



## FEASIBILITY STUDY OF A RAILWAY CONSTRUCTION PROJECT AS INTERMODAL TRANSPORTATION IN TANJUNG PERAK PORT

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### Abstract

The growth of container flows that is not supported by infrastructure needs has caused goods congestion at Tanjung Perak Port. The situation has an impact on the flow of goods and makes container mobilization stop flowing. Railway infrastructure construction is expected to overcome the problem of goods congestion, especially because this project will be integrated with other transportation at the Port in an intermodal transportation system. The Delphi method is used as an approach to get the dominant aspect to be analyzed in a feasibility study of a railway construction project at the Port of Tanjung Perak. Delphi method results show that the financial aspect and market aspect are the dominant parameters to be analyzed in the feasibility study of a railway construction project. The results of the market feasibility analysis showed that 87.67% of stakeholders agreed with the railway development project plan, with a target market of 19.99% of the number of containers and absorption of around 84% of the target market. The results of the financial feasibility analysis are obtained, the Net Present Value (NPV) is  $1,184,370 > 0$  (profitable project), the Benefit-Cost Ratio (BCR) is  $1.39 \geq 1$  (the project is feasible), and the value of the Internal Rate of Return (IRR) is  $13\% > MARR$ , (investment is feasible). From the results of the financial feasibility analysis, the railway construction project is categorized as possible. Meanwhile, the break-even point for this project is in the 12th year with the results of a profit-loss analysis showing that in the fourth year, the railway operational activities have shown a positive trend/profit.

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### INTRODUCTION

Tanjung Perak Port is one of the largest ports in Indonesia, with a total area of 545 ha and six terminals are serving domestic and international activities. Being that, making container traffic activity at this Port becomes very high and dense. The number of export and import activities here in 2018 reached 28.811 thousand tons and an increase in growth of 2,18% per year from 2014 to 2018 [1].

The growth of container flows at Tanjung Perak Port is not supported by the need for infrastructure that is still inadequate, and the loading and unloading activities at the Port have not been maximized, causing goods congestion. The situation means that a lot of

goods are piled up somewhere, causing congestion of goods flow. The condition causes the mobilization of goods to stop flowing or commonly called stagnation. One of the causes of this traffic jam is the unavailability of infrastructure to support container mobilization activities, such as intermodal transportation. Transportation is the primary key to increasing the growth and competitiveness of a country [2].

One effort to reduce the problem of congestion of goods is the development of transportation infrastructure such as railways. Railway transportation can send transportation (people or goods) quickly and has a large capacity. Currently, container mobilization at the Port still uses the truck transportation mode.

So that, the railway construction project can be integrated with other transportation, and become an intermodal transportation system. Intermodal is the movement of goods through two or more different modes of transportation [3].

The intermodal transportation system not only helps in developing effective transportation networks but also contributes to reducing negative impacts on the environment and energy consumption. It also improves resource utilization and transportation services, which leads to better scheduling and delivery with lower logistical costs and higher levels of efficiency.

Many challenges in the planning of infrastructure, in addition to the enormous investment costs, infrastructure development must be right on target according to the needs and in line with the master plan infrastructure development planning [4]. So, in starting an infrastructure project, a feasibility study is needed to ensure the feasibility of the project from several parameters. It aims at making decisions in infrastructure project planning [5].

The purpose of this research is to conduct a feasibility study on a railway construction project that is used as intermodal transportation at the Tanjung Perak Port, Indonesia. The feasibility study is a series of multidimensional actions aimed at analyzing and evaluating projects to determine whether the construction is feasible [6]. Feasibility studies can assess projects that have a possible return on investment and are worth doing [7]. Without a feasibility study, it will harm project time and costs leading to an increase in both time and costs [8]. Railway projects experienced an average cost overrun of 82.70% and experienced a time overrun of 98.36% [9].

The Delphi method is used in this research to determine the dominant parameters in assessing the feasibility of a railway construction project, especially in Tanjung Perak Port. Market feasibility and financial feasibility analysis are the dominant parameters in determining the feasibility of a railway construction project.

## METHOD

This research uses a quantitative method in the form of a field survey conducted at Tanjung Perak Port. The data source used in this study also came from interviews with stakeholders at Tanjung Perak Port and applicable government regulations.

## Delphi Method

Construction, engineering, and management research like experimental research on safety, risk management, innovation, and technology forecasting are often unrealistic and dynamic due to the sensitivity and complexity of the topics [10]. Survey and group-brainstorming techniques are needed to collect subjective data, especially involve advice and judgment from the expert.

The Delphi method is designed to obtain the most reliable consensus from the selection of qualified experts, by a series of intensive questionnaires interspersed with an iterative process (rounds of questioning) [11]. The Delphi Method is a systematic and interactive research technique for obtaining judgments from panellists/experts on a particular topic [10]. This method can be used for structuring a group communication process to make the process more effective in allowing a group of individuals as a whole to deal with the complicated problem [12].

The Delphi study, defined as an iterative forecasting process, is characterized by three main features, namely: repetitive process with control response, anonymity, and statistical response [13]. Three main things become the key to success in preparing the Delphi method were: the definition and selection of experts, the number of rounds, and the structure of the questionnaire [12].

The success of the Delphi method depends on the careful selection of experts. Studies using the Delphi survey have primarily used 15-20 experts for research [11]. In this research, selected Experts were knowledgeable professionals involved in decision-making processes in client, consultant, project management, and contractor firms, which have been active in railway construction projects for more than 15 years.

The rounds number of questioning (iterative process) in the Delphi method can vary between two to seven rounds. Still, too many rounds would waste respondent's time, and stopping the study too soon could yield meaningless results [14]. In this study, the round's number of questioning used was three rounds.

In Round 1 of the Delphi survey, respondents were asked to list at least five parameters in the feasibility study for determining project feasibility. In Round 2 of the Delphi questionnaire survey, the respondents were provided with the consolidated results from Round 1 and were asked to select five dominant aspects in the feasibility study of a railway

construction project. In Round 3 of the Delphi questionnaire survey, respondents were asked to ratings of each dominant aspect from the

consolidated results from Round 2. Figure 1 shows Delphi process in this research.

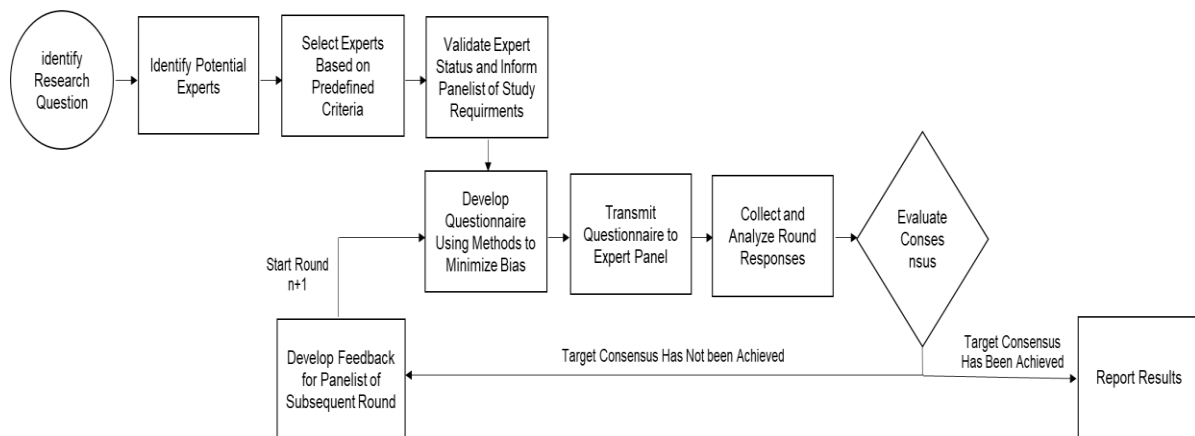


Figure 1. Delphi Process

### Market Analysis

The purpose of the market analysis is to determine the condition of the container transport movement, port capacity, and see the response of the stakeholders to the construction of a railway project. Besides, analysis of target markets is a critical factor for efficient project design and precise estimation of returns and financial performance in the context of Benefit-Cost Analysis [15]. From the results of the survey, we can analyze to determine the market for this railway construction project.

Market analysis determines whether market demand will affect the calculation of profit and rate of return (Internal Rate of Return) in financial aspects [16]. The survey was conducted in four stages, namely a survey of market potential, a survey of the flow of container shipments, a survey of the flow of container movements, and a survey of container traffic. From the results of the market survey, we can analyze to determine market viability in the railway construction project at Tanjung Perak Port.

### Financial Analysis

Financial analysis is the analysis of financial statements through the preparation of cash flows for the proposed project budgeting based on feasibility, stability, and profitability [17]. Analysis activities on this financial aspect include calculating the estimated amount of funds needed for investment needs, the estimated amount of funds required for project maintenance, and the estimated amount of funds as are necessary for other costs such as loans, taxes, and insurance.

Besides, the analysis to determine the most profitable project financing scenario is determined by deciding how much funds must be prepared through loans from other parties and how much funds from their capital. There are several methods used in analyzing financial feasibility in this study, such as Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (BCR), as shown in (1), (2) and (3), respectively.

$$NPV = PWB - PWC \quad (1)$$

Where,

NPV > 0, the project is profitable

NPV < 0, the project is not profitable

NPV = 0, neutral or at Break-even Point (BEP)

$$BCR = \frac{PWB}{PWC} \quad (2)$$

Where,

BCR ≥ 1, the project is feasible

BCR < 1, the project is not feasible

$$IRR = I(+)\frac{NPV(+)}{NPV(+)-NPV(-)}(I(-)-I(+)) \quad (3)$$

Where,

IRR > MARR, Investment is feasible

IRR < MARR, Investment is not feasible

## RESULTS AND DISCUSSION

### Dominant Aspects

In conducting a feasibility study, many aspects must be analyzed to determine the feasibility of a construction project. A construction project, especially an infrastructure project, is said to be feasible not only in terms of financial analysis. The project must also be considered feasible if viewed from the study of other aspects.

Identification of possible problems, specifications, expected performance is an evaluation to achieve an efficient project [18]. It is very important in conducting a feasibility study of a construction project an analysis of several aspects, especially the dominant aspect in determining the feasibility of the project.

The Delphi method is used as an approach to get the dominant aspect in determining the feasibility of the railway construction project at the Port of Tanjung Perak. Fifteen panellists with at least 15 years of experience in the field of railway construction were selected from several sectors to follow a series of rounds on the Delphi method. The panellists consisted of five panellists from the government sector, five panellists from the consultant / Expert sector, three panellists from the contractor sector, and two panellists from the academic sector. Table 1 and Table 2 shows the classification of selected experts.

Table 1. List of Selected Expert

Type of Firm	Year of Experience			
	15 - 20	20 - 25	25 - 30	≥ 30
Government	3	1		1
Consultant	1	1	2	1
Contractor	2	1		
Academic	1			1

Table 2. Job Positions of the Experts

Position	Number
Project Manager	1
Assistant Professor	2
Deputy Project Manager	2
General Director	2
Engineer	2
Deputy division chief in government	1
Chief Engineer	1
Commitment-making official in Government	4
<b>Total</b>	<b>15</b>

Round 1 Delphi was conducted to determine the scope of the analysis in the feasibility study of a railway construction project. In Round 1 the panellists/experts will determine the scope of analysis in the project feasibility study. From the Delphi survey and literature review, there are nine scopes in the feasibility study, namely technical, financial, environment, market, social, economic, management, legal, and policy.

Round 2 Delphi was conducted to determine the dominant aspects of the feasibility study of a railway construction project. The panellists will determine the five dominant

aspects of the scope from the consolidated results in Round 1.

Table 3 shows the result of Delphi Round 2. It is important to ensure clarity and understanding of the Delphi process by all panellists/experts [13]. In Table 4 can be seen, based on the results panellists/expert's selection in Round 1, there are five dominant aspects in the railway development project, namely financial, technical, market, social and environmental.

Table 3. Result of Delphi Round 2

Aspect	Frequency	Percentage	Rank
Technical	15	100.00%	1
Financial	14	93.33%	2
Environment	12	80.00%	3
Market	10	66.67%	4
Social	10	66.67%	5
Economic	5	33.33%	6
Management	5	33.33%	7
Legal	3	20.00%	8
Policy	1	6.67%	9

Round 3 Delphi was conducted in this research to measure the dominant aspects of the feasibility study of a railway construction project. The first of the measurement criteria is based on aspects that must first be analyzed, and the second criteria are aspects that have the greatest influence on the feasibility of a railway project. From the results of the Round 2 of Delphi obtained financial and market aspects have the most significant influence in determining the feasibility of a railway construction project and is an aspect that must be analyzed first.

Table 4. Result of Delphi Round 3

Aspect	Mean	Weight	Rank
Financial	4,93	0,234	1
Market	4,67	0,222	2
Technical	4,40	0,209	3
Environment	3,60	0,171	4
Social	3,47	0,165	5

### Market Survey

A survey of existing conditions in the port area was conducted first to see the situation of container flow activities. One survey conducted was to determine the scale of the container business based on container ownership. The survey results show that container ownership is dominated by large companies (big players) by 51.78%, and the remaining 48.22% consists of several types of companies Shipping and Transporting Goods. The survey results also obtained a classification of container capacity. Container flow is dominated by the container with 20ft capacity (78.91%) and 40ft capacity

(21.09%). **Figure 2** shows container composition based on capacity and ownership.

The movement pattern of container distribution based on hours is carried out to find out the level activity of goods movement in the dimension of the clock for 24 hours a day with an interval of three hours. **Figure 3** shows the movement pattern of containers during peak hours at the Port. The peak of busyness occurs at 15:00 - 18:00, which reaches 18.40% of the number of container trucks passing by in a day.

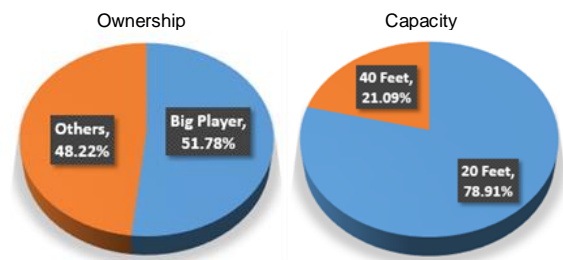


Figure 2. Container composition

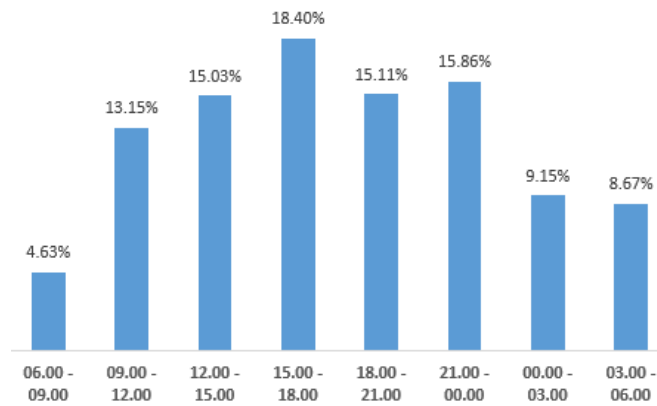


Figure 3. Container Distribution (in hours)

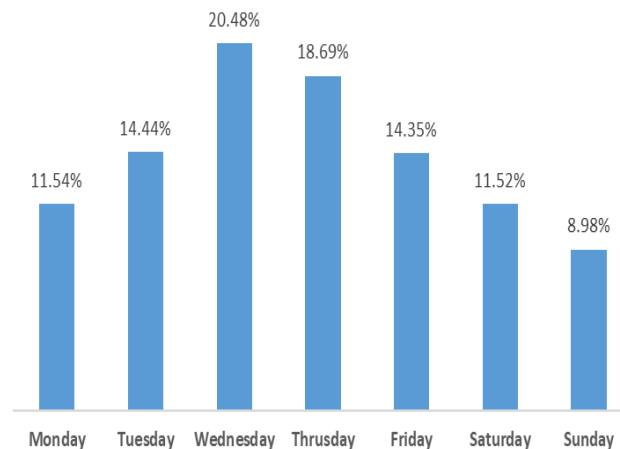


Figure 4. Container Distribution (daily)

A field survey was also conducted to see the pattern of movement of container distribution within the daily period of the week. **Figure 4** shows container movement in a week based on the survey results, the most densely populated distribution occurred on Wednesday (20.48%) and Thursday (18.69%) of the number of container trucks that passed in a week.

From the survey results to see the flow of container traffic at the Port, which is the target market of the railway construction project, this is a big player. Still, it does not rule out the

possibility that small businesses will also take advantage of this facility. From the field survey results, it is found that more than 45% of container movement originates from the depot and inter-terminal surrounds that enter Tanjung Perak Port with the duration of the trip requiring 2.34 times longer than normal due to traffic jams. Costs incurred by the container truck driver during the trip reached IDR 189.000.

This fee consists of parking fees, illegal transportation costs, and other costs, such as fines for unexpected events and toll fees.

### Market Feasibility

From the survey results, we can find out the existing conditions and obstacles that occur during container mobilization activities at the Tanjung Perak Port. For this reason, the construction of intermodal transportation is one alternative to overcome the problem of container mobilization. The survey was also conducted on the stakeholders to find out their opinions with the railway project plan. In Figure 5 it can be seen stakeholder perception with the railway construction project plan. Able to reduce congestion of goods (56.25%) is the dominant perception from the stakeholders with the development of intermodal transportation. Besides, there are also time and cost efficiency (10,94%) and accelerated container flow (6,25%).

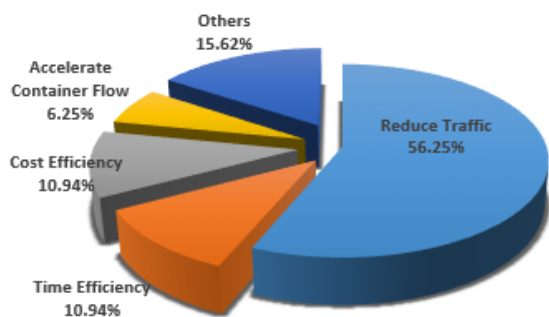


Figure 5. Stakeholder Perception

Absorption analysis is carried out to determine the absorption target of this project. The average container flow growth in Tanjung Perak port in the last ten years was 8.05%. The assumption of installed capacity is based on the Berth Occupancy Ratio (BOR) or dock usage level of 80%. By using the pessimistic scenario, the railway project's target market is 19.99% of the entire container flow, with the absorption of around 84% of the target market.

### Cost Analysis

Cost analysis in the railway construction project is divided into several components, namely investment costs, annual costs, and revenue. Investment costs include the cost of providing consular services and include costs for project preparation and documentation, annexation and acquisition of land, construction, technology sets, technical assistance, promotion, technical supervision, and reserves [19].

The investment cost component in this study consists of direct costs and indirect costs. Direct costs consist of land acquisition costs and construction costs, while indirect costs consist of technical costs, licensing fees, administrative costs, facility fees, and unexpected costs. In

Table 5 we can be seen, the planned construction activities are carried out for two years, with a total cost of IDR 3.038.695 (in a million). Sources of funds for investment costs are divided into its own capital (30%) and loan (70%). The loan duration calculation is 12 years with a loan interest rate of 10.5% and a weighted average cost of capital (WACC) of 11.5%.

Cost analysis Project revenue is derived from the use of railways to deliver containers. Revenue costs are derived from assumptions based on container size (20ft and 40ft), the fullness of container loads (filled and empty), market rates in 2013, and inflation of 15%. In addition to the tariff assumptions, the calculation of feeder costs is also calculated as an addition to the project revenue analysis.

Table 5. Investment Cost

No	Cost Type	Amount In Million (IDR)
1	<b>Direct Cost</b>	
	Land Acquisition	237
2	<b>Indirect Cost</b>	
	Construction Work	2,285,461
	General Works	229,576
	Preliminaries	142,789
	Utilities Diversion	77,035
	Vat (10%)	273,509
	Setup Cost (1%)	30,086
<b>Total investment</b>		<b>3,038,693</b>

Operational costs are one form of annual costs, which is one of the calculations in the financial feasibility of the project. Operational costs are calculated based on energy usage costs per year, human resource costs per year, and maintenance costs per year. There is also an interest instalment fee on loans and insurance costs that are included in the annual cost.

#### 1) Energy Cost

The analysis of energy costs based on electrical power requires operational activities of 19.12 MVA. Assuming electricity costs in the first year of operation is IDR 1,812 / kWh with an increase of 5% every year [20]. Figure 6 shows the simulation from the analysis of energy cost for 30 years.

#### 2) Maintenance Cost

Maintenance cost is divided into two, namely minor cost and major cost. Minor maintenance is carried out annually while major maintenance is carried out at certain times, depending on the type of maintenance cost component. Assuming minor maintenance costs are 2.5% of investment costs, while major maintenance costs are 5%. The economic life of

the project is 30 years, with a 5% increase in maintenance costs per year. Figure 7 shows the

simulation from the analysis of maintenance costs for 30 years.

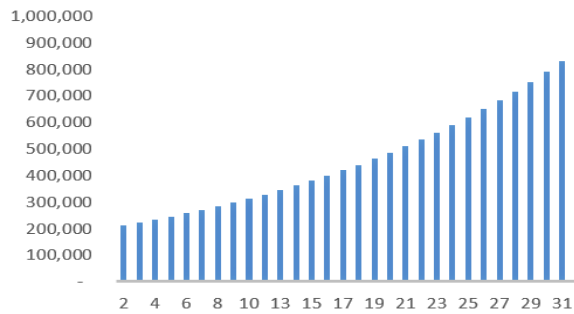


Figure 6. Energy Cost

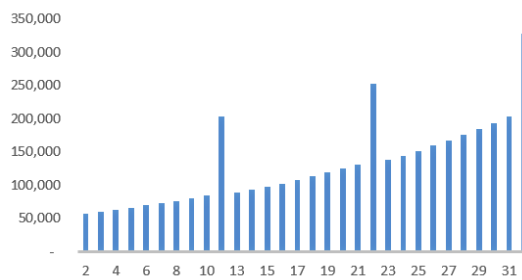


Figure 7. Maintenance Cost

### 3) Human Resource Cost

Human resource cost costs are based on calculating employee wages above 25% of the regional minimum wage, 13 times salary, plus a bonus of 2.5% of profit with each employee salary increasing 5%. The number of human

resources in the first year of the operation is assumed to be 185 people who then experience an increase following need. Figure 8 shows the simulation from the analysis of human resource costs for 30 years.

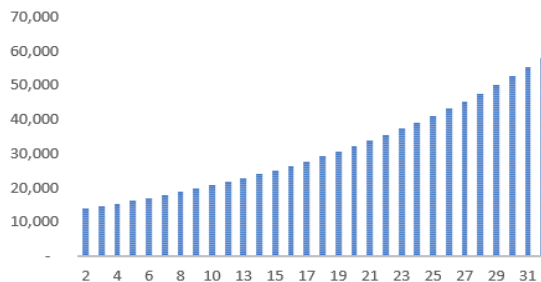


Figure 8. Human Resource Cost

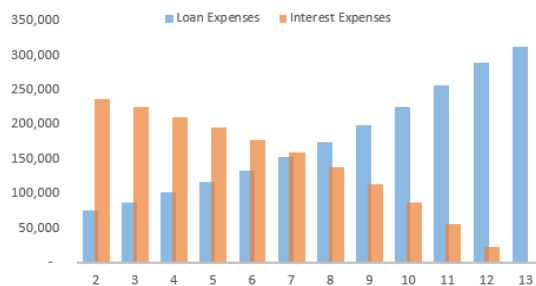


Figure 9. Loan Repayment Cost

#### 4) Loan Repayment Cost

Loan repayment cost is a function of investment debt, assuming a repayment period of 12 years accompanied by interest 10.5% per year. Loan repayment cost consists of principal loans and interest loan. The interest loan payment period is 11 years, in which in the 12th year, all investment debt has been paid off so that it does not incur interest expense. Meanwhile, repayments of the principal loan are carried out for 12 years in which, in the 13th year, all loan debt has been paid off. The calculation of bank debt payments is assumed with the scenario of a payment pattern that is not evenly distributed annually. The interest loan payment is made large at the beginning of the year and getting smaller the following year. The repayment of the principal loan is the opposite of payment of interest loan. Figure 9 shows the simulation from the analysis of loan repayment costs for 30 years.

#### Financial Feasibility

From the results of the calculation of revenue and annual costs (expenses), a profit-loss analysis can be performed. This analysis is conducted to see the pattern of project profits and losses every year. A profit-loss analysis is

carried out in the first year of railway operation. Energy cost, maintenance cost, human resource cost, and loan repayment cost are the main parts in the profit-loss analysis. Figure 10 shows the result from the simulation of profit-loss analysis in 30 years. In the first year to the third year of operational activities, the net earnings results obtained are negative or suffer losses. Net earnings results that are positive or experience a profit are obtained in the fourth year of operational activities.

Cash flow analysis is performed to determine the point at which a project's revenue and expenses are balanced (break-even point). Cash flow analysis provides information about the revenue and expenses of a project from the planning, construction, and operational stages in one period. Cash flows can be expressed in current prices, or target prices, or deflation prices depending on the price at which cash flows are stated at each step of the calculation of inflow and outflow [21]. The components in this analysis consist of investment cost, annual costs, and revenue. Figure 11 shows the result from the simulation of cash flow analysis for 30 years. This project experienced a break-even point in the 12th year or after ten years since the operation of the railway.

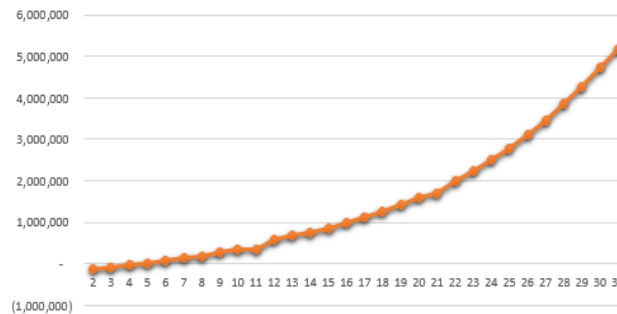


Figure 10. Profit – Loss Analysis

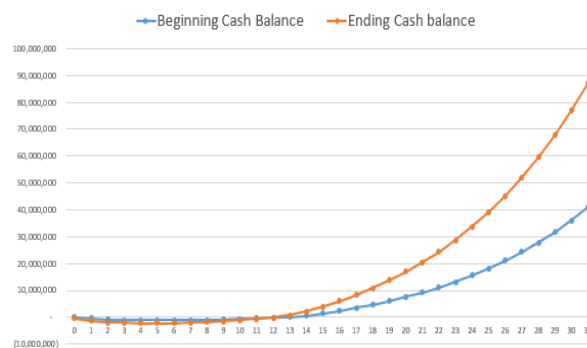


Figure 11. Cash Flow Analysis

The analysis used to determine the financial feasibility of this project is to use Net Present Value (NPV), Benefit-Cost Ratio (BCR),

and Internal Rate of Return (IRR). The calculation of the loan interest rate used is 10.5%, and the weighted average cost of capital



(WACC) is 11.5%. When a public project is evaluated, an appropriate discount rate or an attractive minimum rate of return (MARR) must be chosen [22]. Based on the analysis results, it is obtained:

1) NPV

Net Present Value (NPV) is defined as the sum of the present value of cash inflow and outflow over a while. Based on the calculation results for 30 years of the economic age of the project, the NPV value is 1,184,370 > 0, so the project is categorized as profitable.

2) BCR

Benefit-Cost Ratio (BCR) is defined as the present value of positive net cash flow divided by negative cash flow at a discount. Based on the calculation results, the BCR value is 1.39 ≥ 1, so the project is categorized as feasible.

3) IRR

Internal Rate of Return (IRR) is the rate of return on investment by calculating the interest rate that equates the present value of an investment with the present value of net cash receipts in the future. The calculation result shows that the IRR value is 13% > MARR, so the investment for this project is feasible. The WACC value used is 11.5%.

## CONCLUSION

The results of the Delphi Method show that the financial aspect and market aspect are the dominant parameters in the feasibility study of the railway construction project, so it is necessary to do an analysis first. The results of the market feasibility analysis show that 87.67% of the stakeholder agreed with the railway construction project plan. It is believed that reducing the goods congestion (56.25%) is the biggest reason for the stakeholder for railway construction as intermodal transportation. The target market of the railway construction project is 19.99% of all container flows, with the absorption of around 84% of the target market.

The results of the financial feasibility analysis are obtained, the Net Present Value (NPV) is 1,184,370 > 0 (profitable project), the Benefit-Cost Ratio (BCR) is 1.39 ≥ 1 (the project is feasible), and the value of the Internal Rate of Return (IRR) is 13% > MARR, (investment is feasible). Meanwhile, the break-even point for this project is in the 12th year or after ten years since operational activities are running. For the results of the profit-loss analysis, showing in the first year to the third year of operational activities shows a negative trend. The new positive trend

was seen in the fourth year of operational activities.

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