Cost Analysis of Improving Classroom Capacity at The Polytechnic State of Bali

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Abstract. Interest in applying to PNB has grown by an average of 15%, though there was a decline in 2022 due to the COVID-19 pandemic, especially given Bali's reliance on tourism. However, the number of accepted students has increased. In line with PNB's policy to expand educational access, there has been a rise in active student numbers over the past five years. Effective teaching and learning depend on adequate facilities that meet industry needs. The current classroom buildings at PNB are uniform across departments and serve as classrooms and management spaces. To match the growing interest, increasing classroom capacity is crucial, considering the available land. Previous studies for the 2023 fiscal year confirmed that adding one more floor to the existing buildings is feasible. This research will provide recommendations for either adding floors or constructing new buildings, starting with structural and architectural planning, followed by cost estimates for both options.

Keywords: Classroom Building, Cost, Room Capacity

1 Introduction

Polytechnics are part of higher education in Indonesia, regulated by Law No. 12 of 2012, focusing on vocational education to develop human resources. Their programs equip students with practical skills, theoretical knowledge, and discipline, especially in engineering and business fields, aiming to produce competent vocational professionals. The number of new student registrations at PNB has increased by an average of 15% per year, reflecting strong interest from high school graduates. With rising interest, additional facilities are needed. PNB’s student capacity grew from 1,651 in 2017 to 2,683 in 2022. Current classroom buildings at Politeknik Negeri Bali (PNB) are used for teaching, faculty offices, and department management. They are uniform across departments: two floors, approximately 7 meters high on solid ground. PNB’s facilities include buildings, lab equipment, teaching aids, and learning infrastructure. However, the Mechanical Engineering Department's building is critically lacking, with only 9 out of 23 needed classrooms. To address this, PNB has implemented class management and extended learning hours from 08:00–18:30 WITA, up from 08:00–16:00 WITA. To expand educational access and achieve an ideal lecturer-to-student ratio, PNB has increased the number of classes and study

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programs from 2017 to 2022, including Diploma II, Applied Bachelor's (D IV), and postgraduate programs. This policy has increased the need for learning spaces, with a current space utilization ratio of 0.36. For smooth teaching and learning processes, PNB requires adequate facilities aligned with industry needs. Proper facilities support PNB's sustainable growth and readiness to address globalization, higher education and industry connections, economic development, and sustainable development.

Increasing the capacity of PNB's classroom buildings can be achieved by adding floors, following structural and foundation studies (Suasira et al., 2023). Previous research indicates that the next step is a cost study for construction, starting with structural planning. This research conducts a study from the aspect of comparing the cost of development by adding floors above it with the cost of building a new building.

2 Methodology

2.1 Research Design

The research method used is quantitative descriptive. The method of data collection is by survey, brainstorming and calculation with application to obtain a list of material, tool, and labor prices, structural and architectural drawings, and structural strength calculations based on previous research results.

2.2 Research Data

The types and sources of data needed are primary data and secondary data. Primary data are a list of material, tool, and labor prices and structural and architectural drawings. A list of material, tool, and labor prices is used to create a unit price analysis for the work. Structural and architectural drawings are planned based on the results of the structural calculations that were carried out previously. Secondary data are structural strength calculations based on previous research results and Unit Price Analysis (AHSP) for the year 2023.

2.3 Data Analysis

Briefly, the research steps that must be carried out are: 1). Identifying. In previous research in the 2023 budget year, the structural strength has been assessed with the result that the lecture building is still safe if one floor is added above it. With these results, continue to study the cost of adding floors and study the cost of building a new building. Then further data collection is carried out in the form of a list of material prices, wages, and tools used in making unit price analyses of work. The structural and architectural drawing data for calculating the volume of work. All these data are used to calculate the cost budget plan if the existing building is added to the floor above it and the construction of a new building; 2). Analyze the data. After quantitative data collection in the form of a price list of materials, wages, tools, structural and architectural drawings. the cost budget plan will be made in Microsoft

Excel based on the price list of materials, wages, and tools listed in the unit price analysis. The calculation of volume of work is calculated using Autocad based on structural and architectural drawings. then the total cost will be obtained for adding floors to the existing building and making a new building; 3). Determine Decision-making Recommendations. After analyzing the data and getting the total cost of adding floors to the existing building and the total cost of making a new building, a comparison of the two total costs is made. Decision-making recommendations will be determined from the comparison results.

3 Result and Discussion

3.1 General Description

The building is a physical form of construction work that is integrated with its location, partly or wholly above and/or in the land and/or water, which serves as a place for humans to carry out their activities, both for residential or living space, religious activities, business activities, social, cultural activities, and special activities (Indonesia, 2002). Building functions include residential, religious, business, social, and cultural functions, and special functions are provisions regarding the fulfillment of administrative requirements and technical requirements of building buildings. Building classification is a classification of building functions based on the fulfillment of the level of administrative requirements and technical requirements (Johannes, 2011). In the inspection up to the detailed inspection stage, the level of reliability is determined based on the results of the structural evaluation. The determination of the level of reliability is obtained through the structural evaluation stage after knowing the quality of existing building materials so that each building must meet administrative requirements (Wuryanti, 2013). Each historical building has different characteristics, potentials, and problems, so it is necessary to analyze specifically for each cultural heritage building so that protection, utilization, and development efforts can be carried out appropriately (Suprihatin et al., 2017).

The parameters used in analyzing the existing building structure are plan strength greater than the necessary strength, nominal moment reduction factor greater than the ultimate moment (Afendi et al., 2021). While the design beam resistance must meet the requirements of nominal moment resistance greater than the bending moment due to the factored load (Setiawan, 2008). The structural materials can be concrete, steel, wood, bamboo, and materials from specialized technologies (Indonesia, 2021). The structural analysis of the Civil Engineering building at Politeknik Negeri Bali is based on a 3D analysis using SAP2000 v15 software. The building's structure is modeled as an open frame system with a 3D grid reference. It is designed with a moment-resisting frame system (SRPMM), where the frame handles both gravity loads and lateral forces primarily through bending.

The building structure is designed to meet the strong column-weak beam requirements for earthquake resistance, with plastic hinges allowed only at the ends of beams and at the base of columns and shear walls. It will be constructed on firm soil (site class SA) in Kampus Bukit Street, Jimbaran, Badung–Bali. Earthquake parameters are derived from the PU (PUSKIM) official website according to SNI 1726-2019, using the "Response Spectrum Analysis" method for a 3D elastic response to seismic effects. Reinforcement design for each structural element follows loading combinations specified in the Indonesian National Standard SNI 2847-2019.

3.2 Estimated Data

The cost estimation used in this study is a preliminary estimate aimed at providing an initial indication of construction costs. This rough estimate is based on records of prices and outcomes from similar past projects, general project drawings (plans and elevations), and assumptions based on experience with similar buildings. Standard unit prices for materials, tools, labor, and work tasks are sourced from printed media or periodic publications by relevant agencies. Key factors influencing the estimate include the type and size of the building, type of construction (heavy or light), and building location.

The rough estimation method used is the area-based method. This common method for preliminary cost estimation involves calculating costs by measuring each floor area and multiplying it by the unit price per square meter. It is straightforward and easily understood by clients. This method is suitable for projects like schools or buildings with uniform floor heights. Unit prices per square meter are derived from data of similar completed projects. The following are the drawings used for the preliminary cost estimation.

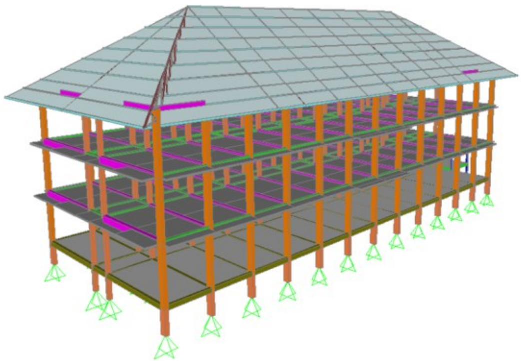

Figure 1. 3D structural system

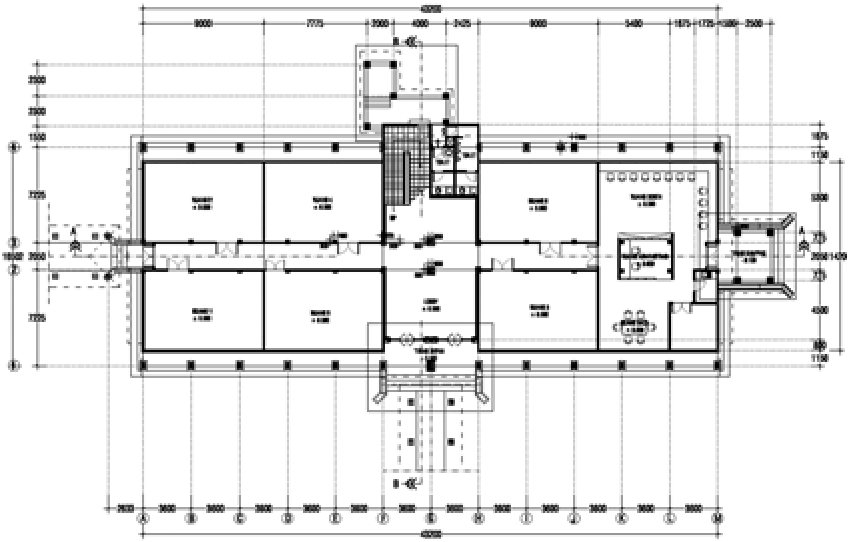

Figure 2. Floor plan 1, civil engineering building

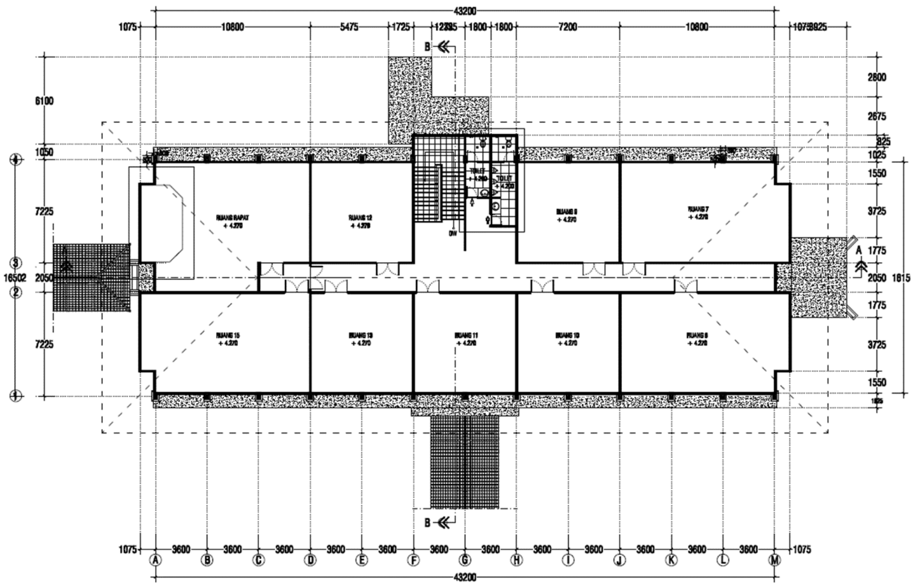

Figure 3. Floor plan 2, civil engineering building

3.3 Cost Estimation

Cost estimation, often referred to as the Budget Plan Calculation (RAB), involves calculating the total expenses required for materials, labor, and other costs related to project execution. It determines the financial needs to complete a task or project in accordance with requirements or contracts (Dannyanti, 2010). Project cost estimation plays a crucial role in project management. It is the process of forecasting the expenses required for the resources needed to complete a project (Pilutomo & Agustapraja, 2021).

The Budget Plan Recapitulation is part of the building cost estimation process, designed to summarize unit price analysis results for clarity and ease of understanding. Before creating the recapitulation, the cost of each individual work item is calculated.

The cost estimation covers the preparation phase, structural work, architectural work, and mechanical and electrical installations. This estimate is solely for the building construction and does not include external work or interior furnishings for learning purposes.

3.4 Cost Estimation Recap for Floor Addition

Based on the floor plans, elevations, and details of similar buildings, the cost for adding a third floor, using SNI 2024 analysis, is as follows:

Table 1. Total estimated cost for adding a floor

No.	Scope of work	Total price (IDR)
A.	Preparation work	478,146,259
B	First floor work	1,419,203,023
I	Concrete work	956,907,100
II	Floor finishing work	378,417,661
III	Painting work	83,878,262
C	Second floor	430,662,271
I.	Concrete work	232,582,567
II	Floor finishing work	114,201,442
III.	Painting work	83,878,262
D	Third floor	2.747,369,563
I	Concrete work	1,464,523,903
II.	Wall work	362,693,638
III.	wall and floor finishing work	508,784,722
IV.	door and window work	165,000,000
V.	Ceiling work	114,201,442
VI.	Painting work	83,878,262
VII.	Sanitary work	48,287,595
E	Roof floor	2,903,289,220
I	Concrete work Roof	129,908,642
I.	Roof frame and covering work	2,456,151,496
II.	Ceiling work	295,628,530
III	Painting work	21,600,552

F	Other works	17,880,695
I	Bathroom mirror work	2,721,535
II	Sink cabinet work	8,750,031
III	Stair railing work	4,973,045
IV	Signs and Logos Work	1,436,084
G	Mechanical, electrical, and plumbing	385,084,721
Total physical cost		8,381,635,753
Construction management cost (4,89 %)		409,861,988
Activity management cost (0.95 %)		79,625,540
Total cost		8,871,123,281

3.5 Cost Estimation Recap for New Building Construction

The total cost for new construction is IDR 40,642,821,000. This amount does not include the cost of the land.

Table 2. Total estimated cost for new construction

No.	Building name	Volume		Unit price (IDR)	Total (IDR)
1.	Main work				
	Construction of a Green-based integrated Innovation building				
	First floor	1.00	ls	9,410,247,000,00	9,410,247,000,00
	Second floor	1.00	ls	9,526,106,333,33	9,526,106,333,33
	Third floor	1.00	ls	10,528,004,666,67	10,528,004,666,67
	Total physical cost				29,464,358,000,00
	Construction management cost (4,89 %)				1,440,807,106,20
	Activity management cost (0.95 %)				279,911,401,00
	Total cost				31,185,076,507,20
	Rounded				40,642,821,000,00

4 Conclusion

The cost required for adding the third floor is a total of IDR 8,871,123,281 but the total cost for new construction is IDR 40,642,821,000. So, the percentage of the cost of adding a floor compared to new construction is 21.83%. Increasing the building's capacity can be achieved by adding floors if there is no land available for new construction.

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