11. The dimensions of the plan, which refers to the golden ratio of the rectangular plan, having the longest and shortest sides when divided, will produce an irrational number of 1.618. Table 11 shows that the one with the largest percentage for the golden ratio is the western prayer room at the Lamongan Great Mosque, with 82%. In comparison, the smallest is the Jami Gresik Mosque Prayer Room, which is 61.8%.

Table 11. Percentage of the golden ratio in the existing dimensions of the prayer room

Mosque case study	Existing Dimensions	Golden ratio	Golden ratio %
The Great Mosque of Lamongan	21 m x 18,85 m	1,11	68,85%
	21 m x 15, 8 m	1,33	82,15%
The Great Mosque of Tuban	23,1 m x 20,9 m	1,10	68,04%
	14,6 m x 13,5 m	1,08	66,84%
The Jamee Mosque of Gresik	20 m x 20 m	1,00	61,80%

The floor plans of the Great Mosque of Lamongan, the Great Mosque of Tuban, and The Jamee Mosque of Gresik, have dimensions that do not meet the criteria of comparing the golden ratio and human scale. If referring to the golden ratio and human scale, the adjustment of the dimensions of the prayer room plan is contained in Table 12.

Table 12 Existing Plan adjustment with the golden ratio and human scale

Mosque case study	Existing Dimensions	Golden Ratio Dimensions	Human Scale Dimensions
The Great Mosque of Lamongan	21 x 18,85 m	21 x 12,97 m	21 x 19,2 m
	21 m x 15, 8 m	21 m x 15, 8 m	21 x 15,6 m
The Great Mosque of Tuban	23,1 x 20,9 m	23,1 x 14,25 m	23,4 x 21,6 m
	14,6 x 13,5 m	14,6 x 9,02 m	15 x 14,4 m
The Jamee Mosque of Gresik	20 x 20 m	20 x 12,36 m	20,4 x 20,4 m

The traditional measurement method in the mosque's prayer room uses "hasta" and "kilan" more effectively. This is because the results of the division of the number of prayer rooms are almost the same as the distribution using modern measurements found in the literature, while "depo" and "kaki" have the same results. The division of the number of prayer rooms is less, and "pecak" has the result of dividing the number of prayer rooms more.

Measurement using this traditional method has a weakness, namely that there is no standard, making it less relevant for use in the modern era. Previous research using the measurement method with the golden section to analyze the mosque plan was carried out by Mustofa [22], who researched mosques in Erbil, while this study used a combination of Western methods, golden sections, and local wisdom measurement methods [12], which used the size of the human body, making this research an effort to review the local architectural culture.

REFERENCES

[1] H. Ramzi and M. Muffeq, "Structure as a Tool of Achieving Human Scale in the Islamic Architecture," in *International Conference on Transport, Civil, Architecture and Environment Engineering*, 2012. [Online]. Available: <https://www.researchgate.net/publication/328582825>

[2] A. Suratkon, N. N. Abd Salam, M. H. Rahmat, A. S. Mohd Arhan, I. Abd Wahab, and S. A. Ghaffar, "Woman Friendly Mosque, Features, and Facilities: A Case Study on Masjid Sultan Ibrahim, Universiti Tun Hussein Onn Malaysia," in *IOP Conference Series: Materials Science and Engineering*, Jan. 2018, vol. 291, no. 1. doi: 10.1088/1757-899X/291/1/012019.

[3] N. A. Salingaros, "The structure of pattern languages," *Architectural Research Quarterly*, vol. 4, no. 2, pp. 149–162, Jun. 2000, doi: 10.1017/S1359135500002591.

[4] L. K. Wardani, "Evaluasi Ergonomi Dalam Perancangan Desain," *Dimensi Interior*, vol. 1, no. 1, pp. 61–73, May 2003, doi: <https://doi.org/10.9744/interior.1.1.pp.%2061-73>.

[5] H. R. Agustapraja and S. J. Windarto, "EVALUASI DIMENSI PERABOT PADA RUANG PERPUSTAKAAN UMUM LAMONGAN BERDASARKAN ANTROPOMETRI DAN

- ERGONOMI,” *AKSEN*, vol. 6, no. 1, pp. 5–18, Oct. 2021, doi: 10.37715/aksen.v6i1.1849.
- [6] S. GS, “Ergonomi Dalam Bidang Perencanaan Arsitektur dan Interior,” *Dimensi*, vol. 5, no. 1, pp. 113–122, 2007.
- [7] H. Purnomo, “PENGUKURAN ANTROPOMETRI TANGAN USIA 18 SAMPAI 22 TAHUN KABUPATEN SLEMAN YOGYAKARTA Hari Purnomo Jurusan Teknik Industri, Fakultas Teknologi Industri Universitas Islam Indonesia,” *Seminar Nasional Industrial Engineering National Conference (IENACO)*, no. 2004, pp. 106–112, 2014.
- [8] S. Supiyati and F. Hanum, “ETHNOMATHEMATICS IN SASAKNESE ARCHITECTURE,” *Journal on Mathematics Education*, vol. 10, no. 1, pp. 47–58, 2019.
- [9] M. A. Cohen, *Two Kinds of Proportion. Proportional Systems in the History of Architecture: A Critical Reconsideration*, vol. 2. 2014.
- [10] I. W. Parwata, “Rumah Tinggal Tradisional Bali dari Aspek Budaya dan Antropometri,” *Mudra Jurnal Seni Budaya*, vol. 26, no. 1, pp. 95–106, 2011.
- [11] N. M. E. N. Dewi, “TRANSFORMASI PEMANFAATAN RUANG KOMUNAL PADA PERMUKIMAN TRADISIONAL BALI DI DESA PEKRAMAN PEDUNGAN,” *SPACE*, vol. 1, no. 1, pp. 41–50, 2014.
- [12] T. PYNKYAWATI, E. AGUNG, A. NOVIANDI, R. N. SUHARDIMAN, and M. A. PUTRI, “Kajian Desain Struktur Rumah Tinggal Masyarakat Kampung Naga di Tasikmalaya,” *Jurnal Reka Karsa, Jurnal Online Institut Teknologi Nasional*, vol. 2, no. 3, pp. 1–11, 2014.
- [13] H. Frick, *Pola Struktural dan Teknik Bangunan di Indonesia*. Kanisius, 1997.
- [14] E. Neufert and S. Amril, *Data Arsitek jilid 2*, 2nd ed. Jakarta: Erlangga, 1995.
- [15] E. Neufert, *Data Arsitek Jilid 1*, 1st ed. Jakarta: Erlangga, 1996.
- [16] M. Ratodi and O. E. Hapsari, “IDENTIFIKASI BEST PRACTICE DESIGN BERDASAR HADITS SEBAGAI PANDUAN PERANCANGAN ARSITEKTUR,” *Nature: National Academic Journal of Architecture*, vol. 4, no. 2, pp. 160–170, Dec. 2017, doi: 10.24252/nature.v4i2a8.
- [17] A. B. Zein, *Masjid-masjid bersejarah di Indonesia*. Gema Insani, 1999.
- [18] H. R. Agustapraja, “Studi Pemetaan Perilaku (Behavioral Mapping) Pejalan Kaki Pada Pedestrian Alun-Alun Kota Lamongan,” *Jurnal CIVILA*, vol. 3, no. 1, p. 134, 2018, doi: 10.30736/cvl.v3i1.220.
- [19] H. R. Agustapraja and S. S. Aslamiyah, “THE IDENTIFICATION OF THE PATTERN OF JAVA ISLAMIC CITY CATUR GATRA TUNGGAL IN LAMONGAN,” *Journal of Islamic Architecture*, vol. 7, no. 1, pp. 67–72, Jun. 2022, doi: 10.18860/jia.v7i1.13263.
- [20] M. W. Zein, *Perkembangan Arsitektur Masjid di Jawa Timur*. Surabaya: PT. Bina Ilmu, 1986.
- [21] F. N. M. Nordin, Nor Aina Mhd Khotib, Abdul Halim Ibrahim, Mohd Rezuan Masran, Shaikh Mohd Saifuddeen Shaikh Mohd Salleh, and Ab Razzak, *PEMBELAJARAN SAINS MELALUI TADABBUR AYAT AL-QURAN: ANALISIS TERHADAP SIRI NOMBOR FIBONACCI DAN KETERATURAN ALAM*. . 2013.
- [22] F. A. Mustofa and S. J. Rashid, “STUDYING THE HUMAN SCALE AND PROPORTIONALITY OF MOSQUE BUILDINGS: SOME SELECTED CASE STUDIES IN ERBIL CITY,” *Journal of Islamic Architecture*, vol. 5, no. 3, pp. 129–135, 2019, <https://doi.org/10.18860/jia.v5i3.5304>.
- [23] H. R. Agustapraja, “Pelestarian Arsitektur Masjid Agung Lamongan Sebagai Upaya Pemeliharaan Identitas Daerah,” *Jurnal Arsitektur dan Perencanaan (JUARA)*, vol. 2, no. 1, p. PRESS, 2019, doi: 10.31101/juara.v2i1.979.
- [24] H. R. Agustapraja and Y. Maulidina, “Morfologi Arsitektur Dan Transformasi Fisik Masjid Agung Lamongan,” *Jurnal Teknika*, vol. 11, no. 2, p. 1104, 2019, doi: 10.30736/jt.v11i2.340.
- [25] N. A. N. Hanifah, “Sejarah dan perkembangan Masjid Agung Tuban Tahun 1987-sekarang: studi tentang fungsi dalam kehidupan sosial kemasyarakatan,” UIN Sunan Ampel Surabaya,

Surabaya, 2020.

- [26] A. Adirin, "Masjid Agung Tuban, Simbol Kejayaan Islam di Bumi Wali," <https://www.liputan6.com/regional/read/4245701/masjid-agung-tuban-simbol-kejayaan-islam-di-bumi->

wali, May 05, 2020.

- [27] M. Wibowo, "Arsitektural Masjid Jami'Gresik: analisis bentuk, simbol dan makna," UIN Sunan Ampel Surabaya, Surabaya, 2019.