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Design and Analysis of the Development of Musical Instrument and Multimedia Facilities Room at HKBP Perumnas Klender Church

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A B S T R A C T

This Community Service Program (PKM) aims to design and analyze the development of a music and multimedia room at HKBP Church Perumnas Klender as part of an effort to enhance the quality of modern and inclusive worship services. The project was conducted by a multidisciplinary team from the Civil Engineering, Architecture, and Electrical Engineering departments of Universitas Kristen Indonesia. The main focus of the project includes three core aspects: (1) architectural design of an ergonomic and acoustically optimized space, (2) structural analysis and reinforcement to support additional loads from musical and multimedia equipment, and (3) efficient and safe design and installation of electrical and multimedia systems. The methodology includes field surveys, user needs analysis, 3D modeling, structural calculations using civil engineering software, and simulation of electrical and multimedia systems.

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INTRODUCTION

The church serves as a place of worship and a central hub for spiritual activities, playing a crucial role in nurturing the faith of its congregation. To support meaningful and solemn worship services, adequate facilities are essential particularly in the areas of music and multimedia. Today, music and multimedia technology have become vital elements in worship, enhancing the delivery of spiritual messages and creating an engaging worship atmosphere (Barus & Gondowijoyo, 2022; Janawati & Gulo, 2022).

HKBP Perumnas Klender Church is currently facing several challenges that hinder the optimal implementation of worship services, especially regarding the availability of space and facilities for musical instruments and multimedia equipment. At present, the church does not have a designated room for storing instruments such as keyboards, guitars, drums, and other multimedia devices. Furthermore, singers and choir members lack a conducive space for rehearsals, resulting in poor coordination and preparation before services. This situation negatively impacts the quality of worship, both in terms of sound and overall congregation comfort (Ola, 2022).

In addition, limited multimedia infrastructure has led to difficulties in operating audio systems, projectors, and live-streaming equipment. The lack of a dedicated control room and poor acoustics have resulted in subpar sound and video quality during worship services. Multimedia devices are often moved around, increasing the risk of damage and adding to the operational burden on the multimedia team.

In a previous Community Service Program (PKM) conducted by the Faculty of Engineering at Universitas Kristen Indonesia (UKI), the existing church building was measured and documented (Tampubolon, 2022). These existing building drawings serve as a foundation for the next development phase. Building upon this, the 2025 PKM activity aims to design and analyze the development of music and multimedia rooms to improve the quality of worship services and better support the church's ministry, (SNI 2847:2019, 2019). The key issues currently faced by HKBP Perumnas Klender Church include:

1. **Limited Physical Space:**
    a. No designated room for storing musical instruments and multimedia equipment.
    b. No proper rehearsal space for singers and choir members.
2. **Impact on Worship and Ministry:**
    a. Poor sound quality due to ineffective room layout.
    b. Difficulties in coordination among musicians and singers due to space constraints.
    c. Frequent relocation of equipment causing inconvenience during services.

3. **Inadequate Multimedia Infrastructure:**
    a. Absence of a dedicated space for audio-visual equipment management.
    b. Poor acoustic planning leads to low-quality broadcasts and recordings.

This PKM aims to design and analyze the development of two additional rooms in the right and left wings of the HKBP Perumnas Klender Church building. A multimedia room equipped with an integrated audio, lighting, and digital control system. A practice room for musicians and singers to allow proper preparation before services. Through this development, the following outcomes are expected More effective management of multimedia and music operations, improved quality of worship services, and a more comfortable and supportive worship environment for the congregation. The scope of this activity includes identifying the church's needs for music and multimedia facilities, planning and designing an effective and efficient room layout, conducting architectural and structural analysis of the church building, producing 2D working drawings for the new rooms, providing technical recommendations related to acoustics, lighting, ventilation, and soundproofing, presenting the design outcomes to the church board and construction team, and educating the church team on room management and maintenance. Figure 1. shows the existing building second floor of HKBP Perumnas Klender Church which will be developed for a multimedia room and musician room (Hikmaturokhman et al., 2021).

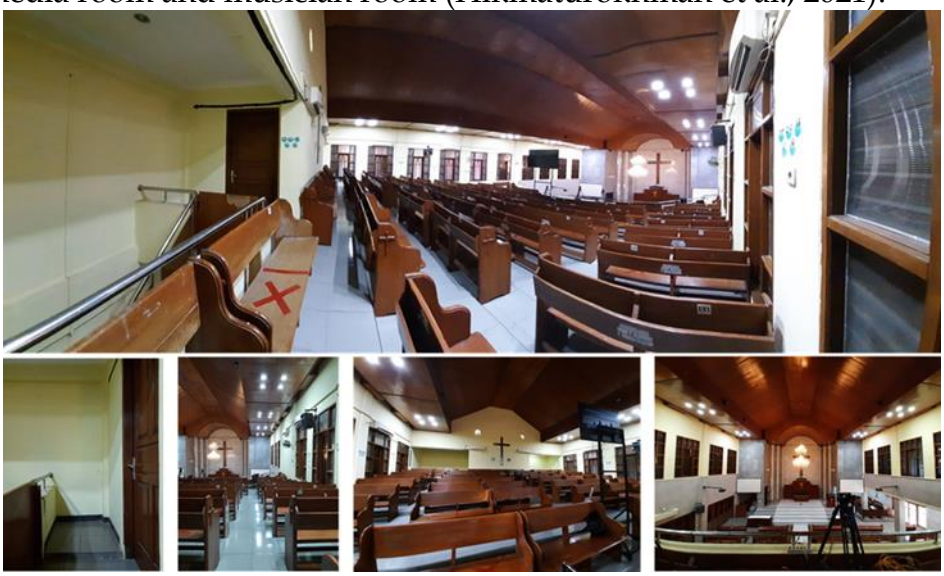

Figure 1. Existing Building Second-Floor HKBP Perumnas Klender Church

IMPLEMENTATION AND METHODS

The implementation of the Community Service Program (PKM) by the Civil Engineering, Architecture, and Electrical Engineering Departments of the Faculty of Engineering at Universitas Kristen Indonesia involves several stages to ensure the development of music and multimedia rooms at HKBP Perumnas Klender Church is carried out effectively. The following outlines the methodology used throughout the program.

Planning Stage, Identification, and Measurement

This initial phase focuses on preparing and conducting preliminary analyses to ensure that the design and development of the music and multimedia rooms are well-targeted and responsive to the needs of the church. Figure 2 shows the field surveys to analyze the existing conditions of the church and determine the most suitable locations for the multimedia and musician rooms. Identifying the necessary musical instruments, multimedia equipment, and supporting facilities such as air conditioning and lighting.

Figure 2. Measurement Existing of the Church

Coordinating with church leaders and congregation representatives to design a layout that meets user needs and expectations as shown in Figure 3. Preparing spatial layout sketches, considering acoustic treatment, lighting arrangements, and airflow circulation. Listing equipment for the musician room, including 2 organs/ keyboards, 3 vocalists, 1 drum set, and 2 saxophones. Listing equipment for the multimedia room, including 1 desktop computer unit, sound system mixer, desk, chairs, and filing cabinet. Preparing a cost budget plan (RAB) based on construction and equipment procurement needs. Submitting a proposal and securing approval from church authorities and potential donors.

Figure 3. Coordinating with Church Leaders and Measuring the Musical Instrument and Multimedia Development Room

Implementation Stage

This stage focuses on the actual construction process, equipment installation, and preparation of a comfortable environment for music and multimedia activities.

a. Site Preparation

1. Cleaning and preparing the designated area and reconfiguring the space to align with the proposed design.
2. Making structural adjustments if necessary, including the installation of Acoustic Panels and additional ventilation.

b. Construction and Installation

1. Installing partitions and soundproofing materials to enhance room acoustics.
2. Installing appropriate lighting systems based on functional requirements (Liu et al., 2022).
3. Installing air conditioning units to ensure user comfort.
4. Procuring and setting up musical instruments such as keyboards, drums, and guitars, as well as the church's audio and multimedia systems.
5. Testing multimedia equipment, including the mixer, speakers, and projector screen.

Testing and Evaluation Stage

1. Testing the audio and multimedia systems during actual worship services to assess performance.
2. Evaluating room comfort, including air circulation and AC effectiveness (Zhao et al., 2023).
3. Gathering feedback from musicians, singers, and congregations to identify areas for improvement and fine-tuning.

Maintenance and Management Stage

1. Establishing a regular maintenance schedule for musical instruments, multimedia equipment, and AC units.
2. Creating clear usage guidelines to ensure the rooms remain organized and well-maintained.
3. Allocating funds for long-term maintenance and operational sustainability.

RESULTS AND DISCUSSION

The design and analysis of music and multimedia rooms for HKBP Perumnas Klender Church were successfully implemented through a multidisciplinary approach, combining principles of architecture, structural engineering, and electrical engineering (Krismiyanto, 2021; Rosalia Rachma Rihadiani & Dwi Lindarto, 2022; Simanjuntak et al., 2019). Figure 4 shows the presentation, discussion, and coordination with church leaders about the development of the design multimedia room and musician room.

Figure 4. Presentation, Discussion, and Coordination Development Design Multimedia Room and Musician Room

Architectural Design

The spatial layout for the music and multimedia rooms was optimized for functionality and acoustics, as shown in the 2D-floor plan in Figure 5.

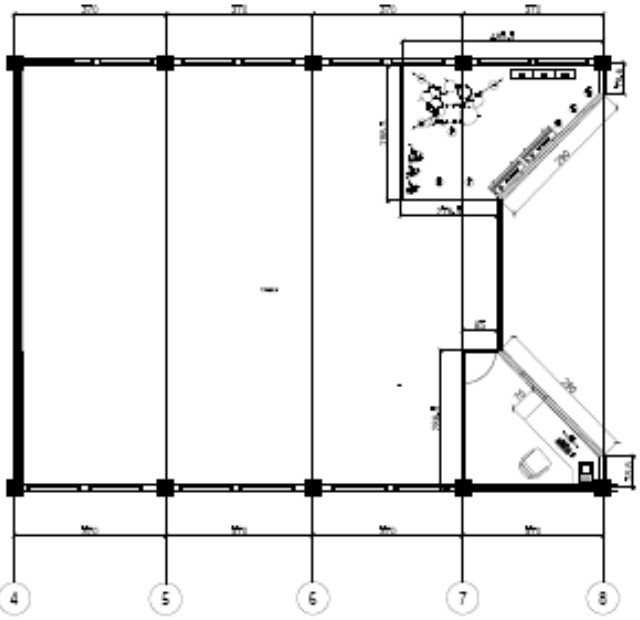

Figure 5. 2D Sketch for the Second-Floor Tribune of HKBP Church Building

The musician room (shown in Figure 6) and multimedia room (shown in Figure 7) were placed in the left and right wings of the church to minimize disruption to the main worship area (Setiawan, 2016; Umar, 2020).

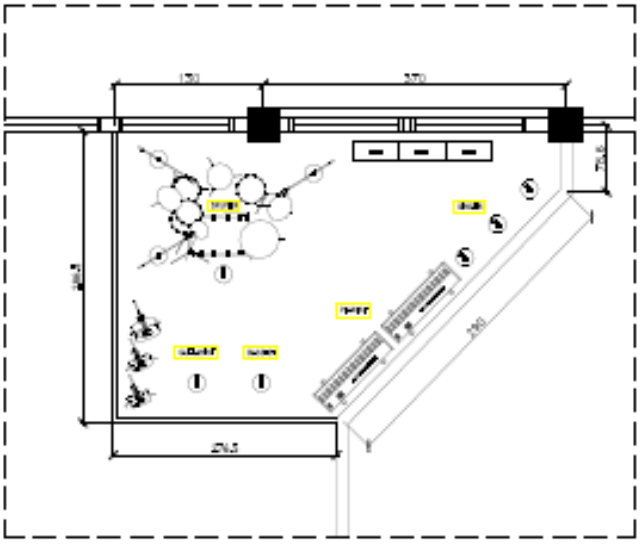

Figure 6. 2D Sketch for the Musician Room on the Second Floor of the HKBP Church Building

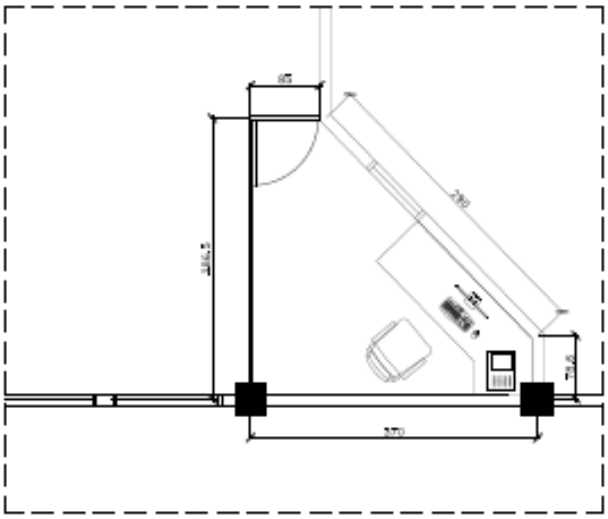

Figure 7. 2D Sketch for the Multimedia Room on the Second Floor of HKBP Church Building

Key dimensions from the 3D model, as shown in Figure 8, include a ceiling height of 3,000 mm (Figure 9(a)) and wall partitions of 1,250 mm (Figure 9(b)), which meet acoustic requirements for soundproofing and ventilation(Pelealu et al., 2017).

Figure 8. 3D Model for the Second-Floor Tribune of HKBP Church Building

(a)

(b)

Figure 9. 3D Model for the Multimedia Room on the Second Floor of HKBP Church Building (a) Side View, and (b) Top View

Structural Analysis

The structural strength of the church building was evaluated to support additional loads from musical instruments and multimedia equipment. The 3D model, as shown in Figure 10, confirmed that the existing framework could accommodate the new rooms without requiring major reinforcements, as the proposed partitions (e.g., widths of 800 mm and 1,250 mm) are lightweight and non-load-bearing.

(a)

(b)

Figure 10. 3D Model of the Second-Floor Tribune of HKBP Church Building (a) Front View, and (b) Side View

Electrical and Multimedia Systems

The electrical design for the music and multimedia rooms focused on safety and energy efficiency, with dedicated circuits for audio-visual equipment and lighting systems to prevent overload. Additionally, the integration of acoustic panels and soundproofing materials into the wall structures, as seen in the 3D model, significantly improved room acoustics by stabilizing sound resonance. This also effectively minimized sound leakage to adjacent areas, ensuring no disruption to the main worship activities.

Feedback and Testing

Initial testing of the music and multimedia rooms during worship services showed significant improvements in audio clarity and comfort for musicians and technicians operating the equipment. Beyond technical aspects, congregants also provided positive feedback regarding the more structured and harmonious coordination of the music team during services. These enhancements contributed to a deeper and more touching worship experience for all attendees, demonstrating the success of the integrated room design.

CONCLUSIONS AND RECOMMENDATIONS

This community service successfully delivered an integrated design for the music and multimedia rooms, meeting the needs of HKBP Perumnas Klender Church to enhance worship facilities. Multidisciplinary collaboration ensured a holistic solution that balanced aesthetics, functionality, and technical requirements. The 3D model and 2D-floor plan provided clear guidance for implementation, with validated dimensions and layouts for practicality.

Implementation:

1. Prioritize the installation of soundproofing materials and electrical systems according to design specifications.
2. Reassess structural capacity before construction to verify technical assumptions.

Maintenance:

1. Establish a routine maintenance schedule for equipment and room facilities to ensure longevity.
2. Train church staff on basic troubleshooting for audio-visual systems.

Future Development:

1. Consider expandable modular designs to accommodate future technological advancements.
2. Integrate smart lighting and climate control systems for energy efficiency.

This project can serve as a model for other churches looking to modernize worship spaces through multidisciplinary engineering solutions.

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