International Review of Practical Innovation, Technology and Green Energy (IRPITAGE) | ISSN (e): 2808-8611
Volumes 6 No. 2 (2026)

DESIGN OF A BUILDING DESIGN, MODELING, AND INFORMATION (DPIB) LABORATORY AS A LEARNING FACILITY AT SMK NEGERI 5 PADANG

Barkhia Yunas[1]*, Mutia Alius[2], Yuni Purnama Syafri [3], Dyla Midya Octavia [4]
Teknik Sipil, Univeristas Adzkia, Padang
Teknik Industri, Universitas Adzkia, Padang
E-mail: barkhiayunas@adzkia.ac.id [1]*, mutiaalius.ti@adzkia.ac.id [2]

Received : 07 June 2026 Accepted : 11 July 2026
Revised : 16 June 2026 Published : 31 July 2026

Abstract

The availability of a laboratory that supports the characteristics of practical learning is an important factor in developing students' competencies in Building Design, Modeling, and Information (DPIB). This community service activity aimed to develop a functional and comfortable DPIB laboratory design at SMK Negeri 5 Padang to support technology-based learning. The activity employed a participatory and user-centered design approach through several stages, including existing-condition observation, identification of partner needs, conceptual design, design development, validation, and finalization. The activity resulted in a laboratory design with an area of approximately 270 m², integrating a planning and model-making practice area, instructor room, computer-based design practice area, circulation system, lighting, ventilation, electrical facilities, and digital learning support. The proposed design provides the school with a technical reference for developing a more structured DPIB laboratory that is aligned with the needs of vocational learning.

Keywords: DPIB laboratory, facility design, vocational learning, BIM, vocational high school

INTRODUCTION

Vocational education plays a strategic role in preparing human resources with competencies that align with technological developments and labor market demands. One of the vocational competencies in Senior Vocational High Schools (SMK) that is directly related to the construction sector is Building Design, Modeling, and Information (DPIB). DPIB learning is not limited to conventional building drawing skills but has developed toward digital modeling, design visualization, construction planning, and the use of Building Information Modeling (BIM) technology. The Phase F Learning Outcomes for DPIB also include two-dimensional and three-dimensional modeling skills for structural, architectural, interior and exterior, building utility, and other digital technology-based design works (Badan Standar, Kurikulum, dan Asesmen Pendidikan, 2022).

These competency developments require the availability of learning facilities that can adequately support practical activities. Laboratories or practical workspaces in vocational education do not merely function as places for equipment, but also as learning environments that allow students to develop technical skills through activities resembling actual workplace conditions. Evaluations of DPIB learning facilities in several vocational high schools have shown that discrepancies still exist between learning requirements and the availability of facilities and infrastructure, particularly in computer laboratories and design practice rooms (Murtinugraha et al., 2021). This condition indicates that laboratory development should consider not only the availability of space but also the suitability of its functions, layout, and facilities for the characteristics of learning activities.

The need for digital learning facilities is becoming increasingly important along with the growing use of BIM in the construction industry. The integration of BIM into construction education is necessary to reduce the gap between graduate competencies and the technological developments applied in the workplace (Telaga, 2022). The use of BIM software, such as Autodesk Revit, in DPIB learning can also strengthen students' competencies and improve their alignment with the increasingly digital needs of the construction industry (Aryanti et al., 2020). Therefore, DPIB laboratories should be developed as learning spaces capable of supporting both manual design activities and digital modeling. The gap between BIM competencies taught in educational institutions and those required in professional practice remains one of the main challenges in construction education. BIM education should be directed toward developing competencies that are not merely theoretical but also provide students with experience in using technology and completing tasks that resemble industrial practices (Guo et al., 2023). This further reinforces the need for learning facilities equipped with appropriate devices, spaces, and supporting systems for digital workflows. At the vocational high school level, BIM implementation also continues to face several challenges. The implementation of BIM in learning is influenced by users' competency readiness, technological proficiency, learning equipment, and the availability of supporting facilities (Sucipto et al., 2024). Studies on the BIM competencies of vocational high school students in the building field also indicate that students' abilities still need further development to more closely meet the competencies required for BIM implementation (Irvansyah & Suryawan, 2024). Therefore, laboratory readiness is one of the important aspects that should be considered in the development of DPIB learning.

SMK Negeri 5 Padang is one of the vocational schools in Padang City that offers the DPIB Study Program. As part of its learning facility development, the school plans to utilize a building with an area of approximately 270 m^2 as a DPIB Laboratory. Based on the initial observation, the building still requires further development and more systematic spatial planning to support DPIB learning activities. The arrangement of spatial functions, placement of facilities, circulation patterns, lighting and ventilation conditions, and relationships among learning activities are several aspects that need to be considered in the design process. The existing condition of the building and its surrounding environment serves as the basis for determining the laboratory development requirements. The existing condition of the building and its surrounding environment is presented in Figure 1.

Figure 1. Existing Condition of the DPIB Laboratory Building and Its Surrounding Environment at SMK Negeri 5 Padang

The challenges faced by the partner are not limited to the physical condition of the building but also concern how the available space can be utilized effectively for various learning activities. The DPIB Laboratory needs to accommodate planning and drafting activities, model or mock-up production, computer-based digital modeling, instructor guidance, as well as discussion and presentation sessions. Without structured spatial planning, the use of space may become inefficient, user activities may interfere with one another, and digital learning facilities may not be utilized optimally.

In addition to spatial functionality, ergonomics and user comfort also need to be considered. Digital modeling and design activities require students to use computers for relatively long periods. Therefore, lighting conditions, room temperature, ventilation, workstation arrangement, and circulation space are important elements in creating a comfortable learning environment. Evaluations of computer laboratories have shown that temperature and lighting are factors that should be considered when improving user comfort in learning spaces (Lius et al., 2022). Ergonomic considerations are increasingly important because the quality of the physical environment can affect students' comfort during practical activities.

Based on these conditions, this community service activity was carried out through the design of a DPIB Laboratory that considers the existing condition of the building, user needs, the characteristics of learning activities, ergonomic aspects, and supporting facilities for digital learning. This approach is expected to produce a solution that not only meets the technical requirements of the building but also responds to the needs of teachers and students as the laboratory's primary users.

This community service activity aims to produce a functional and comfortable design for the Building Design, Modeling, and Information (DPIB) Laboratory at SMK Negeri 5 Padang that supports technology-based learning. The design covers spatial organization and activity functions, circulation patterns, architectural design, lighting and ventilation, electrical installations, and supporting equipment for digital learning. The results are

Publish by Radja Publika
OPEN ACCESS

expected to serve as a reference for the school in developing the DPIB Laboratory while supporting the creation of a vocational learning environment that is more adaptive to developments in construction technology.

LITERATURE REVIEW

Building Design, Modeling, and Information (DPIB) is a vocational education competency that integrates skills in drafting, designing, modeling, and presenting building information. The Phase F learning outcomes for DPIB include two-dimensional and three-dimensional modeling of structural, architectural, interior, exterior, and building utility systems, as well as planning activities supported by digital technology. Therefore, DPIB learning spaces should not only accommodate conventional drafting activities but also support planning, digital modeling, model or mock-up construction, presentations, and the use of construction-related software (Badan Standar, Kurikulum, dan Asesmen Pendidikan, 2022).

The suitability of facilities and infrastructure is closely related to the effective implementation of practice-based learning. Murtinugraha et al. (2021) found that several vocational high schools still experienced inconsistencies between DPIB learning requirements and the conditions of their available practice rooms, particularly design and computer practice rooms. This finding indicates that the availability of a room alone is insufficient when its function, layout, capacity, and facilities do not correspond to the characteristics of learning activities. Therefore, a DPIB laboratory should be designed based on user activities so that each learning function can be conducted effectively.

The digital transformation of the construction industry has increased the demand for Building Information Modeling (BIM) competencies. BIM is not merely a tool for producing three-dimensional models; it also supports the integrated management of building information. Educational institutions must therefore prepare graduates who are capable of understanding and applying BIM technology and workflows. Telaga (2022) explained that limited BIM competencies among graduates remain one of the barriers to BIM implementation in the construction sector. BIM integration in vocational education should involve the curriculum, learning strategies, instructors, software, and supporting practice facilities. A computer-based laboratory is an essential component because it enables students to gain direct experience in applying BIM technology rather than learning it only at a conceptual level.

Aryanti et al. (2020) showed that learning with Autodesk Revit could develop students' basic skills in operating BIM software. Their findings demonstrate that BIM competence requires structured practical activities, adequate computer equipment, and a learning environment that allows students to perform digital building modeling directly. One of the major issues in BIM education is the continuing gap between the competencies taught in educational institutions and those required in professional practice. Guo et al. (2023) argued that BIM education should be developed using a competency-based approach to ensure that learning outcomes are more closely aligned with professional roles and practices in the construction industry. Learning should not focus solely on software operation but should also cover workflow comprehension, collaboration, information management, and construction problem-solving.

This issue has implications for the design of learning facilities. A DPIB laboratory should provide an environment that supports both individual and collaborative activities, software use, demonstrations, design presentations, and instructor assistance. Therefore, the planning of computer practice areas, instructor rooms, planning areas, projection systems, cable networks, and electrical installations should be treated as an integrated learning system. BIM implementation at the vocational high school level still faces several challenges, particularly in terms of teacher competence, equipment readiness, software availability, and supporting facilities. Sucipto et al. (2024), who investigated vocational high school teachers in construction and property-related programs across several Indonesian provinces, found that BIM implementation in DPIB learning was not yet evenly distributed. Its implementation was influenced by user readiness and the availability of learning support systems.

Irvansyah et al. (2024) also indicated that BIM competencies among vocational high school students in the building field need to be further developed to comply with BIM implementation requirements. Their study showed that students' adaptability in mastering BIM software was strongly influenced by non-cognitive competencies. This finding suggests that laboratory facilities should support not only technical activities but also collaborative learning, technological adaptation, communication, and project-based problem-solving. Based on these studies, improving BIM learning cannot be achieved merely by adding BIM-related content to the curriculum. Schools also require adequate practice environments, accessible computer equipment, spatial arrangements that support instructor assistance, and learning systems that resemble professional construction workflows.

OPEN ACCESS

A DPIB laboratory is used for computer-based design and modeling activities that may continue for relatively long periods. Ergonomic considerations should therefore form an important part of the design. Workstation arrangements, distances between tables, movement spaces, viewing directions, lighting, room temperature, ventilation, and cable management can affect user comfort and the effectiveness of learning activities. Lius et al. (2022) found that temperature and lighting were important factors affecting user comfort in computer laboratories. The evaluation and improvement of laboratory conditions should involve users because they directly experience the physical environment during learning activities. These findings support the need to consider natural and artificial lighting, ventilation, air conditioning, and workstation layout in the design of the DPIB Laboratory.

This approach is consistent with the principles of human-centered design outlined in ISO 9241-210:2019. Human-centered design emphasizes that the design process should be based on an understanding of users, their activities, needs, and contexts of use. Users should also be involved in the evaluation and refinement of the design to ensure that the resulting solution corresponds to their actual requirements (International Organization for Standardization, 2019). Spatial organization is fundamental to creating a functional laboratory. Ching (2023) explained that spatial functions are related to form, relationships between areas, circulation, openings, scale, and proportion. In the context of the DPIB Laboratory, these principles are applied through the division of spaces according to activity types, the placement of the instructor room, access arrangements, and the relationship between manual and digital practice areas.

Neufert et al. (2019) emphasized the importance of human dimensions, movement requirements, furniture dimensions, user capacity, and operational distances in spatial design. These principles are relevant when determining the placement of computer desks, circulation routes, student workspaces, instructor positions, and access to supporting facilities. A spatial layout that considers users' physical dimensions can reduce overlapping activities and create a more efficient learning environment. Based on the reviewed literature, the design of a DPIB Laboratory requires an integrated approach that connects curriculum requirements, BIM competencies, spatial planning, digital facilities, ergonomics, and user needs. Previous studies have generally discussed BIM competencies, learning implementation, and facility conditions separately. This community service activity addresses this practical gap by translating these learning requirements into the physical and technical design of the DPIB Laboratory at SMK Negeri 5 Padang.

METHOD

The community service activity was conducted at SMK Negeri 5 Padang, Padang City, West Sumatra. The partner institution was SMK Negeri 5 Padang, particularly the administrators and teachers of the Building Design, Modeling, and Information (DPIB) Study Program. The object of the activity was a building with an area of approximately 270 m², which was planned to be developed into a DPIB Laboratory to support practice-based and digital technology-based learning.

The activity employed a participatory and user-centered design approach. This approach places users as one of the main considerations in identifying needs, developing the design, and evaluating the proposed solution. The principles of human-centered design emphasize the importance of understanding user characteristics, activities, and the context of use in order to produce a design that responds to actual needs (International Organization for Standardization, 2019). In this activity, these principles were applied by involving the school from the needs-identification stage through the presentation and evaluation of the design outcomes.

The community service activity involved lecturers from the Civil Engineering and Industrial Engineering Study Programs at Universitas Adzkia, as well as students. The lecturers were responsible for observation, analysis of the building condition, concept development, design preparation, and evaluation of the results. Meanwhile, the students participated in field measurements, documentation, preparation of existing-condition drawings, development of technical drawings, and preparation of activity documentation. The activity was divided into six stages: observation and identification of existing conditions, identification of partner needs, preparation of the design concept, design development, design validation and refinement, and finalization and handover of the design outcomes.

Observation and Identification of Existing Conditions

The initial stage involved a direct survey of the building to be developed as the DPIB Laboratory. The survey aimed to obtain up-to-date information regarding the physical condition of the building as the basis for the design process. The activities included measuring the building dimensions, observing the spatial condition, identifying the locations of doors and windows, examining entrances and exits, assessing lighting and ventilation conditions,

OPEN ACCESS

identifying user circulation patterns, and observing the surrounding environment. Data were collected through field observation, measurement, and photographic documentation. Observation and documentation are also relevant for evaluating DPIB facilities and infrastructure because they provide an actual description of the suitability of existing facilities for learning requirements (Murtinugraha et al., 2021). The survey data were subsequently used to identify problems and opportunities for spatial development.

Identification of Partner Needs

The partner's needs were identified through discussions and communication with SMK Negeri 5 Padang. The information collected included the expected functions of the laboratory, the characteristics of learning activities, user capacity, facility requirements, teacher and student activities, and plans for utilizing the space. The spatial requirements were also adjusted to the characteristics of DPIB learning. The Phase F Learning Outcomes for DPIB include two-dimensional and three-dimensional modeling, structural and architectural design, building utilities, and the use of Building Information Modeling (BIM) technology (Badan Standar, Kurikulum, dan Asesmen Pendidikan, 2022). Therefore, the DPIB Laboratory needs to accommodate computer-based learning, planning activities, model or mock-up production, instructor activities, and the presentation of design outcomes. The identified partner needs were then combined with the existing-condition data to determine spatial requirements, circulation patterns, learning facilities, equipment layout, lighting, ventilation, and supporting facilities.

Preparation of the Design Concept

The design concept was developed based on the observations and the identified needs of the partner. The main aspects considered were spatial function, ergonomics, comfort, circulation, and efficient use of space. Spatial planning considered room dimensions, user capacity, activity requirements, furniture layout, and the required circulation space. Facility design principles place human dimensions and activity characteristics as the basis for determining spatial requirements and arranging interior elements (Neufert et al., 2019). In addition, relationships between spaces, circulation patterns, openings, and the relationship between form and function are important elements in spatial organization Ching, Francis D. K. Architecture: Form, Space, and Order. 5th ed. Hoboken, NJ: John Wiley & Sons, 2023. Ergonomic aspects were also considered because digital modeling and design activities require students to use computers for relatively long periods. Temperature and lighting conditions are important factors in creating a comfortable computer laboratory environment (Lius et al., 2022). Based on these considerations, the design concept included spatial zoning, workstation layout, instructor positioning, user access, openings, lighting, ventilation, and supporting facilities.

Design Development

The design concept was subsequently developed into technical drawings using AutoCAD and supporting visualization software. This stage aimed to translate user needs and spatial concepts into a measurable, communicative, and easily understandable design for the school.

The design outputs included:

a. floor plans and layout of the DPIB Laboratory;
b. building elevation drawings;
c. building section drawings;
d. lighting and ventilation concepts;
e. user access and circulation arrangements;
f. planning of electrical facilities and digital learning equipment; and
g. two-dimensional and three-dimensional visualizations.

The development of digital facilities also considered the increasing orientation of DPIB learning toward BIM technology. The integration of BIM into construction education is required to ensure that competencies developed through learning remain relevant to developments in the construction industry (Telaga, 2022).

Design Validation and Refinement

The developed design was then presented and discussed with SMK Negeri 5 Padang. This stage aimed to obtain feedback regarding the suitability of the spatial layout, the functions of each area, circulation, facilities, and learning requirements. The partner's feedback was used as the basis for evaluating and refining the design. The evaluation covered: (1) compatibility with the existing building condition, (2) accommodation of DPIB learning requirements, (3) effectiveness of the spatial layout and circulation, (4) user comfort, (5) suitability of digital learning facilities, and (6) the partner's understanding of the proposed design. This stage formed part of the user-centered design approach because the final design was not determined solely by technical considerations but also incorporated the partner's needs and feedback (International Organization for Standardization, 2019).

Finalization and Handover of the Design Outcomes

The final stage involved refining the design based on the evaluation results and the partner's feedback. The final output consisted of a DPIB Laboratory planning document containing the floor plan, spatial layout, elevation and section drawings, supporting facilities, and building visualizations. The design outcomes were subsequently presented to the school to provide an understanding of the spatial concept, the function of each area, circulation, lighting, ventilation, and supporting learning facilities. The resulting documents may be used as technical references for the development of the DPIB Laboratory at SMK Negeri 5 Padang.

RESULTS AND DISCUSSION

The community service activity resulted in the planning of a Building Design, Modeling, and Information (DPIB) Laboratory developed by considering the existing conditions, learning activity requirements, spatial organization, user comfort, and the need for digital learning facilities. The design outcomes were not limited to spatial arrangements but also included architectural aspects and supporting utility systems for the laboratory. The planning documents produced in the activity consisted of site plans, floor plans, elevations, sections, structural drawings, lighting installations, power installations, cable networks, projector facilities, and three-dimensional visualizations.

Identification of Existing Conditions

The initial stage of the activity provided information regarding the existing condition of the DPIB Laboratory development area at SMK Negeri 5 Padang. Based on the existing site plan, the laboratory is located within the school complex, which already contains several practical workshops and other learning spaces and is situated near the school's sports facilities. These conditions were considered in determining the building position, user access, relationships with surrounding buildings, and the utilization of the available site.

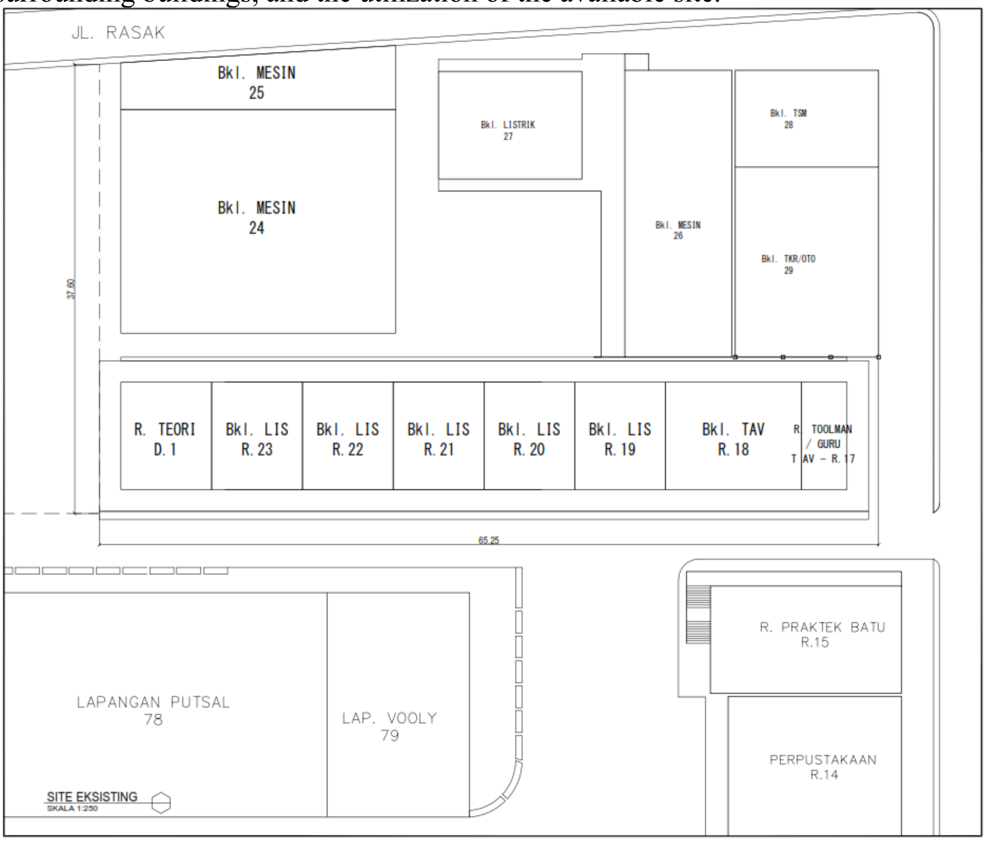

Figure 2. Existing Condition of the DPIB Laboratory Planning Area at SMK Negeri 5 Padang

OPEN ACCESS

The identification results indicated that the laboratory required a more structured spatial organization to accommodate the characteristics of DPIB learning, which include planning, model or mock-up production, drafting, and computer-based design activities. These conditions formed the basis for arranging the spatial layout and positioning the learning facilities.

Results of the DPIB Laboratory Spatial Design

The main outcome of the activity was the spatial design of the DPIB Laboratory. Based on the proposed floor plan, the main DPIB learning area measures approximately 22.50 m × 12.00 m, or about 270 m². The area was organized according to the functions of the learning activities. The floor plan presents three main functional spaces: the Planning and Building Model/Mock-up Practice Room, the Instructor Room, and the Computer-Aided Design and Computer Practice Room. Supporting facilities were also planned adjacent to the main area, including teachers' toilets, students' toilets, and a School Health Unit (UKS).

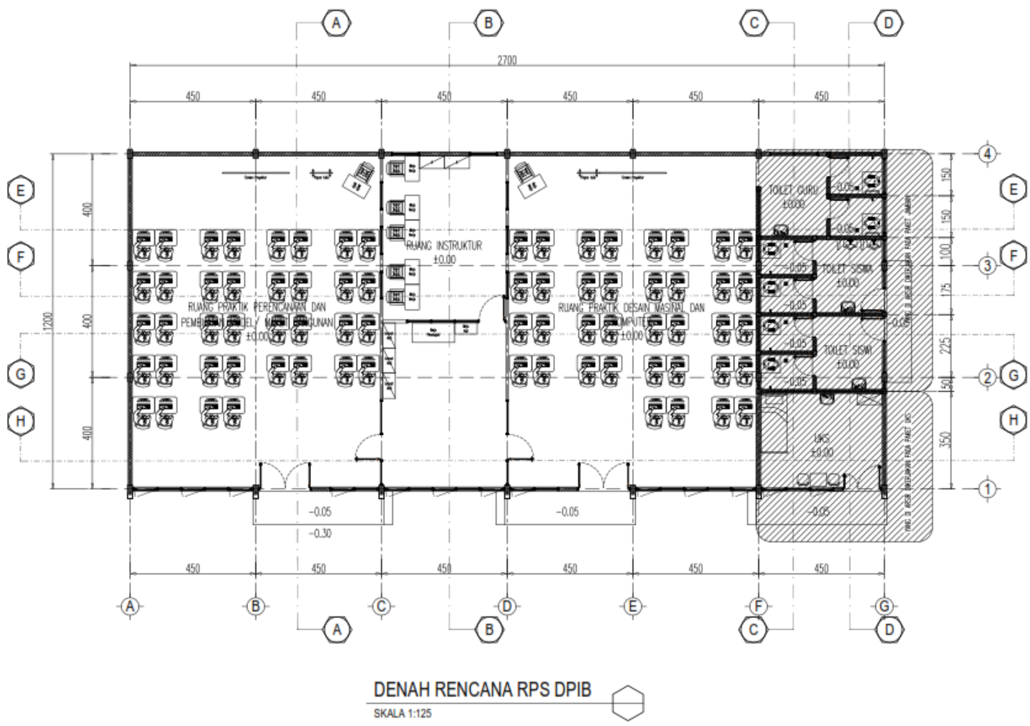

Figure 3. Spatial Design of the DPIB Laboratory at SMK Negeri 5 Padang

This spatial arrangement enables manual and digital learning activities to be carried out in a more organized environment. The planning and model/mock-up practice room supports concept development, drafting, and physical model-making activities. Meanwhile, the computer-aided design and computer practice room is intended for learning activities involving computers and building modeling software. The instructor room is positioned in the central area, providing direct access to both practice rooms. The arrangement of desks and workstations was also designed by considering user circulation space and the ease of supervision during learning activities. With this configuration, the laboratory does not merely function as a place for equipment placement but also creates a learning environment that supports interaction among teachers, students, and practical facilities. A summary of the spatial design results is presented in Table 1.

OPEN ACCESS

Table 1. Functional Design Results of the DPIB Laboratory

Component	Main Function	Design Outcome
Planning and Model/ Mock-up Practice Room	Planning and model-making activities	Student work area with an organized workstation layout
Instructor Room	Supervision and learning assistance	Located between the two practice rooms
Design and Computer Practice Room	Digital modeling and design	Structured computer workstation arrangement
Circulation	Movement of students and teachers	Clear inter-room circulation paths and main access
Sanitation Facilities	Supporting users' needs	Teachers' and students' toilets
School Health Unit (UKS)	School supporting facility	Integrated into the side section of the building

Architectural Design Results

In addition to the spatial layout, the design outcomes also include the architectural form of the building, consisting of front, side, and rear elevation drawings, as well as several sectional drawings. The building elevations show the use of relatively large openings on the front façade to support natural daylighting while also creating a distinctive visual character appropriate for an educational facility.

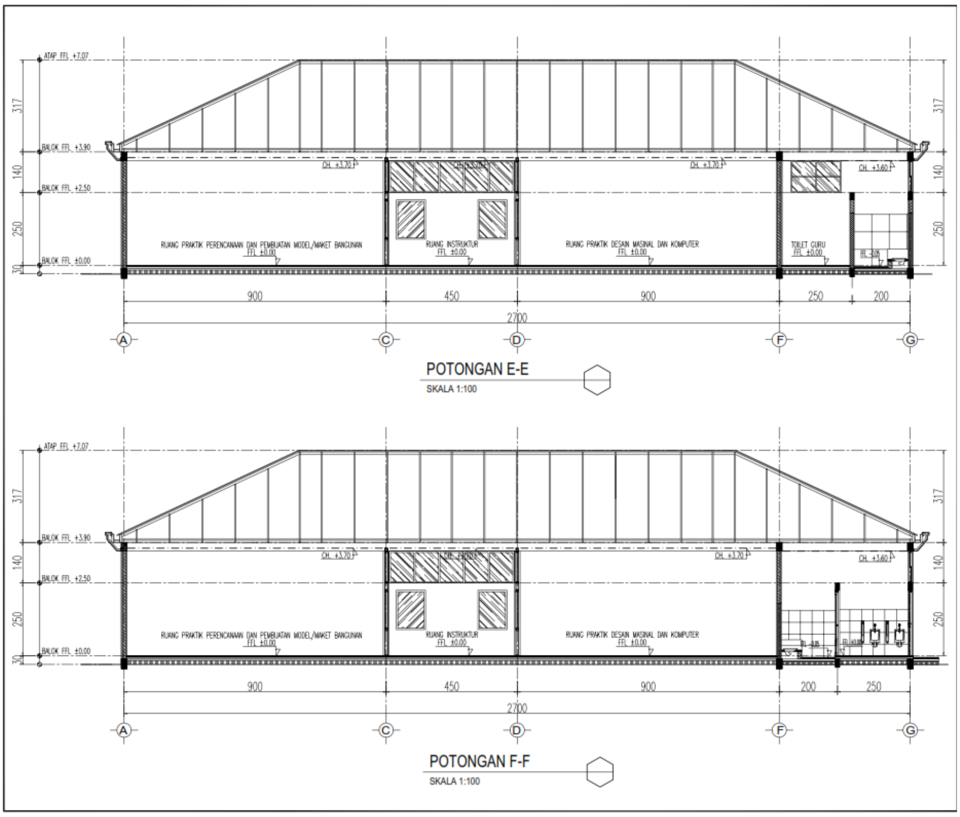

Figure 4. Elevations and Sections of the DPIB Laboratory Design

The sectional drawings illustrate the relationship among the practice rooms, instructor room, openings, ceiling, and roof system. The ceiling height is designed at approximately **+3.70 m**, while the roof ridge elevation reaches approximately **+7.07 m**. These proportions provide sufficient spatial volume to support learning activities and promote air circulation within the building. The architectural design is also complemented by detailed planning for door and window frames, floor patterns, ceilings, roofing, and façade elements. Although not all technical details are presented in this article, the availability of these documents indicates that the design has progressed from the conceptual stage to a more applicable technical planning stage.

Digital Learning Facility Design Results

One of the main characteristics of a DPIB laboratory is its high demand for computers and electronic learning equipment. Therefore, the design also includes lighting systems, electrical outlets, air-conditioning installations, cable trays, and projector facilities.

The electrical installation design includes 36 floor outlet points, primarily intended to support computer workstations, 14 standard electrical outlets, 2 projector outlets, and 8 air-conditioning outlet points. The distribution of the floor outlets was adjusted to the arrangement of desks and computer equipment, allowing cables to be managed more systematically and reducing the need for additional cables crossing circulation paths.

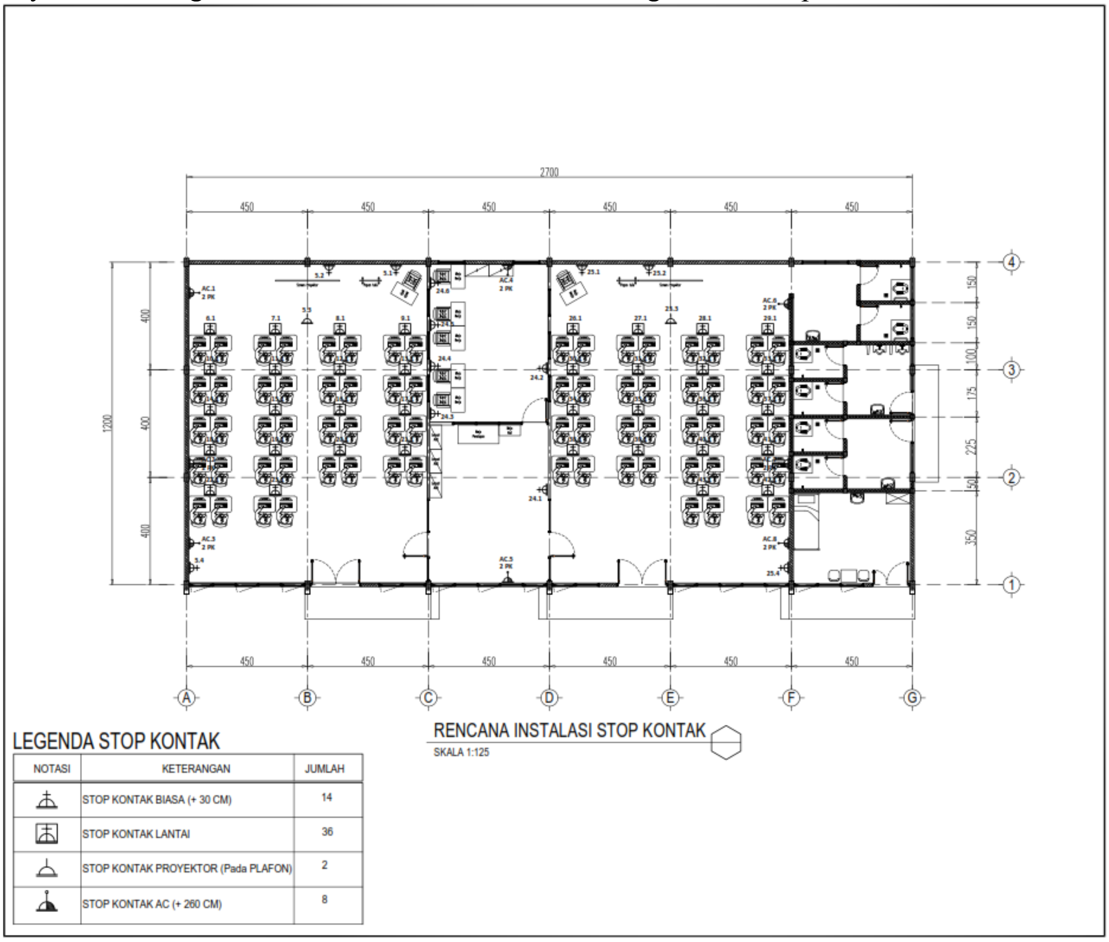

Figure 5. Electrical Installation and Power Outlet Plan for the DPIB Laboratory

The lighting plan was also developed according to the function of each room. The design documents indicate the placement of main lamps, downlights, switches, and exhaust fans. This system is integrated with the building's natural openings to support visual comfort and air circulation during learning activities In addition to the power system, the design provides a 30 × 10 cm cable tray with a total length of approximately 30 m as a cable distribution route. The use of a cable tray is important in a computer-based laboratory because it facilitates the management of electrical cables and digital equipment support cables while reducing unorganized cable arrangements in the work area. The learning facilities are also equipped with a projector and a motorized screen in the practice room. The availability of these facilities enables learning activities to be carried out not only individually through computers, but also through presentations, software demonstrations, and collaborative discussions of design outputs.

Visualization of the Design Results

To help the school better understand the proposed building form, the design results were visualized in three dimensions. The visualization illustrates the relationship between the DPIB Laboratory building and the surrounding school environment, as well as the developed façade character. The roof form, openings, façade colors, and relationship with the outdoor area can be seen more clearly compared to two-dimensional technical drawings alone.

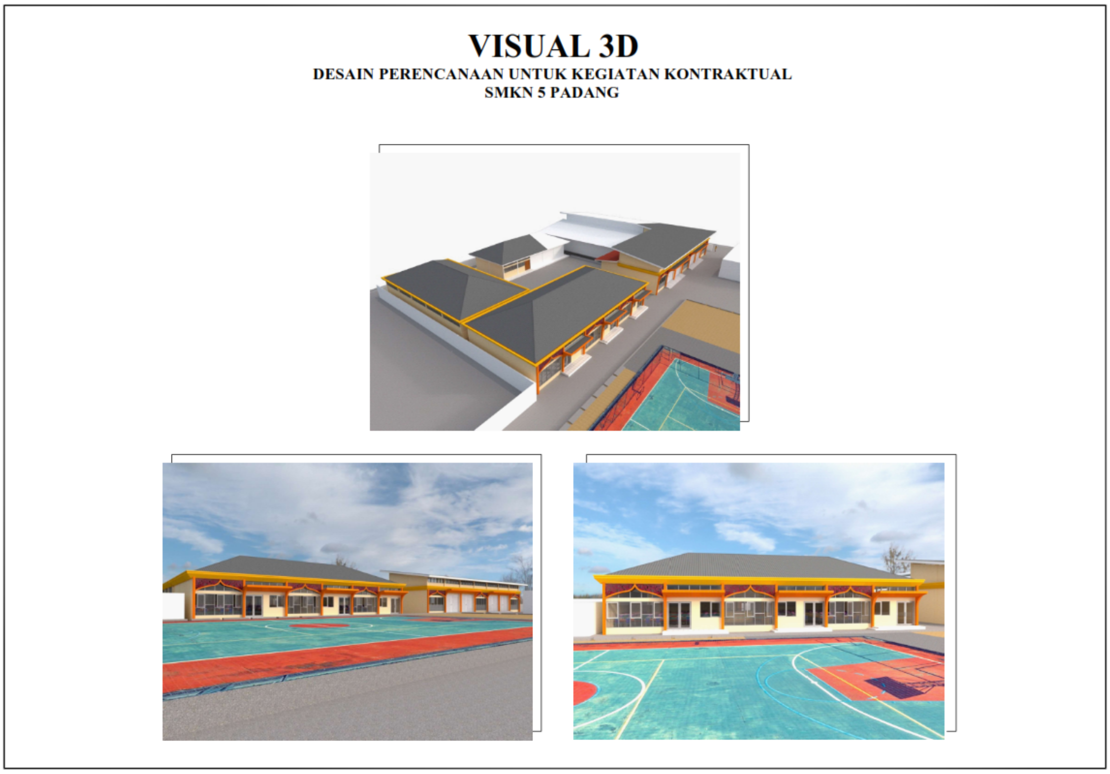

Figure 6. Three-Dimensional Visualization of the DPIB Laboratory Design at SMK Negeri 5 Padang

The three-dimensional visualization serves as a communication medium between the designers and the school, enabling users without a technical background to understand the proposed design more easily. Therefore, the final design documents provide not only technical information regarding dimensions and construction but also a clear representation of the building's final appearance when implemented.

Community Service Activity Outcomes

Based on the overall design process, this activity produced technical documents that can be used as references for the development of the DPIB Laboratory at SMK Negeri 5 Padang. The activity outcomes are summarized in Table 2.

Table 2. Outcomes of the Community Service Activity

No.	Activity Output	Achievement
1	Identification of existing conditions	Existing-condition data and drawings were produced
2	Spatial planning	Floor plans and functional zoning of the DPIB spaces were produced
3	Architectural design	Elevation, section, flooring, ceiling, and roof drawings were produced
4	Computer facility planning	Workstation layouts and electrical installation plans were produced
5	Learning facility planning	Lighting, projector, and supporting system plans were produced
6	Design visualization	Three-dimensional building visualizations were produced
7	Technical documents	A complete drawing package was produced to support facility development

These results indicate that the design activity provided a more structured solution for developing DPIB learning facilities. While the available area previously lacked a clear functional arrangement, the proposed design provides a comprehensive framework for spatial zoning, equipment layout, circulation systems, digital facilities, and the overall building form, all of which can serve as a basis for the future development of the laboratory.

Discussion

The results of the community service activity indicate that the design of the Building Design, Modeling, and Information (DPIB) Laboratory needs to integrate spatial planning, the characteristics of learning activities, user comfort, and the requirements of digital facilities. Dividing the laboratory into a planning and model/mock-up practice area, an instructor room, and a design and computer practice area provides a clearer spatial organization than an undivided space. Such an arrangement is important because DPIB learning requires an environment capable of accommodating planning, drafting, modeling, discussion, and computer-based activities within a single learning facility.

The suitability of facilities for the characteristics of learning activities is an important factor in vocational education. Research on DPIB facilities and infrastructure has shown that design practice rooms and computer practice rooms may still be inconsistent with actual learning requirements (Murtinugraha et al., 2021). This finding reinforces the importance of laboratory planning that considers not only the size of the building but also the relationship among student activities, the facilities used, user capacity, and patterns of space utilization.

The spatial organization of the DPIB Laboratory should also consider functional relationships and circulation patterns. According to architectural design principles, spatial organization, relationships between areas, form, scale, openings, and circulation are interconnected components in creating an effective space (Ching, 2023). In addition, human dimensions, movement requirements, and the characteristics of activities provide an important basis for determining the size and placement of furniture and facilities (Neufert et al., 2019). Therefore, workstation placement, student circulation routes, access points, and the relationship between the instructor room and the practice rooms are important components of the design.

The availability of design and computer practice spaces has become increasingly important because current DPIB competencies are no longer limited to manual drafting. The DPIB learning outcomes include two-dimensional and three-dimensional modeling, structural and architectural design, building utilities, and the use of Building Information Modeling (BIM) technology (Badan Standar, Kurikulum, dan Asesmen Pendidikan, 2022). Accordingly, the laboratory needs to provide an environment that supports software-based and digital technology-based learning processes.

The integration of BIM into construction education is also closely related to industry requirements. The development of BIM competencies in vocational education is necessary to ensure that graduates possess skills aligned with the digital transformation of the construction sector.[3] The use of BIM software, such as Autodesk Revit, in DPIB learning can also improve students' understanding of digital building modeling processes (Aryanti et al., 2020). Therefore, the provision of a computer practice area within the DPIB Laboratory represents an effort to create learning facilities that are more adaptive to developments in construction technology.

A gap also remains between the BIM competencies developed in educational institutions and those required in professional practice (Guo et al., 2023). This condition indicates that BIM learning should not focus solely on theoretical knowledge or isolated software skills. Instead, it should be supported by a learning environment that enables students to understand digital workflows in a more integrated manner. In this context, the DPIB Laboratory can function as a space that connects theoretical learning with practical experience.

At the vocational high school level, BIM implementation still faces several challenges, particularly those related to human resource readiness, technological proficiency, learning equipment, and supporting facilities (Sucipto et al., 2024). The BIM competencies of vocational high school students in the building field also need to be further developed to meet the requirements of BIM implementation (Irvansyah & Suryawan, 2024). Therefore, the availability of a laboratory specifically designed to support digital activities can become an important component in strengthening students' competencies.

Laboratory design also needs to address ergonomic aspects and user comfort. Computer-based design and modeling activities may be carried out for relatively long periods; therefore, lighting, room temperature, air circulation, workstation layout, and user movement space require careful consideration. Studies of computer laboratories have shown that temperature and lighting influence user comfort and should therefore be included in the evaluation and development of learning facilities (Lius et al., 2022). Accordingly, the arrangement of openings, ventilation, natural and artificial lighting, and facilities within the DPIB Laboratory forms an essential part of the design.

OPEN ACCESS

User involvement in the design development process was also an important aspect of this community service activity. The principles of human-centered design place users' needs, activities, and characteristics at the center of the design and evaluation process for a system or environment (International Organization for Standardization, 2019). In this activity, the needs of the school were used as the basis for identifying spatial functions, determining the required facilities, and refining the proposed design. This approach enabled the outcomes to respond more closely to the partner's actual conditions rather than being based solely on the technical considerations of the design team.

From a community service perspective, the outcomes of the activity were not limited to planning drawings. They also provided the school with a more systematic reference for developing the DPIB Laboratory. Learning requirements were translated into spatial functions, facility layouts, circulation arrangements, user comfort considerations, and digital learning infrastructure. Therefore, the main contribution of this activity at the current stage is the improved readiness of the partner to plan and develop learning facilities that are more closely aligned with the needs of the DPIB Study Program.

Nevertheless, this activity remained focused on the planning stage and therefore cannot yet be used to conclude that students' learning outcomes or competencies have directly improved. Such impacts can only be assessed after the laboratory has been implemented and used in the learning process. Further evaluation may include measurements of user comfort, teacher and student satisfaction, spatial effectiveness, utilization of digital facilities, and the laboratory's contribution to the achievement of DPIB competencies.

Overall, the results indicate that the development of a DPIB Laboratory requires an integrated approach combining spatial planning, ergonomics, user needs, digital learning, and BIM development. Such an approach enables the laboratory to function not merely as a practice room but as a learning environment that is more relevant to the characteristics of vocational education and technological developments in the construction industry.

CONCLUSION

This community service activity produced a design plan for the Building Design, Modeling, and Information (DPIB) Laboratory at SMK Negeri 5 Padang based on the existing condition of the building and the identified learning requirements. The design includes the arrangement of the planning and model/mock-up practice room, instructor room, design and computer practice room, as well as supporting facilities for digital learning activities. The design also integrates architectural aspects, lighting, ventilation, electrical installations, power outlet placement, cable trays, projectors, and other supporting facilities. This integration demonstrates that a DPIB laboratory requires not only adequate space but also a functional, comfortable, and well-organized learning environment that is consistent with the characteristics of computer-based learning and Building Information Modeling technology.

Through this activity, SMK Negeri 5 Padang obtained planning documents that can be used as technical references for the development of its DPIB Laboratory facilities. The primary benefit at this stage is the improved readiness of the partner institution to plan learning facilities and the availability of a more structured design that responds to user needs. Further evaluation should be conducted after the laboratory has been implemented and used in learning activities. The evaluation may cover user comfort, spatial effectiveness, utilization of digital facilities, teacher and student satisfaction, and the contribution of the laboratory to improving the quality of DPIB learning.

REFERENCES

Aryanti, F. N., Busono, R. R. T., & Siswoyo, S. (2020). Implementation of Building Information Modelling (BIM) Revit to meet the needs of the construction industry. IOP Conference Series: Materials Science and Engineering, 830, Article 042054. https://doi.org/10.1088/1757-899X/830/4/042054

Badan Standar, Kurikulum, dan Asesmen Pendidikan. (2022). Capaian pembelajaran mata pelajaran Desain Pemodelan dan Informasi Bangunan Fase F untuk SMK/MAK [Learning outcomes for the Building Design, Modeling, and Information subject, Phase F, for vocational high schools]. Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia.

Ching, F. D. K. (2023). Architecture: Form, space, and order (5th ed.). John Wiley & Sons.

Guo, B. H. W., Gonzalez, V. A., Puolitaival, T., Enegbuma, W., & Zou, Y. (2023). Bridging the gap between Building Information Modelling education and practice: A competency-based education perspective. International Journal of Construction Management, 23(15), 2558–2569. https://doi.org/10.1080/15623599.2022.2077546

International Organization for Standardization. (2019). Ergonomics of human-system interaction—Part 210: Human-centred design for interactive systems (ISO Standard No. 9241-210:2019; 2nd ed.).

Irvansyah, Muchlis, N., & Suryawan, W. A. (2024). Analysis of the BIM implementation competencies of building cluster vocational high school students in East Java. Border: Jurnal Arsitektur, 4(2), 95–108. https://doi.org/10.33005/border.v4i2.122

Lius, J. F., Oktiarso, T., & Putrianto, N. K. (2022). Usulan perbaikan laboratorium komputer Universitas Ma Chung pada aspek suhu dan pencahayaan dengan pendekatan ergonomi partisipatori [Proposed improvements to the Ma Chung University computer laboratory regarding temperature and lighting using a participatory ergonomics approach]. Jurnal Sains dan Aplikasi Keilmuan Teknik Industri (SAKTI), 2(2), 101–112. https://doi.org/10.33479/jtiumc.v2i2.32

Murtinugraha, R. E., Ramadhan, M. A., & Andarista, P. L. (2021). Kesesuaian standar sarana prasarana SMK kompetensi keahlian Desain Pemodelan dan Informasi Bangunan: Studi pada SMKN 56 Jakarta dan SMKN 35 Jakarta [Conformity with vocational high school facility and infrastructure standards for the Building Design, Modeling, and Information competency program]. Jurnal Pendidikan Teknik Sipil, 3(1), 1–10. https://doi.org/10.21831/jpts.v3i1.41881

Neufert, E., Neufert, P., & Kister, J. (2019). Architects' data (5th ed.). Wiley-Blackwell.

Sucipto, T. L. A., Sajidan, Akhyar, M., & Roemintoyo. (2024). Investigating Building Information Modelling (BIM) adoption in vocational high school learning. In Proceedings of the 5th Vocational Education International Conference (VEIC-5 2023) (pp. 1096–1101). Atlantis Press. https://doi.org/10.2991/978-2-38476-198-2_155

Telaga, A. S. (2022). A lesson learned from the integration of BIM in construction engineering education in an Indonesian polytechnic. Jurnal Pendidikan Vokasi, 12(2), 130–140. https://doi.org/10.21831/jpv.v12i2.48455

OPEN ACCESS