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The Effect of Spatial Zoning Design on Noise Reduction in the Worship Room of Gereja HKTY Ganjuran

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ABSTRACT

Churches are places to worship for Christians and Catholics, which should be free from noise in order to create a solemn atmosphere during worship. Most worship rooms in churches are closed rooms, because it is easier to design the acoustics in a closed worship room than in an open worship room. The worship room at Gereja HKTY Ganjuran is a semi-open worship room, so the noise control in this worship room is not only focused on the worship room itself, but also depends on the zoning plan of the area of Gereja HKTY Ganjuran. This study was conducted to determine the effect of space zoning design, which includes the distance between each activity zones, building layout, and noise barrier design, on noise reduction in the worship room of Gereja HKTY Ganjuran. This research used a quantitative research method, which was conducted by collecting noise level data through measurements using a Sound Level Meter (SLM) and direct observation on the spatial zoning design in the area of the Gereja HKTY Ganjuran. The collected data was then analyzed using IBM SPSS Statistics. Through the analysis, it was found that noise reduction in the worship room of Gereja HKTY Ganjuran was influenced by the distance between zones and the design of sound barriers in each activity zone.

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1. INTRODUCTION

Churches are places to worship for Christians and Catholics, consisting of a main worship room and supporting rooms, such as office and storage room. The design of worship room in Christian and Catholic churches is commonly a closed worship room, which is made up of walls, roof, and floor to minimize disturbing noises from the outside (Novita & Lukman, 2023).

Although the design of the worship room in churches is generally enclosed, there are also semi-open worship rooms, one of them is the worship room at Gereja HKTY Ganjuran. Gereja HKTY Ganjuran is a church that adopts the traditional Javanese building design, called Joglo Tajug. The Gereja HKTY Ganjuran area implements Javanese cultural acculturation in every design of its rooms (Krismiyanto, 2025).

The design of Gereja HKTY Ganjuran, which uses the concept of Javanese Joglo Tajug cultural acculturation, makes this church have a semi-open worship room (Zamzami & Wakhid, 2024). Semi-open refers to a room that is a permanent enclosed room, but has an open section in another part of the room (Nediari et al., 2022). The worship room of Gereja HKTY Ganjuran has a roof, floor, and walls on one side of the building, but has no walls on the other three sides.

In a room with semi-open concept, the noise level will be higher compared to a closed room (A'yun et al., 2025). On the other hand, a worship room must be acoustically comfortable and free from any kind of noise that could disturb the solemnity of the worship session (Sangkertadi & Manganguwi, 2021). Therefore, in the concept of room and environmental acoustics, spatial zoning is an important aspect in designing worship rooms with a semi-open concept (Jusmawandi, 2025).

The zoning design in environmental acoustic concepts aims to achieve acoustic comfort levels including distance between each activity zones, building layout design, and noise barrier design. Noise that is heard in a room will decrease when the room is far from the noise source (Mediastika, 2005). Rooms that require tranquility can be placed far from the noise source, so that the noise from outside cannot enter the room or the noise level can be reduced when it reaches the room (Siska, 2015). Besides that, noise levels can be reduced with proper noise barrier design. The noise barrier is designed to block direct noise transmission into the building. Other than the distance, the density and thickness of the vegetation are also the factors that can reduce noise levels (Putra et al., 2018).

According to Romadona et al., (2024), the distance from the noise source to the noise receiver is the main factor that has an effect to the decrease the noise level. Meanwhile, based on research on the effectiveness of noise barriers on noise levels in residences next to highways, it is known that noise barriers have no correlation with noise levels in the residences. This happens because of the lack of noise barriers in the residences that were used as the research objects (Ola et al., 2020).

Therefore, this study was conducted to identify the effect of space zoning design, which includes distance, building layout, and noise barrier design, on noise reduction in the worship room of the Gereja HKTY Ganjuran.

2. RESEARCH METHODS

The research was conducted using quantitative research methods. Quantitative research methods were used to test existing theories through analysis of research variables (Creswell, 2014). Variables in this study were independent and dependent variables. The independent variable in this study is the spatial zoning of the Gereja HKTY Ganjuran area, while the

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dependent variable in this study is the noise reduction in the worship room of Gereja HKTY Ganjuran.

The data required for this research are the zoning data in the area of Gereja HKTY Ganjuran, noise level data at each measurement point in each zone, and barrier data in each zone. The determination of the zone boundaries was based on the activities carried out in the area of Gereja HKTY Ganjuran (Agni et al., 2022). Noise level measurements were taken using a Benetch GM1356 Series Sound Level Meter (SLM). Barrier data was obtained through observations in the area around Gereja HKTY Ganjuran.

The measurements were taken on April 22, 2025, from 4:00 p.m. to 6:00 p.m. Western Indonesian Time and on May 9, 2025, from 9:00 a.m. to 11:00 a.m. Western Indonesian Time. The measurement times were chosen based on the routine activities schedule at Gereja HKTY Ganjuran to obtain optimal results (Sasmita et al., 2021).

The collected data was then summarized and analyzed. The correlation between the two variables was analyzed using IBM SPSS Statistics software with linear regression analysis. Linear regression analysis was chosen as the form of analysis used to determine the causal correlation between the two variables (Nurhaswinda et al., 2025). In this research, the type of regression analysis that is used is multivariable linear regression, which aims to find out the correlation between spatial zoning design, including distance, spatial layout, and noise barrier design, and the reduction in noise levels in the worship room of Gereja HKTY Ganjuran.

3. RESULT AND DISCUSSION

3.1 Result

Gereja HKTY Ganjuran is located on Jl. Ganjuran, Jogodayoh, Sumbermulyo, Bambanglipuro District, Bantul Regency, Daerah Istimewa Yogyakarta. The church area of Gereja HKTY Ganjuran consists of several functional buildings, including worship buildings, a hospital, a school, and a commercial area. The church area is not only a place to worship, but also a place to practice Javanese traditional music and a religious tourist attraction for Catholics and non-Catholics (Alfian et al., 2024).

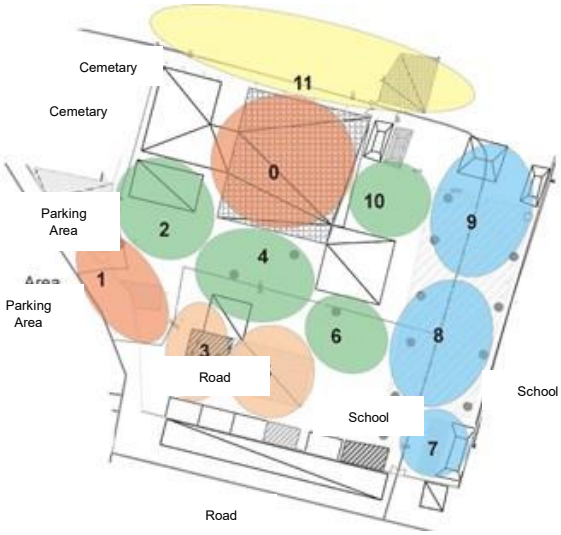

Figure 1. Spatial zones in Gereja HKTY Ganjuran area
(Source: Author, 2025)

Figure 1 shows that there are 12 spatial zones in the area of Gereja HKTY Ganjuran. These zones are: worship room (Zone 0), entrance (Zone 1), secretarial building (Zone 2), pavilion

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for gamelan practice (Zone 3), front yard of the worship room of Gereja HKTY Ganjuran (Zone 4), pavilion for visitors to rest (Zone 5), the front yard of the rectory (Zone 6), the Virgin Mary statue praying area (Zone 7), the central praying zone (Zone 8), the Ganjuran Temple praying area (Zone 9), the Adoration Chapel (Zone 10), and the souvenir sales area (Zone 11).

As shown in Figure 1, the worship room of Gereja HKTY Ganjuran is not directly located near to the road. There are several zones that surround the worship room of Gereja HKTY Ganjuran. The zoning formation as applied in the Gereja HKTY Ganjuran area aims to reduce the noise level inside the worship room. The areas that require privacy, such as worship room, are placed away from noise by placing public areas around the worship room (Putri & Setyowati, 2023). Therefore, design of the area becomes an important part of acoustic design in semi-open spaces, such as the worship room at Gereja HKTY Ganjuran.

The noise measurement in the Gereja HKTY Ganjuran area was conducted twice, on April 22, 2025, from 4:00 p.m. to 6:00 p.m. Western Indonesian Time and on May 9, 2025, from 9:00 a.m. to 11:00 a.m. Western Indonesian Time. The dates and times of the measurements were adjusted to the regular activities that are held at Gereja HKTY Ganjuran. The measurements were taken at 12 spots in the Gereja HKTY Ganjuran area. Below are the average noise measurement results at each measurement spot at the same time.

Table 1: Average Noise Levels on April 22, 2025, from 4:00 p.m. to 6:00 p.m. (Western Indonesian Time)

Measurement Zone	Average Noise Level (dBA)
Zona 0 (Worship Room)	49,78
Zona 1 (Entrance)	64,00
Zona 2 (Secretarial Building)	56,92
Zona 3 (Pavilion for Gamelan Practice)	62,46
Zona 4 (Front Yard of the Worship Room of Gereja HKTY Ganjuran)	53,13
Zona 5 (Pavilion for Visitors to Rest)	59,59
Zona 6 (The Front Yard of the Rectory)	57,63
Zona 7 (The Virgin Mary Statue Praying Area)	55,67
Zona 8 (The Central Praying Zone)	51,54
Zona 9 (The Ganjuran Temple Praying Area)	45,49
Zona 10 (The Adoration Chapel)	48,00
Zona 11 (The Souvenir Sales Area)	45,60

Source: Author, 2025

As shown in Table 1, Zone 0 is a semi-open worship room in Gereja HKTY Ganjuran. This measurement spot is called as Zone 0 because the measured noise reduction level is the noise reduction from other zones (zone 1 to zone 11) to Zone 0 (the worship room of Gereja HKTY Ganjuran).

During the noise measurement that was conducted on April 22, 2025, from 4:00 p.m. to 6:00 p.m. Western Indonesian Time, there was gamelan practice in the pavilion for gamelan practice (Zone 3), so the closest noise source to the worship room of Gereja HKTY Ganjuran at the measurement time was the sound of gamelan practice in Zone 3. Other noise sources that found during the measurement were the sound of vehicles on the road, human

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conversations in Zone 3, human conversations in Zone 0, birds chirping, people sweeping in Zone 9, and human footsteps in Zone 10.

As can be seen in Table 1, the average noise level in the worship room of Gereja HKTY Ganjuran (Zone 0) was 49,78 dBA. The highest average noise level in the measurements that were conducted on April 22, 2025, was at the Zone 3, which was 62,46 dBA, while the lowest average noise level in the noise measurements that were conducted was in Zone 9, which was 45,49 dBA.

The second measurement was conducted on May 9, 2025, from 9:00 a.m. to 11:00 a.m. Western Indonesian Time to collect noise data during the daytime at Gereja HKTY Ganjuran. The average noise level measurements in the area of Gereja HKTY Ganjuran are shown in Table 2.

Table 1: Average Noise Levels on May 9, 2025, from 9:00 a.m. to 11:00 a.m. (Western Indonesian Time)

Measurement Zone	Average Noise Level (dBA)
Zona 0 (Worship Room)	51,60
Zona 1 (Entrance)	59,38
Zona 2 (Secretarial Building)	56,72
Zona 3 (Pavilion for Gamelan Practice)	56,39
Zona 4 (Front Yard of the Worship Room of Gereja HKTY Ganjuran)	53,12
Zona 5 (Pavilion for Visitors to Rest)	62,83
Zona 6 (The Front Yard of the Rectory)	62,24
Zona 7 (The Virgin Mary Statue Praying Area)	55,44
Zona 8 (The Central Praying Zone)	57,00
Zona 9 (The Ganjuran Temple Praying Area)	58,45
Zona 10 (The Adoration Chapel)	56,31
Zona 11 (The Souvenir Sales Area)	47,24

Source: Author, 2025

During noise level measurements that were conducted on May 9, 2025, from 9:00 a.m. to 11:00 a.m. Western Indonesian Time, the sources of noise that found were the sound of vehicles from the road, the sound of human footsteps in the area of Gereja HKTY Ganjuran, the sound of people sweeping in Zone 9, the sound of Javanese music from speakers in Zone 3, the sound of human conversation in Zone 5, the sound of birds chirping, and the sound of human conversation in Zone 4. The noise level received in the worship room of Gereja HKTY Ganjuran (Zone 0) was 51,60 dBA. The highest noise level recorded is at Zone 5, which is 62,83 dBA, while the lowest noise level is at Zone 12, which is 47,24 dBA.

3.2 Discussion

The highest noise level from the measurement that was conducted on April 22, 2025, was at the Zone 3, which was 62,46 dBA, and the noise level received in the worship room of Gereja HKTY Ganjuran was 49,78 dBA.

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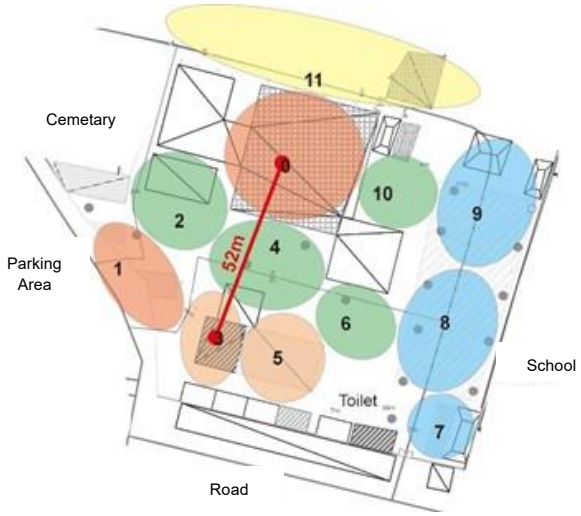

Figure 2: Distance between Zone 0 and Zone 3
(Source: Author, 2025)

Figure 2 shows that there is a 52 meters distance from Zone 0 to Zone 3. Zone 3, which has the highest noise level, is a pavilion that is used for gamelan practice. During the measurement, there was gamelan practice activity in Zone 3. Zone 3 is a pavilion with an open layout, so that sound from Zone 3 can easily spread to the other zones. With a 52 meters distance, the noise level from Zone 3 (the pavilion used for gamelan practice) to Zone 0 (the semi-open worship room of Gereja HKTY Ganjuran) decreased by 12,68 dBA.

In Figure 2, between Zone 3 and Zone 0, there is Zone 4, which is the front yard of the semi-open worship room of Gereja HKTY Ganjuran. This front yard is used as an additional worship space during major Catholic events, such as Easter and Christmas. The noise level reduction from Zone 3 to Zone 4 is 9.33 dBA, and the noise level reduction from Zone 4 to Zone 0 is 3.35 dBA. This means that Zone 4 in front of the worship room of Gereja HKTY Ganjuran (Zone 0) has a significant effect on decreasing the noise level in the worship room of Gereja HKTY Ganjuran (Zone 0).

Figure 3: Plant barrier between Zone 3 and Zone 4
(Source: Author, 2025)

Between Zone 3, Zone 4, and Zone 0, there are plants that act as noise barriers. These plants are shrubs such as palms and trees with irregular crowns (Syarafina et al., 2022). The

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noise level reduction that is caused by plants depends on the density of the leaves and the density of the plant setup (Azura et al., 2015). There were 5 shrubs with wide crowns and 1 a medium-density tree between Zone 3 and Zone 4, as shown in Figure 3. Meanwhile, there were 5 shrubs with wide crowns, 5 shrubs with small crowns, a tree with high leaf density, and 2 trees with low leaf density between Zone 4 and Zone 0, as shown in Figure 4.

Figure 4: Plant barrier between Zone 4 and Zone 0
(Source: Author, 2025)

In the measurement that was conducted on May 9, 2025, the highest noise level was at the Zone 5, which was 62,83 dBA, and the noise level in the worship room of Gereja HKTY Ganjuran was 51,60 dBA. The noise level decreased by 11.23 dBA from Zone 5 to Zone 0. The noise level can decreased by 11,23 dBA at a distance of 55,3 meters.

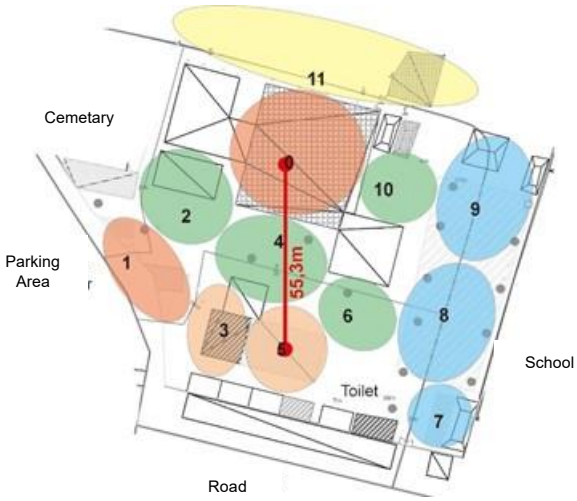

Figure 5: Distance between Zone 0 and Zone 5
(Source: Author, 2025)

Zone 5 is an area for visitors to rest, with a semi-open pavilion-style building. Noise level measurements were taken during the day when visitors were praying in the area of Gereja HKTY Ganjuran. The activity that is done by visitors in Zone 5 is having conversations, so the dominant noise sources during the noise level measurements were the sound of human conversation, the sound of human footsteps, and the sound of music speakers that are mounted in Zone 3.

Noises that come from Zone 5 that will be received by Zone 0 must pass through Zone 4 first. The noise barriers between Zone 4 and Zone 0 are 5 shrubs with wide crowns, 5 shrubs with small crowns, 1 tree with a high leaf density, and 2 trees with a low leaf density. With

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this noise barrier design, the noise level from Zone 5 to Zone 4 is decreased by 9,71 dBA. The noise barrier designs between Zone 5 and Zone 4 are 4 small-crowned shrubs, 5 wide-crowned shrubs, and 1 tree with high leaf density. With this noise barrier design, the noise level from Zone 4 to Zone 0 decreased by 1,52 dBA.

Figure 6: Plant barrier between Zone 5 and Zone 4
(Source: Author, 2025)

Based on the results of the analysis of the first noise level measurement on April 22, 2025, from 4:00 p.m. to 6:00 p.m. Western Indonesian Time and the results of the analysis of the second measurement on May 9, 2025, from 9:00 a.m. to 11:00 a.m. Western Indonesian Time, Zone 4, which is the front yard of the worship room of Gereja HKTY Ganjuran, has an important role in reducing noise levels from zones with high noise levels to Zone 0, which is the worship room of Gereja HKTY Ganjuran. Therefore, in semi-open worship room, there should be a transition zone from zones with high noise levels to zones that require low noise levels.

An analysis using IBM SPSS Statistics was done to find out the correlation between the elements of space zoning design, including distance, room layout, and noise barrier design, and the level of noise reduction in the worship room of Gereja HKTY Ganjuran. To simplify the process of analyzing the influence of zoning design using IBM SPSS Statistics software, a scoring was applied to the noise reduction factors in the zoning design, which are distance, building layout, and noise barriers in the area of Gereja HKTY Ganjuran, as shown in Table 3.

Table 3: Scores for noise zoning design

Types of Vegetation	Score
Open space layout	1
Closed space layout	2
Small crown shrubs	1
Wide crown shrubs	2
Low leaf density trees	3
Medium leaf density trees	4
High leaf density trees	5
Brick fence wall	6

Source: Author, 2025

The analysis using IBM SPSS Statistics began with an analysis of the factors that influence the noise level decrease in the worship room of Gereja HKTY Ganjuran.

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Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Noise Barrier Design, Distance Between Each Activity Zones[b]	.	Enter

a. Dependent Variable: Noise Level Reduction

b. All requested variables entered.

Figure 7: Results of the analysis of variables that affect the noise level reduction in the worship room of Gereja HKTY Ganjuran
(Source: Author, 2025)

Based on the results of the factor analysis of noise level reduction in the worship room of Gereja HKTY Ganjuran using IBM SPSS Statistics in Figure 7, can be seen that the independent variables that can be accepted in the IBM SPSS Statistics analysis are the distance between activity zones and the design of noise barriers in the Gereja HKTY Ganjuran area. The building layout design cannot be used as an analysis factor that affects noise level reduction because the layout design of all zones in the HKTY Ganjuran Church area is an open building.

Correlations

		Noise Level Reduction	Distance Between Each Activity Zones	Noise Barrier Design	Room Layout
Pearson Correlation	Noise Level Reduction	1.000	.970	-.908	.
	Distance Between Each Activity Zones	.970	1.000	-.848	.
	Noise Barrier Design	-.908	-.848	1.000	.
	Room Layout	.	.	.	1.000
Sig. (1-tailed)	Noise Level Reduction	.	.015	.046	.000
	Distance Between Each Activity Zones	.015	.	.076	.000
	Noise Barrier Design	.046	.076	.	.000
	Room Layout	.000	.000	.000	.
N	Noise Level Reduction	4	4	4	4
	Distance Between Each Activity Zones	4	4	4	4
	Noise Barrier Design	4	4	4	4
	Room Layout	4	4	4	4

Gambar 8: Hasil analisis korelasi desain zonasi ruang (jarak dan penghalang kebisingan) terhadap penurunan tingkat kebisingan di ruang ibadah Gereja HKTY Ganjuran
(Source: Author, 2025)

The results of the correlation analysis between the spatial zoning design (distance between each activity zones and noise barrier design) on noise level reduction in the worship room of Gereja HKTY Ganjuran in Figure 8 shows that there is a positive connection between the distance between each activity zone and noise level reduction in the worship room of Gereja HKTY Ganjuran and there is a negative connection between noise barrier design and noise level reduction in the worship room of Gereja HKTY Ganjuran. This means that if the distance between each activity zones in Gereja HKTY Ganjuran is added, the noise level

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reduction in the worship room of Gereja HKTY Ganjuran will be higher, while if the noise barrier design variation is added, the noise level received in the worship room of Gereja HKTY Ganjuran will be lower.

Figure 8 also shows the Sig (1-tailed) value, which is the significance probability value of the correlation between the spatial zoning design (distance between each activity zones and noise barrier design) and the reduction in noise levels in the worship room of Gereja HKTY Ganjuran. The Sig (1-tailed) value between the distance between each activity zones in the HKTY Ganjuran Church area and the reduction in noise levels in the HKTY Ganjuran Church worship room is 0.015 < 0.05, which indicates that there is a significant correlation between this two variables. The Sig value (1-tailed) between the noise barrier design in the Gereja HKTY Ganjuran Church area and the reduction in noise levels in the Gereja HKTY Ganjuran worship room is 0.046 < 0.05, which also indicates that there is a significant correlation between this two variables. As a result, the spatial zoning design which includes the distance between each activity zones and the noise barrier design in each activity zone in the Gereja HKTY Ganjuran area has a significant correlation with the reduction in noise levels in the worship room of Gereja HKTY Ganjuran.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1.315	10.369		-.127	.920
	Distance Between Each Activity Zones	.444	.211	.712	2.104	.282
	Noise Barrier Design	-.217	.241	-.305	-.901	.533

a. Dependent Variable: Noise Level Reduction

Figure 9: Results of coefficient analysis: the effect of spatial zoning design on noise reduction in the worship room of Gereja HKTY Ganjuran
(Source: Author, 2025)

Figure 9 is the result of a multivariable linear regression analysis between the spatial zoning design, which includes the distance between each activity zones and the noise barrier design in the area of Gereja HKTY Ganjuran and the noise level reduction in the worship room of Gereja HKTY Ganjuran using IBM SPSS Statistics, and the equation obtained is as follows:

$$Y = -1{,}315 + 0{,}444X1 - 0{,}217X2$$

Y is the value of noise reduction in the worship room of Gereja HKTY Ganjuran. X1 is the distance between each activity zones in Gereja HKTY Ganjuran. X2 is the design of noise barriers that separate each activity zones in Gereja HKTY Ganjuran. Through the multivariable linear regression analysis test, it can be seen that the distance between each activity zones has a more significant effect on the noise level reduction in the worship room of Gereja HKTY Ganjuran compared to the noise barrier design used in Gereja HKTY Ganjuran.

4. CONCLUSION

This research concludes that the spatial zoning design of Gereja HKTY Ganjuran Church area includes distance, layout, and noise barrier design. Among these three aspects, the distance between activity zones has the highest impact on reducing noise levels in the worship room of Gereja HKTY Ganjuran. The bigger the distance between each activity zones, the

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lower the noise level will be. This research can be improved by focusing on the noise barrier design in each activity zone in the Gereja HKTY Ganjuran area.

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