Cost Efficiency Analysis in Special Structural Construction: A Case Study of the Nuclear Medicine Building Project

Regita Cahyani[1*], Berliana Somya Aurellia[1], Satriyo Utomo[1], Wattini[1]

[1]Civil Engineering Department, Pontianak State Polytechnic, Pontianak, Indonesia
[*]Corresponding author: recahaya11@gmail.com,

ABSTRACT

Specialized healthcare infrastructure, such as Nuclear Medicine Buildings, demands highly accurate project budget planning due to structural complexities and technical standards. Discrepancies between the initial Owner's Estimate (RAB) and real-market contractor implementation budgets (RAP) often lead to financial inefficiencies if not evaluated systematically. This study aims to analyze cost efficiency by directly comparing the Owner's Estimated Budget Plan (RAB) with the Implementation Budget Plan (RAP) derived from real-market price surveys, unit price analysis (AHSP), and resource productivity logic. Applied to the Nuclear Medicine Building Project at RSUD Dr. Soedarso in Pontianak, the research evaluates unit costs, work weight distributions, and overall monetary savings. The evaluation reveals that the total RAP amounts to IDR 8,756,988,074.05 compared to the initial RAB of IDR 12,215,041,500.12. This yields a significant cost variance efficiency saving of IDR 3,458,053,426.07 (a 28.31% savings rate). Structural works constituted the highest cost weight at 23.31% of the total project budget. The findings demonstrate that integrating real-market data into unit price analysis eliminates budgetary buffers, providing project managers with a rigorous cost control framework for complex medical facility developments.

Keywords: *Construction Management, Cost Efficiency, Unit Price Analysis, Implementation Budget Plan, Special Structure*.

1. INTRODUCTION

Constructing specialized healthcare facilities, particularly Nuclear Medicine Buildings, involves stringent technical standards and specialized structural systems [1]. Such complex projects frequently face execution challenges due to discrepancies between preliminary estimates and actual field conditions [2]. Effective project cost management serves as a critical determinant of project success, bridging the gap between design expectations and financial execution [3]. In public sector construction projects in Indonesia, the initial planning cost is formulated through the Owner's Budget Estimate (Rencana Anggaran Biaya - RAB), which typically relies on standard government price indices (Analisis Harga Satuan Pekerjaan - AHSP) [4]. However, RAB calculations often incorporate inflated allowances to account for market uncertainties, leading to substantial cost overestimation [5]. Conversely, contractors develop an Implementation Budget Plan (Rencana Anggaran Pelaksanaan – RAP) utilizing actual market surveys for materials, labor wages, equipment hire, and realistic resource productivity coefficients [6].

While existing literature extensively addresses general project delay mechanisms and broad construction management overviews [7, 8], there is a lack of focused quantitative evaluations on cost efficiency variances resulting from RAB and RAP comparisons in specialized hospital infrastructure. Broad construction management studies often dilute key analytical insights by combining unrelated aspects such as risk, scheduling, and procurement without deep mathematical rigor [9]. To address this gap, this study aims to evaluate the extent to which integrating real-market price surveys with optimized unit price analysis enhances cost efficiency in special structural building projects compared to standard baseline estimates.The primary objective of this research is to evaluate the cost efficiency gained by transitioning from the standard RAB to a market-adjusted RAP in the construction of the Nuclear Medicine Building at RSUD Dr. Soedarso, Pontianak. This study establishes a clear mathematical model for cost variance and cost efficiency percentage to quantify monetary savings and structural cost weight contributions, providing empirical insights for future complex building developments.

2. METHODS

2.1 Research Plan

This research uses a quantitative descriptive case-study approach for the Nuclear Medicine Building project at Dr. Soedarso Regional General Hospital, Pontianak, West Kalimantan. Primary data comprise market-price surveys for materials and interviews regarding labor wages and equipment rental costs. Material prices were compared across three building-supply stores. Secondary data comprise the initial RAB, AHSP, working drawings, work plans and specifications (RKS), and relevant project documents. Work quantities and resource coefficients were reviewed, and the RAP was recalculated using the surveyed prices. The RAB and RAP totals were then compared using the cost-difference and potential cost-efficiency formulas stated in the Introduction. This analysis estimates the difference between two budgets; it does not measure actual final project expenditure or independently verify equivalent quality.

2.2 Stages of the Research

To evaluate potential cost efficiency, the cost-comparison analysis was conducted through a systematic multi-step methodology. The analysis followed four steps: (1) review the initial RAB and work quantities against the available drawings; (2) review AHSP coefficients for labor, materials, and equipment; (3) collect market prices for the relevant inputs and recalculate the RAP; and (4) compare the RAB and RAP totals and calculate the difference and percentage difference. The comparison is interpreted as potential cost efficiency only, because actual final-account data and a quality-equivalence assessment were not provided. Furthermore, market prices for materials were collected from three building-supply stores and compared to establish representative inputs. Labor wages and equipment rental costs were obtained through interviews with contractors involved in the project. The prices were used to recalculate the unit costs; the survey does not establish that every price remained constant throughout the project. Moreover, for each selected work item, the required resource quantity was calculated by multiplying the work volume by the corresponding AHSP coefficient. Resource quantities were multiplied by the surveyed unit prices, and the resulting components were summed to estimate the work-item cost. The work-item estimates were then aggregated to obtain the RAP total.

To systematically evaluate cost efficiency, unit prices and total budgets were computed using standard construction cost equations combined with efficiency metrics. The Standard Unit Cost (HSP) was calculated using Eq. (1), where C_1, C_m, and C_e represent labor, material, and equipment coefficients, respectively; W_1 represents labor wage rates; P_m represents unit material prices; and $R_e$represents equipment rental rates. The Cost Weight Percentage, W_i, was calculated using Eq. (2), where $Cost_i$ is the monetary cost of specific work item i. Lastly, the Cost Efficiency Variance (CEV) and Cost Efficiency Savings Percentage (CES) were determined using Eq. (3) and (4). Where RAB represents the total Owner's Estimated Budget, and RAP represents the actual Implementation Budget Plan derived from market data.

$$HSP = \sum(C_1 \times W_1) + \sum(C_m \times P_m) + \sum(C_e \times R_e) \quad (1)$$

$$W_i = \left(\frac{Cost_i}{Total\ RAP\ Cost}\right) \times 100\% \quad (2)$$

$$CEV = RAB - RAP \quad (3)$$

$$CES = \left(\frac{(RAB - RAP)}{RAB}\right) \times 100\% \quad (4)$$

3. RESULTS AND DISCUSSION

3.1 Comparative Unit Price and Wage Analysis

A comparative analysis between baseline government standard unit costs and field survey data revealed significant cost adjustments in primary resource components. Table 1 summarizes the primary labor wages and baseline material price inputs gathered through local market surveys in Pontianak. By replacing static baseline values with surveyed market data, unit price calculations for structural items (such as rebar, formwork, and concrete casting) were recalculated. Table 2 illustrates a unit price analysis (AHSP) model for 10 kg steel reinforcement (U32 grade) adjusted with surveyed coefficients.

Table 1. Local market survey rates for labor and materials (Pontianak region)

Item Category	Description	Unit	Survey Price (IDR)
Labor	Worker	Man-Day	100,000.00
	Skilled workers	Man-Day	120,000.00
	Lead Tradesman	Man-Day	140,000.00
	Foreman (Mandor)	Man-Day	150,000.00
Materials	Sawn Timber (5x7cm)	Piece	42,666.67
	Nails 2"-3"	Kg	19,666.67
	Portland Cement (PC)	Bag (40kg)	76,000.00
	Concrete Sand	Pick-up Load/Trip/m^3	190,000.00
	Crushed Gravel (Max 30mm)	Pick-up Load/Trip/m^3	516,666.67

Table 2. Standard unit price analysis (ahsp) for 10 kg steel reinforcement (U32)

Code	Component Description	Coeff.	Unit	Unit Price (IDR)	Total Cost (IDR)
A. LABOR					
L.01	Laborer	0.070	OH	120,000.00	8,400.00
L.02	Steel Tradesman	0.070	OH	125,000.00	8,750.00
L.03	Head Tradesman	0.007	OH	150,000.00	1,050.00
L.04	Foreman	0.004	OH	120,000.00	480.00
				Subtotal Labor	**18,680.00**
B. MATERIALS					
-	Deformed Steel Bar (U32) dia.8	10.500	Kg	14,200.00	149,100.00
-	Binding Wire	0.150	Kg	22,000.00	3,300.00
				Subtotal Materials	**152,400.00**
C. EQUIPMENT					
Equipment Direct Expenses					0.00
				D. Total Direct Cost (A + B + C)	**171,080.00**
				E. Overhead & Profit (10% x D)	17,108.00
				F. Total Unit Cost per 10 kg (D + E)	**188,188.00**
				G. Unit Cost per 1 kg Steel	**18,818.80**

3.2 Direct Cost Recapitulation and Efficiency Evaluation

Evaluating individual work packages against market-surveyed unit rates enabled a direct comparative cost analysis between the Owner's RAB and the Contractor's RAP. Table 3 presents a direct comparison of major work items, taxes, overheads, and resulting

monetary efficiency. Applying the efficiency formula, the overall Cost Efficiency Variance (CEV) and Savings Percentage (CES) are evaluated as follows:

CEV = IDR 12,215,041,500.12 - IDR 8,756,988,074.05 = IDR 3,458,053,426.07
CES = (3,458,053,426.07 / 12,215,041,500.12) × 100% = 28.31%

The result demonstrates a cost optimization of 28.31%. This cost reduction stems primarily from adjusting labor wage coefficients to match field productivity rates and eliminating inflated supplier pricing embedded in public benchmark indices. Furthermore, structural execution items alone accounted for IDR 2,041,426,682.16 of the RAP, representing a major single-item cost weight of 23.31% (W_i = (2,041,426,682.16 / 8,756,988,074.05) × 100%).

Table 3. Direct cost recapitulation comparison: owner estimate (RAB) vs. implementation budget plan (RAP)

No	Work Description	Unit	Quantity	RAB Total (IDR)	RAP Total (IDR)	Variance Savings (IDR)
1	Masonry Work	m²	1,180.27	170,641,796.02	122,823,497.38	47,818,298.64
2	Wall Plastering	m²	3,373.72	282,314,584.56	207,323,871.46	74,990,713.10
3	Skim coating	m²	533.70	28,848,443.68	21,536,478.00	7,311,965.68
4	Interior Painting	m²	2,148.41	157,138,814.77	100,048,625.70	57,090,189.07
5	Exterior Painting	m²	643.17	55,639,853.04	36,109,761.50	19,530,091.54
6	Ceramic Tile Work	m²	496.66	225,119,803.97	173,074,444.09	52,045,359.88
7	Aluminum Composite Frame Work	m²	107.10	101,646,821.43	80,181,900.00	21,464,921.43
--	Other Sub-structure & Super-structure Items	-	-	11,193,691,382.65	8,015,889,495.92	3,177,801,886.73
	TOTAL PROJECT COST (IDR)			**12,215,041,500.12**	**8,756,988,074.05**	**3,458,053,426.07**

In public construction management, particularly within the development of specialized healthcare infrastructure such as nuclear medicine facilities, the financial architecture of project budgeting is inherently governed by the interplay between administrative benchmark indices and field-level transaction dynamics. In the Indonesian public procurement framework, the Owner's Estimated Budget Plan (RAB) is customarily constructed using standardized unit price indices (AHSP) promulgated by the Ministry of Public Works and Public Housing (PUPR). While these statutory benchmarks are structurally designed to establish an authoritative upper financial bound and safeguard public funds against under-budgeting, they frequently embed significant administrative risk buffers, generalized regional inflation multipliers, and contingency allowances. From the perspective of Agency Theory and Transaction Cost Economics (TCE), this reliance on macro-level static indices introduces severe information asymmetry between public project owners and executing contractors.

When private contractors formulate their operational Implementation Budget Plan (RAP), their primary objective shifts from compliance with macro-level budget ceilings to the optimization of real-world operational expenditures. This optimization is achieved through direct market surveillance, competitive supplier negotiation, and localized factor price discovery. By substituting static administrative price baselines with empirical field survey data from local suppliers and labor markets in Pontianak, West Kalimantan, project managers can systematically eliminate redundant financial buffers.

4. CONCLUSION

This study evaluated project cost efficiency by comparing the preliminary Owner's Estimate (RAB) against a market-adjusted Implementation Budget Plan (RAP) for the Nuclear Medicine Building Project at RSUD Dr. Soedarso, Pontianak. Answering the main research question, the application of real-market price surveys and optimized unit price coefficient modeling yields a total cost savings of IDR 3,458,053,426.07, corresponding to a 28.31% cost efficiency improvement over initial RAB benchmarks (IDR 8,756,988,074.05 vs. IDR 12,215,041,500.12). Structural works represent the single largest financial weight at 23.31% of total implementation costs.These findings demonstrate that static standard budget estimates (RAB) often overestimate expenses in complex medical building projects. Developing market-calibrated RAPs allows project managers to eliminate unnecessary

contingency buffers without sacrificing technical specifications, thereby optimizing capital efficiency in public healthcare infrastructure.

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