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FEASIBILITY ANALYSIS OF A BATCHING PLANT INVESTMENT FOR THE KEDIRI-TULUNGAGUNG TOLL ROAD PROJECT

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ABSTRACT
This study evaluates the feasibility of establishing a batching plant for the Kediri-Tulungagung toll road construction, specifically for the Dhoho Kediris Airport toll access, section 2. Observations were conducted with key stakeholders at the project site, including concrete production costs, operational schedules, and potential bottlenecks. The data was analyzed using a quantitative approach with statistical software, focusing on investment feasibility indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (Rohman & Husin, 2024). The results of the analysis show that the NPV is IDR5,599,938,029.34 with IRR reaching 82.71%, far above the Minimum Attractive Ratio (MARR) of 12%. In addition, the efficiency of concrete distribution time to the site improved daily work productivity. This study provides critical insights into the logistical, economic, and operational aspects of setting up a batchesing plant, which is essential for ensuring the efficient production of concrete required for the construction project. The findings can serve as a valuable reference for future projects in similar contexts, enhancing the planning and execution of toll roads in Indonesia.

INTRODUCTION

Concrete is the main construction material used in various types of infrastructure projects due to its high strength and adaptability to various conditions. As a construction material, concrete is produced by mixing materials such as cement, fine aggregate, coarse aggregate, water, and other additives. The characteristics of good concrete are strongly influenced by the quality and composition of the forming materials, as explained by Nawy (1990). In the context of modern infrastructure, the need for quality concrete is getting higher as construction standards and project volumes increase. The Kediri-Tulungagung Toll Road project, particularly the Dhoho Kediri Airport access section 2, requires a significant volume of concrete, namely 125,969.55 m³. As much as 70% of the requirement will be produced through internal batching plant. This policy is taken to reduce the risk of delays, maintain concrete quality according to specifications, and reduce dependence on external suppliers (Purnomo et al., 2022). In addition, in-house production allows better control over the quality, cost, and schedule of concrete delivery to the project site.

Batching plants are facilities designed to mix and produce ready-mixed concrete on a large scale. Based on national standards, as regulated by the Indonesian National Standardization Agency (*Badan Standarisasi Nasional*), the design of batching plants must meet certain specifications to ensure the quality of the products produced. In addition, technical aspects such as the method of making normal concrete mixtures must also follow the applicable guidelines (Kementerian PUPR, 2016). Large infrastructure projects, such as the Kediri-Tulungagung Toll Road, face complex challenges, including logistical constraints, raw material quality, and cost efficiency. For this reason, the use of internal batching plants provides strategic advantages, namely reducing concrete transportation costs, ensuring timely delivery, and minimizing the risk of losses due to quality discrepancies (Demissew, 2022; Martins et al., 2022). However, the construction of a batching plant requires significant initial investment, making a feasibility study an important step before implementation (Rani et al., 2020).

In this feasibility study, various technical and economic aspects are analyzed, including concrete production costs, operating efficiency, as well as financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (Rohman & Husin, 2024). The results of this study will determine whether the batching plant investment is feasible. For example, previous research by Abdulmalek & Chakkamalayath (2023) showed that the utilization of self-compacting concrete can improve cost efficiency and quality, which is relevant for large projects like this. In addition, the technical review also included an analysis of the most suitable concrete mix design method to meet the needs of the project. As outlined by Zhou et al. (2021) and Wiyanti & Laksono (2024), the mix design method should be tailored to the project specifications to achieve optimal compressive strength and durability.

In the concrete production process, environmental factors are also a concern. Carbon emissions from the cement industry, which is the main component of concrete, have a significant impact on the environment. Therefore, the use of additives such as fly ash and cement slag can help reduce environmental impacts (Elsalamawy et al., 2020; KAYA & KAYA, 2023). This is also in line with global efforts to improve sustainability in the construction industry (El-Reedy, 2009). In the context of this project, the decision to establish a batching plant was based on a thorough analysis of the project needs, cost efficiency, and environmental impact. Considering the large volume of concrete required and the existing logistical challenges, an internal batching plant was the most rational and efficient solution (Nugroho et al., 2019). However, the operational efficiency of a batching plant is also highly dependent on good design and logistics (Coelho et al., 2022; Najafi et al., 2024; Vilas-Boas et al., 2023; Weerapura et al., 2023; Zehetner & Gansterer, 2022).

In the face of the huge challenges and needs of the Kediri-Tulungagung Expressway project, several key questions arose. First, how much does it cost to produce concrete in an internal batching plant? This question is important to evaluate the cost advantage over purchasing from external suppliers. Second, is the investment in setting up a batching plant feasible? A feasibility analysis is required to ensure that this investment provides significant financial benefits, both in the short and long term, and supports the efficient achievement of project targets. The answers to these questions will form the basis of strategic decision making for the success of the project. The need for quality concrete in Indonesia is increasing, especially in large projects that require large volumes of concrete and high quality standards. In supporting infrastructure such as toll roads, concrete plays an important role as the main element of construction. Concrete, which is produced by mixing materials such as cement, fine and coarse aggregates, water, and additives, is produced by observing certain methods and standards. The Indonesian National Standardization Agency (*Badan Standarisasi Nasional*) has established technical guidelines related to the manufacture and use of normal concrete, which must be followed by all construction industry players in Indonesia.

The Kediri-Tulungagung Toll Road construction project is one notable example of the large-scale demand for concrete. The project, particularly the Dhoho Kediri Airport access section 2, was designed to use 125,969.55 m³ of concrete, of which 70% was produced through an in-house batching plant. This step provides significant advantages in terms of cost efficiency and quality control, as outlined by Purnomo et al. (2022). In addition, with an internal batching plant, concrete delivery can be better scheduled and reduce the risk of delays that often occur due to dependence on external suppliers. Cost analysis is an important part of batching plant construction. For example, a study by Abdulmalek & Chakkamalayath (2023) showed that a cost-benefit analysis on self-compacting concrete provides advantages in terms of reduced labor costs and efficient working time. This study is relevant in supporting the batching plant construction policy to ensure that the concrete produced meets the set technical specification standards.

In supporting such a large project, it is also necessary to consider the environmental impact of concrete production. El-Reedy (2009) highlighted that carbon emissions from the production of cement as the main ingredient of concrete is one of the largest sources of greenhouse gas emissions. Therefore, efforts to reduce emissions through the use of additives such as fly ash and cement slag are prioritized in concrete mix design (Kaya et al., 2023). In addition, waste management from batching plants is also important to ensure the sustainability of operations, as described by Martins et al. (2022). Simulation of production and logistics in batching plant operation is an important aspect that must be well planned. In the context of this project, the optimization of batching plant operations not only minimizes downtime but also ensures that daily production targets can be achieved without constraints.

The investment of a batching plant should also be viewed from the perspective of financial viability. Financial feasibility analysis using indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period is an important step to assess whether the investment is profitable (Rani et al., 2020). Their research shows that the batching plant designed with high efficiency has a positive NPV value, IRR greater than the market interest rate, and a relatively short payback period, so the investment is considered feasible. The study by Demissew (2022) emphasized the importance of choosing a cost-effective concrete mix design method. In this project, mix design methods that comply with local and international specifications, as outlined in SNI 03-2834-2000 and other standards, will be used to ensure concrete quality. This is in line with the research results of Ahmed et al. (2021), which showed that the order of mixing materials greatly affects the compressive strength of concrete. In this study, the calculation of concrete production costs and the evaluation of the feasibility of batching plant investment are the main focus. The study by Nugroho et al. (2019) highlights the efficiency comparison between national and local project-based construction contracts, which can provide additional insights into cost management in large projects. By combining technical and financial approaches, the project aims to achieve operational efficiency and sustainability in the long term.

This study evaluates the feasibility of establishing a batching plant for the Kediri-Tulungagung toll road construction, specifically the Dhoho Kediri Airport toll access, section 2. The research contributes to the field of civil engineering and infrastructure development by providing a comprehensive evaluation of the feasibility of establishing a batching plant for the Kediri-Tulungagung toll road construction, particularly for the Dhoho Kediri Airport toll access, section 2. This study offers critical insights into the logistical, economic, and operational aspects of setting up a batching plant, which is essential for ensuring the efficient production of concrete required for the construction project. By assessing factors such as location, cost, supply chain logistics, and environmental impact, the research aids stakeholders in making informed decisions regarding infrastructure investments. Additionally, the findings can serve as a valuable reference for future projects in similar contexts, enhancing the planning and execution of toll road construction in Indonesia.

METHODS

This study employs quantitative methods to evaluate the feasibility of establishing a batching plant for the Kediri-Tulungagung toll road construction, specifically for the Dhoho Kediri Airport access, section 2. Data was collected through direct observation, interviews with key stakeholders, and analysis of relevant documents. The objective is to create a comprehensive picture of the technical, financial, and environmental aspects of the project. By integrating quantitative data and statistical analysis, the research provides objective results that support informed decision-making.

The operational efficiency of the batching plant was assessed through concrete production cost analysis and profit projection. Collected data was analyzed using statistical software to ensure accuracy and validity. The analysis included calculations of Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period as indicators of investment feasibility. This structured approach facilitates the development of strategic recommendations.

The research was conducted at the Kediri-Tulungagung Toll Road project site, specifically at the Dhoho Kediri Airport access section 2, chosen for its high concrete demand and logistical efficiency. The proposed batching plant location is strategically placed to minimize transportation costs while maximizing accessibility, allowing for direct analysis of field conditions and project operations. The research period lasted six months, encompassing data collection, analysis, and report preparation, ensuring that the results were reflective of actual conditions and aligned with project needs.

Data collection involved a combination of observation, interviews, and document analysis. Observations at the batching plant and project site provided insights into the concrete production process and logistics, including production capacity, operational schedules, and potential bottlenecks. Interviews with project managers, batching plant technicians, and contractors offered in-depth perspectives on operational challenges and opportunities. Additionally, historical data was gathered from financial statements and project documents, ensuring both completeness and accuracy.

The data was analyzed using a quantitative approach with statistical software, focusing on investment feasibility indicators such as NPV, IRR, and Payback Period to evaluate financial efficiency and economic benefits. Sensitivity analysis identified key factors affecting investment outcomes, while operational data assessed production capacity and efficiency. Environmental impact analysis evaluated potential carbon emissions and waste from concrete production, providing a comprehensive view of the feasibility and sustainability of the batching plant investment.

To ensure the accuracy and reliability of the results, data validation involved cross-checking with additional sources, including project reports and stakeholder interviews. This process aimed to minimize bias and ensure the data accurately reflected real conditions. Data verification included comparisons with previous studies and relevant standards, as well as discussions with experts in construction and finance to confirm the analysis results, ensuring findings are both justified and supportive of project implementation.

RESULTS

Concrete Production Cost Analysis

Concrete batching plant is a kind of equipment used to mix concrete in a concentrated way, which is widely used in large and medium construction engineering projects. We are a family owned business and have been involved in supplying ready-mix concrete batching plants and equipment to the industry over the last 25 years. The cost of cement as the main component of concrete accounts for the largest portion, followed by sand and coarse aggregate. The use of local sand from Blitar and coarse aggregate from Mojokerto provides cost efficiency, but still maintains quality in accordance with PUPR specifications.

Energy costs, which include electricity and fuel for heavy equipment such as loaders and truck mixers, account for 20% of total production costs. Labor costs account for about 10%, with efficiency improved through technical training for batching plant operators. The overall calculation shows that the in-house concrete production cost per cubic meter is Rp1,200,000, which is 25% less than the cost of purchasing from external suppliers.

Table 1. Cost of Concrete Production per m3

No.	Material Type	Unit	Unit Price	Index*> Tools.	Total
I	Tools:				
1	Batching Plant	Hours	371,416.00	0.013	4,828.41
2	Wheel Loader	Hours	116,813.00	0.013	1,518.57
3	275 Kva Generator	Hours	40,582	0.013	527.57
4	Travo	Hours	34,300.00	0.013	445.90
5	Land Rent and installation 197 Kva electrical installation.	M3	4,591.51	1	4,591.51
6	BP + Office Installation Cost +Laboratory equipment + Accessories	M3	14,662.06	1	14,662.06
7	Repair and Maintenance.	M3	4,311.32	1	4,311.32
	Sub Total				30,885.33
II	Labor				
1	Opr. Batching Plant	Hours	39,375.	0.013	511.88
2	Opr. Wheel Loader	Hours	39,375.	0.013	511.88
3	Opr. BP & Loader Backup	Hours	39.375.	0.013	511.88
4	Laboratory Personnel, Concrete Eng. Technician, and Daily 4.	Hours	168,750.	0.013	2,193.75
	Sub Total				3,729.38
III	Electricity**>	m3.	4,137.62	1	4,137.62
	Sub Total				4,137.62
	Total Production Cost				38,752.33

Source: Researcher Processed Data 2024

Evaluation of Investment Feasibility

The batching plant investment evaluation was conducted using various financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP). The results of the analysis show that the NPV is IDR5,599,938,029.34 with IRR reaching 82.71%, far above the Minimum Attractive Rate of Return (MARR) of 12%. The investment payback period (PP) is 10 months and 15 days, which is faster than the main project duration. This indicates that the batching plant investment is feasible because it generates financial benefits and supports the smooth running of the project.

Table 2. Net Present Value Calculation

Month	Investment (Rp.000)	Cost (Rp.000)	Benefit (Rp.000)	Net Benefit (Rp.000)	DF 12% per year (1% per month)	Present Value (Rp.000)
0	2,861,270			-2,861,270	1	-2,861,269.50
1	1,285,862			-1,285,862	0.990099	-1,273,130.69
2	5,287,001			-5,287,001	0.980296	-5,182,825.70
3		1,136,503	1,315,739	179,237	0.97059	173,965.34
4		1,267,234	1,466,934	199,700	0.96098	191,907.93
5		2,738,497	3,289,522	551,025	0.951466	524,281.22
6		3,958,301	4,685,188	726,887	0.942045	684,760.41
7		8,395,827	10,152,286	1,756,459	0.932718	1,638,280.91
8		9,835,372	11,747,316	1,911,944	0.923483	1,765,648.53
9		9,616,182	11,503,452	1,887,270	0.91434	1,725,606.24
10		10,265,407	12,327,315	2,061,908	0.905287	1,866,618.75
11		9,860,741	11,859,627	1,998,886	0.896324	1,791,648.84
12		10,633,860	12,672,909	2,039,049	0.887449	1,809,552.77
13		9,787,124	11,657,928	1,870,804	0.878663	1,643,805.64
14		5,878,386	7,144,057	1,265,672	0.869963	1,101,087.34
		83,373,432	99,822,273			5,599,938.03
						NPV: 5,599,938.03

Source: Researcher Processed Data 2024

Effect of Internal Concrete Production on the Project

In-house concrete production, which reached 70% of the total project requirement or approximately 88,179 m³, had a positive impact on the project schedule. Direct quality control enabled timely completion of rigid pavement and bridge structure works. In addition, the efficiency of concrete distribution time to the project site improved daily work productivity. However, there was a potential loss of profit from daily production of 126 m³ due to the policy of purchasing from external batching plants as backup. This policy, while reducing operational risk, requires further evaluation to optimize overall project profitability.

Concrete Specifications and Production Quality

Concrete produced in accordance with PUPR specifications has a range of grades, from fc' 10 MPa to fc' 50 MPa, depending on the needs of the structure. The concrete quality for rigid pavement (fr 4.5 MPa) showed optimal results, with deviations in compressive strength within standard tolerances. The presence of additives such as superplasticizers improves the workability of the concrete without reducing the compressive strength. The strict quality control process at the batching plant produces a consistent product that meets the standards required by the project contract.

Table 3. Material cost for each concrete grade (JMD 01)

Material Quality and Type	Unit	Volume A	Index	Unit Price (Rp.) B	Total (Rp) = A x B
fc'.35 Mpa.					
Cement	Kg	404.76	1.05	840.00	356,998.32
Water	ltr	170.00	1.05	13.13	2,343.71
Sand	m3.	730.00.	1.05	170,000.00	86,294.70
Aggregate /					
Split Stone	m3	1,095.14	1.05	180,000.00	143,192.89
Additive Type D	Ltr	1.28	1.05	4,700.00	6,336.54
Additive Type	Ltr	1.76	1.05	31,000.00	56,897.40
NS Exspander					
				Σ Cost	652,063.56
.f'c. 30 Mpa.					
(Structure)					
Cement I	kg.	422.68	1.05	840.00	372,803.76
Water	ltr	205	1.05	13.13	2,826.23
Sand	m3.	698.93	1.05	170,000.00	82,621.86
Aggregate/	m3	1048.39	1.05	180,000.00	137,080.19
Split Stone	Ltr	4.03	1.05	9,500.00	40,199.25
Additive SS 1				Σ Cost	635,531.29
.f'c. 20 Mpa.					
Cement I	kg.	341.67	1.05	840.00	301,352.94
Water	ltr	205	1.05	13.13	2,826.23
Sand	m3.	731.33	1.05	170,000.00	86,451.92
Aggregate /	m3	1097.00	1.05	180,000.00	143,436.09
Split Stone	Ltr	3.25	1.05	9,500.00	32,418.25
Additive SS 1				Σ Cost	566,485.94
.f'c.15 Mpa.					
Cement I	kg.	301	1.05	840.00	265,482.00
Water	ltr	205	1.05	13.13	2,826.23
Sand	m3.	758	1.05	170,000.00	89,604.64
Aggregate /	m3	1137.00	1.05	180,000.00	148,666.22
Split Stone				9,500.00	28,628.25
Additive SS 1				Σ Cost	535,207.33

Source: Researcher Processed Data 2024

Environmental Impact and Operational Efficiency

The batching plant is designed with a waste management system that meets environmental regulations. Concrete waste is recycled into coarse aggregate for non-structural use. In addition, the use of energy efficient machines and raw material stock management systems reduces the carbon footprint of the operation. The use of the latest technology in batching plants, such as automatic control systems, also improves production efficiency. Thus, not only the economic aspect is improved but also the environmental sustainability aspect.

Discussion

The success of batching plant investment is inseparable from the support of comprehensive technical and financial analysis. In the technical aspect, the use of local raw materials with strict quality control is a key factor to achieve cost efficiency while maintaining high quality concrete.

From the financial side, the analysis shows that the batching plant provides significant benefits. The IRR of 82.71% far exceeds the MARR, indicating that this investment has a high potential return. With a positive NPV, this investment is also able to provide significant added value to the company.

However, the potential profit loss of 126 m^3 of concrete per day due to purchasing from external batching plants is a challenge that needs to be further evaluated. Alternative solutions such as increasing production capacity or optimizing distribution schedule can be considered to reduce the loss. Effective waste management is an added value of this batching plant. The effort to recycle concrete waste into coarse aggregate shows commitment to environmental sustainability. It is also in line with the trend of the construction industry which is increasingly emphasizing on environmentally friendly practices.

In the context of project sustainability, the availability of an in-house batching plant provides greater flexibility for project management. In addition, the customization of the production schedule to the needs of the project ensures optimal operational efficiency. Overall, the batching plant not only improved technical and financial efficiency but also made a positive contribution to the smooth implementation of the project. Data-driven decision making and thorough analysis ensured that this investment provided maximum benefits for all parties involved.

CONCLUSION

The cost of concrete production for the Kediri-Tulungagung Toll Road project is calculated at Rp1,200,000 per cubic meter, incorporating materials, labor, energy, and equipment depreciation, and is 25% lower than external suppliers due to the use of local materials and optimized processes. Financial analysis indicates that the batching plant investment is feasible, with a positive Net Present Value (NPV) of Rp5,599,938,029.34, an Internal Rate of Return (IRR) of 82.71%, and a Payback Period (PP) of 10 months and 15 days, highlighting its profitability and contribution to project efficiency. Recommendations include increasing internal batching plant capacity, implementing digital management technologies, improving concrete waste recycling, and adopting adaptive production planning to align with demand. Future research could focus on optimizing production processes, assessing the impact of digital management systems, evaluating recycling initiatives, conducting periodic risk assessments, and enhancing training programs for operators to improve overall batching plant performance in large-scale projects.

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