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POST-OCCUPANCY EVALUATION ON RENOVATION ELEMENTS IN THE GPDI ELOHIM CHURCH BUILDING, SIDOARJO, INDONESIA

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Abstract

The church building is a place of meeting and worship for Christians. Throughout history, Christianity has evolved into numerous synods spread across the world, including in Indonesia. Each sect has its own worship procedures or liturgy, which differ but still share the same identity as followers of Christ. Meanwhile, the architecture of the church building is greatly influenced by these liturgies. Not only the ornaments, spatial arrangement, and circulation in it, but also regarding the acoustics of the room, thermal comfort, and lighting. All of these elements help the congregation enjoy the spiritual experience in worship. One of the many sects of Christianity, Pentecostalism is a synod that continues to develop today in the world and in Indonesia, with its synod name being the Gereja Pantekosta di Indonesia (GPdI), which was first established in 1924, both in small and large groups. GPdI Elohim, located in Sidoarjo City, was established in 1966 and relocated to a new building on Jalan Kombespol M. Duryat in 1991. Since 2011, the main building has undergone renovation with the aim of enhancing thermal comfort, improving acoustics, upgrading sound systems, refining lighting arrangements, and enhancing other building properties. Post-occupancy studies and preference studies were conducted to determine the achievements of the renovation activities enjoyed by the congregation, and are expected to be used as a reference for other church buildings, especially in other GPdI synods

Keywords: church building comfort, church architecture, renovation preferences, Post-occupancy evaluation (POE)

1. Introduction

According to a comprehensive analysis presented in an article published by the Orthodox Church in America, the term that encapsulates the essence of the early Christian Church specifically relates to the ecclesial community founded on the momentous occasion of Pentecost, which occurred exactly fifty days after the miraculous resurrection of Jesus Christ from the dead (AmericaTM, n.d.). The day that Christians believe is the day the Holy Spirit came down and began to speak in other languages (life.church, n.d.). Since the day of Pentecost, the community of believers has increased and grown, and now it has spread to more than 2.6 billion people throughout the world (Encyclopedia et al., 2015).

The Pentecostal Church in Indonesia was founded with the arrival of two missionary families from the Bethel Temple Church in Seattle, USA, in 1921, namely Rev. Cornelius Groesbeek and Rev. Richard Van Klaveren (Tambunan & Ruslim, 2021). On June 4, 1924, the existence of "De Pinkster Gemeente in Nederlandsch Indie" as a "Vereeniging" (association)



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was legally recognized by the Dutch East Indies Government. Then, on June 4, 1937, the Pentecostal movement was elevated to the status of a church fellowship with the name "Pinksterkerk in Nederlansch Indie," which was subsequently changed in 1942 to "Gereja Pantekosta di Indonesia" (GPdI) (Aritonang, 2012).

As part of the Pentecostal Church synod in Indonesia, GPdI Elohim Sidoarjo was pioneered by Pdt. Silas Juwono and Pdt. Dina Aspara since 1966. The first location was on Sisingamangaraja Street, and then, since December 18, 1991 officially moved to a new building on Kombespol M Duryat Street, Sidoarjo, until now (GPdI Elohim Sidoarjo, n.d.). The building has a larger capacity than the old building, which can now accommodate up to 1200 seats. With building facilities that are also more complete to support congregational activities it.

The architectural design of the GPdI Elohim Sidoarjo church building features numerous openings on both the walls and the roof. It appears that the architect of this building attempted to utilize air circulation and natural lighting, as indicated by the numerous openings.



Figure 1. Map of the location of the GPdI Elohim Sidoarjo church building



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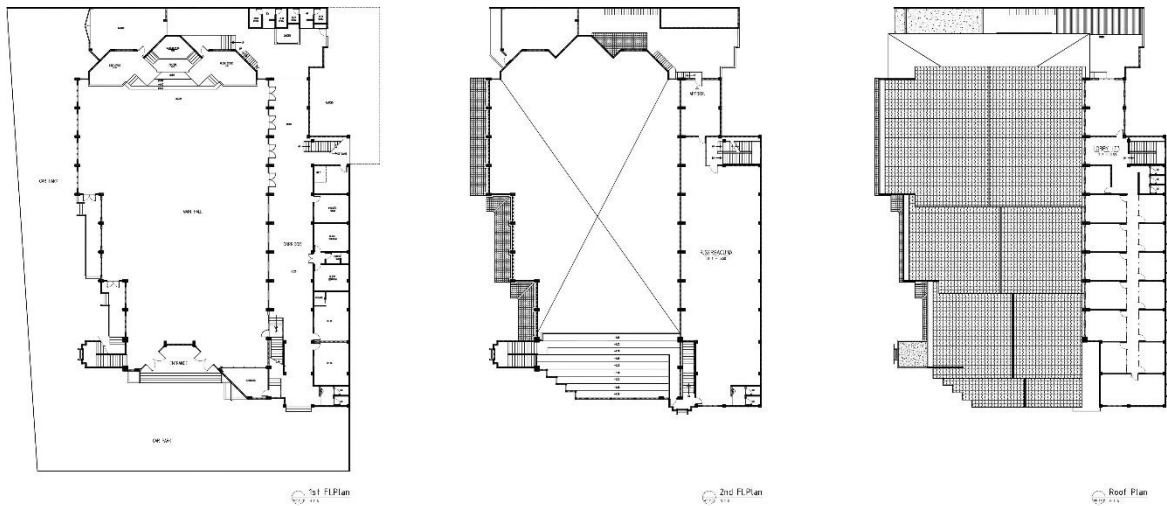


Figure 2. GPdI Elohim Sidoarjo church building plan

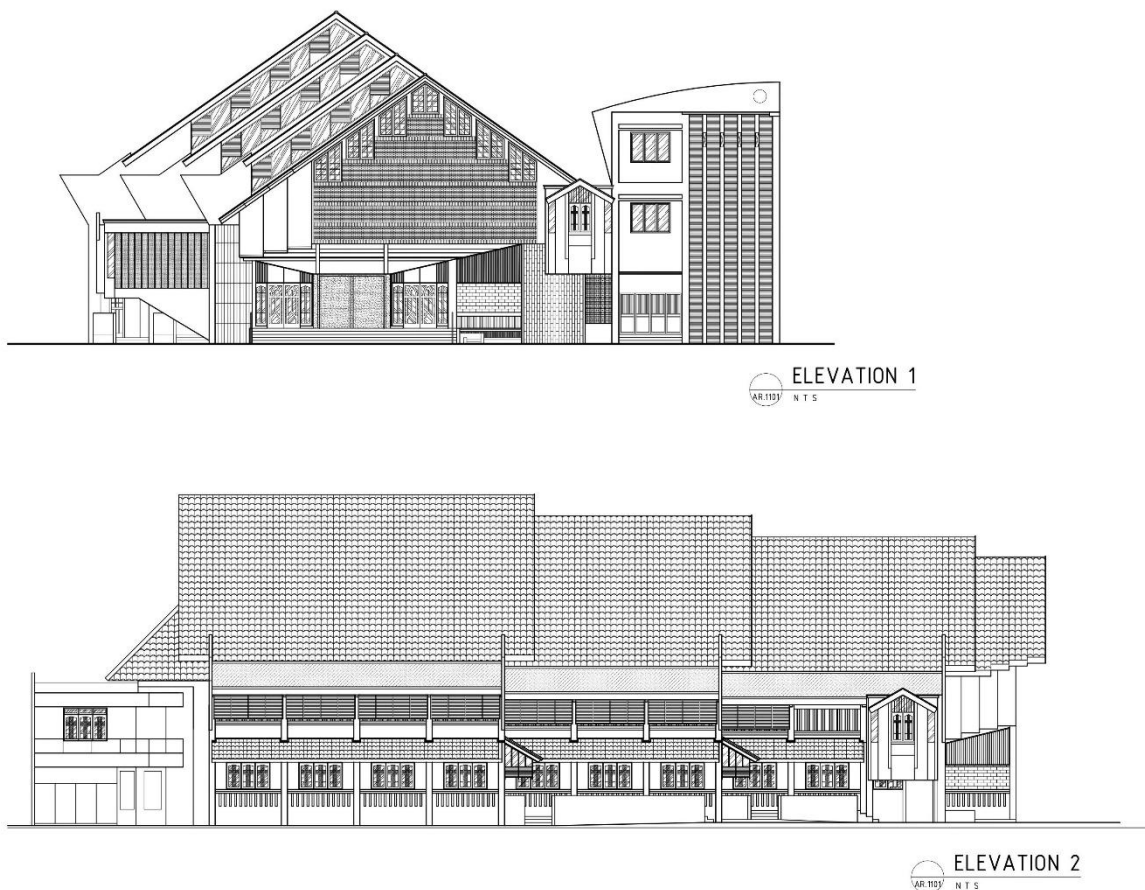


Figure 3. Existing elevation plan

GPdI Elohim Sidoarjo or churches in general in worship, music has a very important role. Music helps create an atmosphere of respect and spirituality so that the congregation can express their faith and emotions. In addition, praise and worship foster a sense of unity and bond between congregations. The lyrics of the songs that are sung have theological messages



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and teachings and biblical teachings (Austin Cole Lovelace, 1987). In GPdI Elohim as Pentecostal churches also charismatic sing new spiritual songs, with more modern arrangements, the use of modern and complete musical instruments. So that modern sound system equipment is used in this church building.

In 2009 when the pastorate was replaced by Pdt. Franklin Lumoindong and his wife Pdt. Nina Kenanga, the daughter of the pioneer pastor Pdt. Silas Juwono, intended to renovate the church building. There were several reasons why the work needed to be done. The first reason was that the building was 18 years old and had not been renovated. In addition, the church leaders felt that the sound system and temperature were uncomfortable. Both of these things were the results of observations and things felt by the pastor with reports and input. It was also seen that many congregants were fanning paper because they felt hot as a sign of uncomfortable temperature. With the sound system, it was reported that the sitting position at the back made it difficult to hear the sermon properly. This triggered the congregation to chat during the worship service. Even several times there were congregants who fell asleep during the service.



Figure 4. GPdI Elohim Sidoarjo church facade



Figure 5. Church interior before renovation



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Then a team was formed to carry out renovation activities to try to improve the condition. The architectural team began to analyze the church building and began to determine what things needed to be done to improve the interior of the church building, especially in terms of sound and room acoustics, thermal comfort of the room, and rearranging the lighting in the building.

From the analysis, it was found that in terms of room acoustics, with many openings and cavities with a building size that large, it becomes a problem and disturbance to the room's acoustic system. The openings themselves become a source of sound from outside the church building and become a disturbance. Poor acoustics hinder speech clarity and listening to music (Luigi, 2020). Meanwhile, contemporary churches have different acoustic conditions with reverberation times of 3 to 5 seconds and clarity between -2.2 to -5.8 dB and it affects the perception of sound during worship (Astolfi, 2023). This shows the importance of improving the acoustics of church buildings to improve the quality and distribution of good sound.

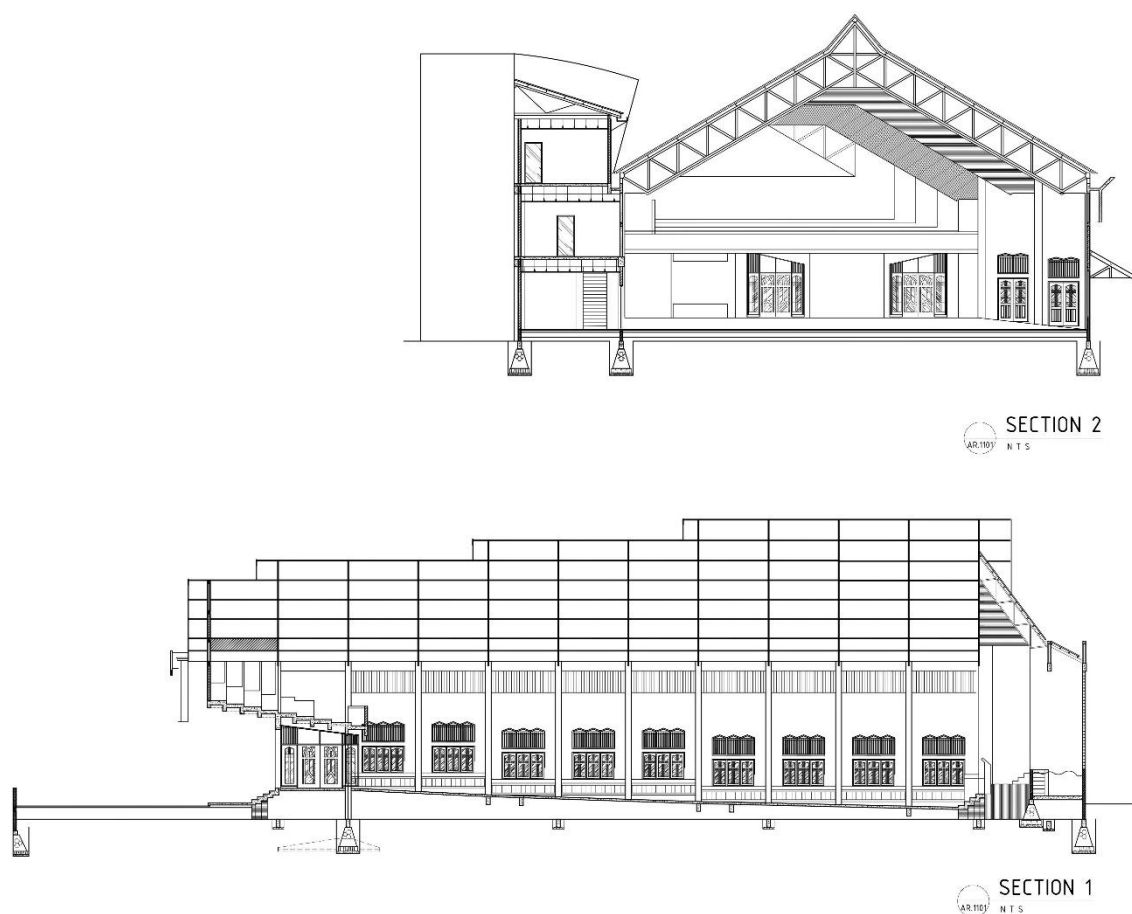


Figure 6. Existing section plan

Sidoarjo City Where the church building stands is between $112^{\circ} 5'$ and $112^{\circ} 9'$ east longitude and between $7^{\circ} 3'$ and $7^{\circ} 5'$ south latitude with a level of 3 meters above sea level with a tropical wet and dry climate with two seasons. With rainfall between 1,300-1,700 mm per year. The air temperature varies between 21° - 34° Celsius with a relative humidity of around 76% (Kabupaten Sidoarjo, n.d.). However, if monitored daily, the environmental

temperature in Sidoarjo can reach 37 °C, which is quite warm, tending to be hot. This condition necessitates cooling to achieve thermal comfort, especially during worship activities, as it can enhance the worship experience and accommodate increased attendance (Vella et al., 2022).

Meanwhile, the results of observations and experiences of church leaders stated that church buildings still lack thermal comfort, even with the semi-open design of church buildings. Even after installing an AC machine, it still feels lacking, so additional AC is needed. This is felt and observed by the many congregations who appear to feel hot during worship. The initial hypothesis of this situation is that the open design of the building, the roof and ceiling with narrow distances without heat insulation do not provide thermal comfort for congregation activities in it.

Data iklim Sidoarjo , Jawa Timur, Indonesia													[sembunyi]
Bulan	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des	Tahun
Rata-rata tertinggi °C (°F)	31.5 (88.7)	30.9 (87.6)	31.1 (88)	31.5 (88.7)	31.6 (88.9)	31.6 (88.9)	31.4 (88.5)	31.5 (88.7)	32.4 (90.3)	33.6 (92.5)	33.5 (92.3)	32.3 (90.1)	31.91 (89.43)
Rata-rata harian °C (°F)	27.6 (81.7)	27.3 (81.1)	27.4 (81.3)	27.6 (81.7)	27.3 (81.1)	27.2 (81)	26.9 (80.4)	27.1 (80.8)	27.7 (81.9)	28.8 (83.8)	28.9 (84)	28.2 (82.8)	27.67 (81.8)
Rata-rata terendah °C (°F)	23.7 (74.7)	23.6 (74.5)	23.7 (74.7)	23.7 (74.7)	23.1 (73.6)	22.9 (73.2)	22.4 (72.3)	22.6 (72.7)	23.1 (73.6)	24.1 (75.4)	24.4 (75.9)	24.1 (75.4)	23.45 (74.22)
Presipitasi mm (inci)	343 (13.5)	337 (13.27)	299 (11.77)	196 (7.72)	94 (3.7)	59 (2.32)	24 (0.94)	6 (0.24)	8 (0.31)	36 (1.42)	110 (4.33)	252 (9.92)	1.764 (69.44)
Rata-rata hari hujan	15	14	13	9	5	3	2	0	1	2	5	12	81
% kelembapan	83	81	80	79	75	71	69	67	65	68	72	77	73.9
Rata-rata sinar matahari bulanan	141	152	177	204	215	236	259	298	300	297	246	183	2.708
Sumber #1: Climate-Data.org ^[8]													
Sumber #2: BMKG ^[9] & Weatherbase ^[10]													

Figure 7. Climate data Sidoarjo (Kabupaten Sidoarjo, n.d.)

The third need is about lighting in the interior of the building. It does not mean that the old lighting is lacking, but it requires lighting that focuses on the pulpit area and aesthetic lighting to provide a more attractive visual effect and a broader and more meaningful emphasis. The color of light brings and creates an atmosphere during worship in church services. (Warbung et al., 2021). The third need is about lighting in the interior of the building. It does not mean that the old lighting is lacking, but lighting is needed that focuses on the pulpit area and aesthetic lighting to provide a more attractive visual effect and a broader and more meaningful emphasis. The color of light brings and creates an atmosphere during worship in church services. In addition to creating an atmosphere in the room, it can also provide strength to the shape in the interior so that it provides a more dynamic contrast between light and shadow. (Sovilj, 2020). This property was not owned before the renovation and could only be rented for certain events or celebrations of big days such as Easter and Christmas. The addition of lighting needs to be planned for both the position, type of lamp and its intensity. Lighting that is more flexible to different needs in a series of worship activities.

No less important and arguably the main one is the interior design inside the church building itself. With a different time period of approximately 18 years the building was standing at that time, a more modern atmosphere refreshment was needed. With the new concept also facilitating improvements in terms of acoustics and sound systems, improvements in thermal comfort and better lighting. All of these elements integrate with each other in creating a holistic atmospheric experience. (Wang & Dai, 2023)(Grietēna, 2014)(Zhang & Ban, 2022)

Based on the needs and responding to issues in the renovation work of the church building, several things were done. With the condition of the building and the condition of the congregation who had not long experienced the tragedy of a plane crash that claimed the lives

of Rev. Jonah and his family, the pastor, before the inauguration of Rev. Franklin Lumoindong to replace his predecessor, the concept of the theme raised was "The New Atmosphere". It is hoped that this theme will provide a new spirit and offer new experiences, both emotionally and spiritually. The renovation focused on the interior of the building while maintaining the facade. The interior where worship services are held. The icon chosen is the Ark of the Covenant, a symbol of the covenant between humans and God, but with a modern touch. Symbols in the church are important because they reflect the identity of the church, thereby helping to strengthen faith (Żurek, 2018).

Based on these issues, renovations began on all interior elements of the church building. Repairs were carried out gradually to adjust to the church's financial condition, all of which were made possible through voluntary collections from the congregation. The following are things that were renovated in the interior of the church, including:

1. Improvement of thermal comfort

Thermal comfort improvements were made by adding thermal insulation to the top of the room's ceiling. The building previously utilized the roof's shape to shape the ceiling inside the room, as well as openings for air and light circulation. The space between the ceiling and the roof tiles is only as wide as the steel frame, which is approximately 1.5 meters without using insulation.

The insulation used is bubble aluminum foil with glasswool installed on top of the new ceiling frame. The new ceiling shape slightly changes the overall shape of the ceiling by closing the openings in the roof. With this method, it is expected to inhibit the spread of solar heat radiation from the roof into the building.(Zeng, 2018). This is done to stabilize the temperature and humidity conditions in the room, allowing the air conditioner to perform more optimally.

In addition to the roof renovation, the wall cavities that were previously used for cross ventilation were also sealed with boards and covered with wall curtains on the right and left sides of the room. The AC machine's capacity was also increased from 60PK to 80PK, with the addition of four standing AC units.

2. Improvement of sound system and room acoustics

The first step in improving the sound system and acoustics of the building is to analyze the acoustic conditions of the room. According to the standard room reverberation for the use of church space, the ideal reverberation time is between the auditorium and music room, which is 1-2 seconds. But from the calculation table data (Global, n.d.) the church building room with existing RT60 material (room reverberation time simulation results) is 10.41 seconds, and that is far from ideal.



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Tabel 1. Room echo standard, source (Global, n.d.)

STANDART GEMA RUANGAN

Jenis Ruangan	Waktu Dengung Ideal (RT60)
Ruang Kelas	0.6 - 1.0 detik
Ruang Rapat	0.5 - 0.8 detik
Ruang Auditorium	1.0 - 1.5 detik
Ruang Konser	1.5 - 2.0 detik
Ruang Studio Musik	0.3 - 0.7 detik
Ruang Perpustakaan	0.6 - 1.0 detik
Ruang Rumah	0.3 - 0.6 detik

Tingkat Waktu Dengung Berdasarkan SNI 03-6386-2000

Tabel 2. Room Reverberation Level Simulation Calculation at 500 Hz Frequency, (Global, n.d.)

Perhitungan Simulasi Tingkat Gema Ruangan Pada Frekuensi 500 Hz

Panjang Ruangan (m):

Lebar Ruangan (m):

Tinggi Ruangan (m):

Material Dinding:

Material Lantai:

Material Plafon:



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Hasil Perhitungan	
Parameter	Nilai
Panjang Ruangan:	36 m
Lebar Ruangan:	23 m
Tinggi Ruangan:	12 m
Luas Dinding:	1416.00 m ²
Luas Plafon:	828.00 m ²
Luas Lantai:	828.00 m ²
Total Luas:	3072.00 m ²
RT60 (Hasil Simulasi Waktu Gema Ruangan):	10.41 detik

Hasil perhitungan ini hanya berdasarkan nilai NRC Material di frekuensi 500Hz saja, untuk frekuensi lainnya butuh analisa lebih lanjut oleh tim akustik kami.

According to the calculation results above, it is necessary to make improvements to the surface material inside the church building. The new design of the ceiling on the shape of the ceiling surface and changes in the ceiling material. The ceiling that previously used gypsum was changed to a ceiling with Yumen acoustic board with a thickness of 1.5 cm. While on the walls are installed curtain cloth hanging from the ceiling to the floor. The use of curtains is very good in acoustic functions in the room, very efficient in absorbing medium to high sound transmission. (Kumar et al., 2021)

Spesifikasi Yumen Acoustic :

Ukuran (cm)			Motif	Pengikat	Aplikasi
Tebal	Lebar	Panjang			
1.5	60	120	Serat halus	Semen Putih	Acoustic Dinding Plafon
2.5	60	120			
1.5	60	60			
2.5	60	60			

Color :

The image displays four square color swatches arranged in a 2x2 grid. Each swatch has a textured, slightly mottled appearance. The top-left swatch is a dark, earthy brown with the word 'BROWN' printed in white capital letters at the bottom. The top-right swatch is a dark, forest green with the word 'GREEN' printed in white capital letters at the bottom. The bottom-left swatch is a light, off-white or cream color with the word 'IVORY' printed in white capital letters at the bottom. The bottom-right swatch is a light, pale green with the words 'LIGHT GREEN' printed in white capital letters at the bottom.



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chosen because the pulpit area is the main source of sound in the building, so as not to damage the sound produced by the speakers received by the congregation, and to facilitate sound control from the controls on the mixer.



Figure 9. Use of acoustic materials on the ceiling and rear wall of the pulpit

On the previously ceramic floor, a carpet with a thickness of 4mm was installed in both the pulpit area and the congregation's seating area. Wooden benches were also replaced with single chairs, using sponges and cloth. In addition to providing better sitting comfort, it can also increase the congregation's seating capacity. The number of people previously around 800 can be increased to 1200, including those on the balcony.

The audio system plan was handed over to the specialist. The chosen sound system consisted of a direct speaker, utilizing two types of speakers: a line array hung under the ceiling at a predetermined height and a woofer positioned on the floor below. The speaker location, speaker power, and number were used in the program simulation by the specialist team. However, the results of this simulation were not documented at that time.

3. Interior lighting plan

The lighting arrangement in the interior of the church building is divided into four parts: direct general lights, indirect lights, aesthetic lights, and stage lights. The intensity, type, and layout of the lights are adjusted to the needs and activities in the church building. General lights are directly used for main lighting with sufficient capacity, even for reading. The lights used are armature downlights with 23W LED bulbs in two colors: 4000K and 6000K.



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Figure 10. Direct and indirect lighting atmosphere

Indirect lighting is used to create a warmer atmosphere. These indirect lights use TL lights with a color of 3000K, which are placed on the hanging ceiling and curtain lines along the right and left sides of the interior.

The aesthetic lights in question are spotlights that highlight objects in the interior. These lights form highlights and shadows that give a 3D impression to these objects. The lights were used to highlight the wing icons and the back of the pulpit in front of the acoustic wall. And lastly, there are the stage lights. These stage lights play a role in providing color in the pulpit area, spotlighting the worship leader on the pulpit, and motion lights to provide a spectacular effect. The placement of these stage lights is hung above the pulpit and positioned on the pulpit (specifically for motion lights)



Figure 11. Light sprinkles provide color in the pulpit area



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4. Interior design with new concepts and themes

The theme taken in the interior is "the New Atmosphere". Complete overhaul of the interior appearance of the church building, featuring new elements and a fresh atmosphere, resulting in improved function and aesthetics.

On the back of the pulpit, there are eight curved blades that depict two cherubim with four wings. This image is taken from the shape of the Ark of the Covenant. A wooden coffin overlaid with gold, with a coffin lid on top of which is an icon of a pair of cherubim, each of which has 4 wings, 2 wings covering the body of the cherubim and another pair on top meeting each other. It contained the two stone tablets of the covenant, which contained the Ten Commandments, Aaron's rod, and a pot of manna. (Fisher, 2013). In Judaism and Christianity, Cherubim are angelic figures who have a very high position, even more than the angels, being close to the Father, the God of the universe. (Paşca-Tuşa & Popa-Bota, 2019)(Johnson, 2022)



Figure 12. The Ark of the Covenant (The Ark of the Covenant, Exodus 25, 2022)

There are 4 sheets standing on the pulpit as a depiction of the wings of the cherubim, which is a symbol of the throne of the Most High and the presence of His power in the church building. An icon that reminds the congregation of His presence and reverence for God.

5. Multimedia properties update

In a world that is becoming increasingly digital, the church is also updating its properties accordingly. The beginning of the church was opened for messages or texts presented through congregational bulletin sheets, which were displayed using an overhead projector (OHP). The OHP was then replaced with an LED Projector, which was still used when this renovation was carried out. After the LED display became popular, church leaders decided to replace the projector with an LED Display. To support a better, more communicative, and efficient display, multimedia properties were also upgraded. Among other things, computer control, digital cameras integrated with multimedia, and the use of social media as a means of communication between the church and its congregation.



6. Improvement of other supporting facilities

The supporting facilities that have been improved include the addition of a multimedia room, a sound system control room, increased toilet capacity, a corridor area that has been converted into a communal space, and a music studio for recording and practice. With the increasing improvements made to the church building, there has been a corresponding increase in congregational activities. Also triggered by the COVID-19 pandemic a few years ago, multimedia activities have become very important. There are no worship activities in the church building; instead, they are held online at people's respective homes. The increasingly complete supporting facilities also increase the creativity of young people to be active.

Since 2012, the first phase of renovation work has been completed. From personal observations, improvements have been noted in terms of sound systems and room acoustics, as well as thermal comfort and more varied and attractive lighting. In the distribution of sound, personal observations were made in a straightforward manner, namely by walking around the entire congregation seating area during music practice. It was felt that there was no area that received less sound from the front speakers. The sound was received clearly, both music and speech, from all over the room. Even after the practice stopped, the sound of conversation in the pulpit area could still be heard, albeit faintly, from the mixer control room behind, without the use of loudspeakers. This was not visible before the renovation was carried out.

For room cooling, the AC capacity was increased from 60 PK to 80 PK. During worship activities, it turned out that not all ACs needed to be turned on; some units were left off, and the cool air was felt to be enough. Some of the congregation felt cold, unlike before, even though all ACs were turned on, the congregation still felt hot and seemed to be fanning sheets of paper towards their faces. It seems that the use of heat insulation on the ceiling and closing the air circulation holes has an effect on the effectiveness of AC use.

Changes in the interior, lighting, floor materials, and types of chairs give a different atmospheric effect than before. This was obtained from the confession of several congregations and church leaders who were happy with the updates made.

What is apparent from the congregation's behavior when attending worship is that there has been a change, as they have observed. Things that have changed in the behavior of the congregation when attending worship include:

1. There is no or drastically reduced behavior of the congregation chatting during the service.
2. If talking to other congregations, it is not done in a loud enough voice as before, but is done in a whisper.
3. There is a decrease in congregants falling asleep during worship, especially when the sermon is being delivered.
4. There is a great decrease, and it is rare to find congregations fanning paper as a sign of being hot. If there is, there is indeed an AC that is deliberately turned off. When the AC is turned on, it is no longer found.
5. Sounds from outside that used to be clearly heard inside the building are now not too audible and do not interfere with the sound of music or sermons.
6. Trash is also left very little inside the church building, unlike before.



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According to the initial hypothesis, renovating the interior of the church building to improve sound quality, acoustics, materials, properties, and thermal comfort can alter the congregation's behavior in attending worship. With this change in behavior, the congregation will follow the course of worship more and improve order.

The numerous improvements made at GPdI Elohim Sidoarjo can run smoothly, even though they are implemented in stages, thanks to the congregation's great support. The number of registered congregations exceeds 1,600 people and provides significant support, enabling this work to be carried out.

Background of the Problem

The results of personal observations regarding behavioral changes may be correct but may also be less accurate. Post-occupancy study analysis will be more accurate if the behavioral changes can be explained by the congregation themselves regarding what they felt before and after the renovation. And can reveal the reasons for the congregation when behavior changes during worship through the congregation's personal experiences.

As explained above, the support of a large congregation with great ability can also make this renovation can be done well. Almost all the interior elements of the church building were affected by the renovation. Perhaps for churches with fewer congregations and limited financial capabilities, it will be difficult to replicate the approach taken in the GPdI Elohim Sidoarjo church building. Therefore, a scale of priorities is necessary to consider what needs to be improved, ensuring that the most basic needs of the congregation are met.

Identification of problems

After numerous renovations have been carried out and observations made on changes in congregation behavior during worship, a post-occupancy evaluation (POE) has never been conducted directly with the congregation. and despite the various parts or interior elements that have been improved, it remains unclear what the congregation's preferences are for the parts or elements that are most needed to enhance their worship experience.

Formulation of the Problem

There are two problem questions in this research plan, including:

- Based on the post-occupancy evaluation (POE), is it true that the interior renovation of the GPdI Elohim Sidoarjo church building has an impact on changes in congregation behavior in worship?
- What are the congregation's preferences for the renovated elements? Which renovation elements have a significant contribution to the comfort and satisfaction of the congregation in worship?

Research Purposes

Theoretically, this study can contribute to the understanding of post-occupancy evaluation in the context of architectural places of worship. Practically, the results of this study are expected to help the church improve the quality of its facilities and environments, making them more in line with the congregation's needs. and for churches that will make improvements and renovations, the results of this study are expected to be a reference for determining the

priority scale of parts that will be improved according to the needs of the congregation in worship.

2. Literature Review

This review will cover several important topics, including the concept of Post-Occupancy Evaluation (POE), a study of user preferences for renovation elements, and the relevance of the study to church buildings in Indonesia.

2.1. Post-Occupancy Evaluation (POE) in the Building Context

POE is an evaluation method used to assess the performance and user satisfaction of a building after it has been in use. This concept helps identify the success or failure of design elements that have been implemented in a construction project (Preiser, 2001). POE typically includes factors such as comfort, energy efficiency, accessibility, and safety, all of which affect the user experience. Studies have shown that POE can be an important tool to improve future building design and provide valuable input for more efficient renovation and space planning projects (Preiser, 2001)(Zimmerman & Martin, 2001).

2.2. Preference Study in Renovation Projects

Preference studies are a crucial component in understanding user needs and desires for specific elements in a building, particularly when the building is undergoing renovation. In the context of a religious building renovation project, user preferences may include aspects such as lighting, acoustics, ventilation, aesthetics, and design elements that support religious activities. User preferences are often influenced by cultural background, religious traditions, and the specific functional needs of the worship space (Yabes, 2000)(Sanoff, 1999). This research can also help determine the priority of renovation elements to improve user comfort and satisfaction with the building.

2.3. POE and Preferences in the Context of Church Buildings

In the context of church buildings, POE can help in understanding how design elements and renovations can support liturgical functions and community activities. Studies related to POE in church buildings often emphasize acoustic comfort, natural lighting, and design elements that support worship concentration (Watson & Kessler, 2012). In addition, the church, as a public space that is used by the community regularly, requires special attention to aspects of building durability, accessibility, and spatial flexibility.

This study also considers how renovations can affect user engagement. In church buildings, attention to user preferences often reflects the need for harmonious, calm, and liturgical-supportive spaces. A deeper understanding of these preferences can provide insight for decision makers in determining which renovation elements are most important to the church community (Hershberger, 2000).

2.4. Post-Occupancy Evaluation Methods in Places of Worship

2.4.1. Understanding Post-Occupancy Evaluation (POE)

Post-Occupancy Evaluation (POE) is a systematic process to measure the effectiveness of a building after it has been used for a certain period of time. According to (Preiser, 2001), POE is conducted to understand how a building supports the needs of its occupants, including

functional, technical, and behavioral aspects. This evaluation allows for the development of recommendations for future improvements.

POE is very important in the context of building places of worship because the success of design and renovation is determined by the comfort, satisfaction, and needs of users in worship and social activities.

2.4.2. Post-Occupancy Evaluation Methods

There are several POE methods that are commonly used, including:

1. Questionnaire Survey

A questionnaire survey was used to collect data from building users regarding their satisfaction, comfort, and perceptions of the renovation elements. This survey involved parameters such as thermal, acoustic, visual comfort, and space functionality (Vischer, 1989).

- Application example: A questionnaire for church users involved evaluating the level of comfort during services, the clarity of the sermon, and visual perception of interior design elements such as lighting and ventilation.

2. In-depth Interview

In-depth interviews allow for deeper exploration of user opinions and experiences. This method is effective for understanding specific preferences in religious contexts, where symbolism and spiritual atmosphere are important.

- Application example: Interviews with congregation, pastor, and church administrators to understand the extent to which renovation elements support spiritual aspects and liturgical needs.

3. Direct Observation

Direct observation is done by monitoring user activities inside the building. The focus of observation can include patterns of space use, comfort of activities, and the flow of congregation movement.

- Application example: Observation of congregation distribution in the main church hall during services to evaluate room capacity and air circulation.

4. Quantitative and Qualitative Data Analysis

The use of quantitative data such as temperature, noise and lighting measurements helps evaluate technical aspects. This data is complemented by qualitative analysis of user experience to provide a holistic picture.

- Application example: Measuring noise levels in prayer rooms and correlating them with user perception of sound clarity.

5. Focus Group Discussion (FGD)

FGD involves group discussions consisting of building users, stakeholders, and experts. This method is used to explore specific issues and develop collaborative solutions.

- Application example: Discussion with renovation team and church congregation to evaluate the success of new design elements.

2.4.3. Relevance of POE in Buildings of Places of Worship

POE in the context of places of worship, such as churches, has a special focus because these buildings have high spiritual, social and symbolic value.

1. Spiritual and Aesthetic Aspects



The evaluation includes the extent to which design elements and renovations support the spiritual experience of users. This aspect involves visual comfort, interior design aesthetics, and symbolic harmony that supports the atmosphere of worship.

2. Thermal and Acoustic Comfort

Places of worship often involve activities with high sound intensity (such as music and sermons). Therefore, acoustic evaluation becomes crucial. In addition, thermal comfort ensures that worship can run smoothly without disturbance from environmental factors.

3. Space Functionality

The POE also assesses the functionality of the space, such as furniture layout, accessibility for all congregants, and the flexibility of the space to support various community activities.

2.5. POE Case Study in Place of Worship

Several previous studies on POE in places of worship can be used as references:

1. *Study on Jakarta Cathedral Church* – Evaluation of acoustic and thermal comfort for worship activities and the influence of renovation design on congregation satisfaction (Susanti et al., 2015).
2. *Design of Space and Artificial Lighting to Support an Atmosphere of Contemplation at the Regina Caeli Catholic Church, Jakarta* (Mandala, 2020).
3. *POE Study in Surabaya Modern Church* – Focus on space flexibility and use of technology to support worship (Prasetyo & Widodo, 2018).
4. *A review of architectural Design of a sanctuary for the Independent Baptist Bible Church of New Haven, Enugu.* (Haven, 2022)

The results of this study indicate that design elements such as natural lighting, good acoustics, and ventilation arrangements have a significant influence on user satisfaction in places of worship.

2.6. Conclusions and Implications of the Literature Review

The Post-Occupancy Evaluation method allows for a comprehensive evaluation of the success of a renovation of a place of worship. Through a combination of survey methods, interviews, observations, and data analysis, POE helps identify areas for improvement and ensures that the building can optimally support the function of worship.

3. Method

This study uses the Post-Occupancy Evaluation (POE) method with a mixed-methods approach, involving qualitative and quantitative methods. The following are the stages of the research method that will be used:

1. Questionnaire Survey

- Objective: To collect data on congregation perceptions related to renovation elements, such as thermal comfort, acoustics, lighting, and functionality.
- Technique: Distributing questionnaires to GPdI Elohim church congregations.
- Measuring instrument: Likert scale 1-10 to measure user satisfaction levels

2. Semi-Structured Interview

- Objective: To obtain in-depth data on user preferences and experiences with renovation elements.
- Participants: Pastors, church administrators, and several congregation members.

- Technique: Direct interview guided by open questions.

3. Direct Observation

- Objective: Understand space usage patterns and user comfort during worship activities.
- Technique: Observation during worship, including circulation patterns, congregation distribution, and user activities in the worship space.

4. Quantitative Measurement

- Objective: To assess thermal comfort, lighting, and noise levels.
- Measuring instruments: Digital thermometer for temperature, lux meter for lighting, and sound level meter for noise.

5. Focus Group Discussion (FGD)

- Objective: Identify solutions and input from the congregation regarding renovation elements that still need improvement.
- Participants: Congregation representatives, church administrators, and renovation planning team.

4. Result and Discussion

The results of this study are expected to show the effectiveness of renovation elements at GPdI Elohim Church, Sidoarjo in supporting user comfort and satisfaction.

1. Thermal Comfort Aspects:

- The results of room temperature measurements indicate the optimal range or require improvement of the ventilation system.
- Questionnaire data shows the extent to which users feel thermally comfortable during worship activities.

2. Acoustic Quality:

- Noise measurements and user perception of sermon clarity.
- Identify areas that may experience acoustic problems, such as echo or noise interference.

3. Lighting Quality:

- Results of measurements of natural and artificial lighting and congregation perceptions of visual comfort.

4. Space Functionality and Layout:

- Findings on flexibility and accessibility in church spaces.
- Evaluation of furniture design and space distribution to support worship and community activities.

5. Recommendation:

- Based on the findings, recommendations are provided for further improvements in the technical and functional aspects of building design.

5. Conclusion

The results of this study can be input to church building managers in the future. In addition to input for GPdI Elohim Sidoarjo, it is also a reference for other churches that have

similarities in liturgy and are going to renovate their worship buildings so that planning can be done in the long term and there are priorities so that it runs efficiently.

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