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Feasibility Analysis of Cicalengka Tofu Factory Expansion

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ABSTRACT

Tofu is a popular and affordable protein source widely consumed across Indonesia. The Cicalengka Tofu Factory in Bandung Regency is experiencing increasing demand, resulting in frequent overtime to meet production requirements. The factory plans to expand its production area by utilizing adjacent vacant land to address this challenge. This study evaluates the feasibility of the expansion, forecasting tofu demand until 2026 using time-series analysis with a single moving average method. The proposed expansion aims to increase production capacity from 264 to 396 tofu planks per day, requiring an investment of IDR 1,551,129,586. Financial analysis reveals that without expansion, the Net Present Value (NPV) over the next three years would be IDR 825,211,554, with an Internal Rate of Return (IRR) of 121%. With the expansion, the NPV increases to IDR 972,087,040, with an IRR of 43%. Incremental IRR analysis further supports the expansion, yielding an IRR of 22%, which exceeds the Minimum Attractive Rate of Return (MARR) of 16.36%. These findings validate the expansion plan as a financially viable strategy to enhance production capacity, minimize overtime, and ensure the factory's long-term sustainability.

Keywords: *Feasibility Analysis, Expansion, Cicalengka Tofu Factory, Incremental Analysis*

Introduction

Tofu is a popular food in Indonesia that is loved for its deliciousness and high vegetable protein content, making it an affordable alternative protein source [1]. The tofu industry in Indonesia is experiencing significant growth on both small and medium scales. This growth is driven by the increasing demand for tofu, which continues to increase due to changes in people's consumption patterns, variations in tofu products, and improvements in product quality regarding raw material selection and production processes [2]. Indonesia has around 84,000 tofu processing industries, ranging from household scale to large sectors [3]. The tofu industry in Indonesia consumes around 2.56 million tonnes of soybeans annually [3], with an average tofu consumption of 2.782 kg per capita from 2019 to 2023. Even though tofu consumption experiences fluctuations, industries like the Cicalengka Tofu Factory see opportunities to grow with the right strategies**.**

The tofu industry in Indonesia plays a significant role in the regional economy and in providing affordable plant-based protein. According to a study on small-scale tofu production, the industry improves the livelihoods of many artisans and their communities by offering employment opportunities and boosting local economies. Tofu production also supports many small and medium-sized enterprises (SMEs) nationwide, creating value chains in various regions [4]. Regarding nutritional value, tofu is often called "meat without bones" due to its high protein content comparable to animal meat. Tofu's protein quality is higher than soybeans, providing an excellent source of plant-based protein with a complete amino acid profile. The digestibility of tofu is also high, ranging between 85–98%, making it a preferred choice for a sustainable and affordable protein source, particularly in areas where access to animal-based proteins is limited or expensive[5].

The Cicalengka Tofu Factory is located in Bandung Regency. It implements a daily production system with an average daily production of 209 boards. Each board consists of 100 tofu, sold for IDR 46,000 per board, and retails for IDR 650 per piece. Tofu sales have increased with an average annual increase of 4.13%.

Currently, the Cicalengka Tofu Factory has a production capacity of 264 planks per day, with one production batch lasting 145 minutes and producing 66 planks. If production were carried out at that capacity, the factory would need 4 batches daily, which would take 9.7 hours. Overtime is required when demand exceeds this capacity, and the number of overtime instances has increased from 13 times from April 2020 to March 2021, 12 times from April 2021 to March 2022, and 20 times from April 2022 to March 2023.

The factory plans to expand its production capacity by utilizing vacant land next to it to meet the increasing demand. This expansion aims to meet growing demand without relying on overtime, thus improving operational efficiency. However, the factory faces potential supply chain challenges, particularly securing a consistent soybean supply for tofu production. Therefore, this research uses incremental analysis to determine the best investment alternative to analyze the feasibility of the Cicalengka Tofu Factory's expansion plan from market, technical, and financial aspects. By addressing production capacity limitations and improving efficiency, the factory can meet demand better while reducing dependence on overtime. The tofu industry, therefore, remains an essential component of Indonesia's food security strategy and economic development, particularly in urban and rural areas[4].

Feasibility Study

A feasibility study is research on a business plan to determine whether the business is feasible to build and operate to achieve maximum profits [6], [7], [8]. The intensity of a feasibility study varies depending on several factors [9]:

1. The magnitude of the impact that may occur.
2. High or low level of business certainty.
3. The amount of investment required to run the business.

The objectives of a business feasibility study include avoiding the risk of loss and facilitating planning, work implementation, supervision, and control [10]. The process consists of several stages: idea discovery, research, evaluation, sequencing of feasible proposals, implementation planning, and implementation [11].

Feasibility Study Aspects

In determining the feasibility of a business idea, several main aspects need to be considered in the feasibility study: legal, environmental, market and marketing, technical and technological, management and human resources, and financial aspects [9]. The following is an explanation of the aspects of business valuation:

1. Market Aspect

   The market aspect relates to selling products to the market. The analysis is carried out to determine growth, competition, and product market share [6].
2. Technical Aspects

   Technical aspects include processes and technical requirements in designing business projects. Several important technical aspects include determining production capacity[12], raw material supplies [13], machine and equipment criteria [14], [15], [16], production facility requirements, labor [17], and location design and layout (layout).
3. Financial Aspect

   Financial aspect analysis determines investment plans by considering the expected costs and benefits [9], [18], [19]. This involves comparing expenses and related income, such as the availability of funds, the cost of capital, and the project's ability to return investment funds. The three main stages in this analysis are making a revenue recap, making a cost recap, and testing cash inflows based on existing feasibility criteria[20].

Business Feasibility Method

There are several business feasibility indicators used, namely

1. Net Present Value (NPV)

   Net Present Value (NPV) is a financial analysis method that determines the viability of a business by measuring the difference between the current investment value and future net cash receipts [21]. A project is considered feasible if the NPV is positive and not viable if the NPV is negative. To calculate NPV, information is needed regarding investment costs, operations, maintenance, and estimated income. NPV analysis helps in investment decision-making by ensuring efficient allocation of resources for optimal results.
2. Internal Rate of Return (IRR)

Internal Rate of Return (IRR) is a technique used to calculate the interest rate which makes the present value of all cash receipts the same as the present value of all cash expenditures on an investment project [9], [22], [23]. IRR calculations are usually done through trial-and-error methods to find the right interest rate. This method helps evaluate project investments by determining whether the investment will provide the expected rate of return.

3. Payback Period (PP)

   Payback Period (PP) is an evaluation method used to determine the time period in which investment can be returned in a project or business [21]. Payback Period analysis provides information about the speed of returns on invested capital, helping investors understand the short-term risks associated with the investment. Although this method does not provide a complete picture of long-term profitability, PP remains a valuable tool for measuring the liquidity and risk of an initial investment.

4. Incremental Analysis

   Incremental IRR Analysis is a development of IRR analysis to select the best alternative from several options. This is done by looking for the IRR value from the cash flow difference between alternatives and considering MARR (Minimum Acceptable Rate of Return). If the incremental IRR is more significant than MARR, the alternative with a more considerable investment is considered more profitable.

   The incremental analysis procedure involves several steps to evaluate and select the best alternatives. First, all options are identified, and the IRR value is calculated, with options having an IRR less than the MARR being eliminated. Next, a temporary ranking is created based on the lowest investment cost, assuming the option with the least investment is the best. The process then compares Option I (defender) with Option II (challenger) by calculating the difference in cash flows (ΔCF) and determining the IRR of ΔCF (ΔIRR). This ΔIRR is compared to the MARR; if ΔIRR exceeds MARR, Option II is selected; otherwise, Option I remains the best. The process continues by comparing the winning option from the previous evaluation with the next option, repeating the steps of calculating ΔCF and ΔIRR, and comparing it with the MARR until all options have been evaluated, resulting in the final selection of the best option.

Research Methods

Data Collection Stage

Data collection is a systematic process of gathering information relevant to research or analysis, sourced from primary data obtained through direct observation and interviews and secondary data gathered from existing materials such as literature studies and statistical records. The required data for the market includes historical tofu sales and production figures, population statistics in Greater Bandung, and regional tofu consumption patterns. In the technical aspect, data is collected on factory operations, including factory location and layout, production data, raw material requirements, production equipment and facilities, production processes, job descriptions, and the number of employees. For the financial aspect, the necessary data comprises costs related to production equipment and facilities, building expenses, raw material costs, product selling prices, electricity and petrol costs, and labor costs. This financial data is critical for conducting cost-benefit analyses to ensure that the planned factory expansion is financially viable and capable of delivering the anticipated benefits.

Data Processing Stage

Data processing involves several key stages, each addressing a specific aspect of analysis. For the market aspect, demand trends were estimated using time-series forecasting in Microsoft Excel, enabling a clear projection of future needs. In the technical aspect, production capacity, raw material requirements, equipment needs, labor allocation, and factory layout were analyzed to ensure operational efficiency. Regarding the financial aspect, income projections, investment costs, operational expenses, and funding requirements were assessed to evaluate the feasibility of factory expansion. The single-moving average method was employed for demand forecasting, offering a simple yet reliable estimation by minimizing errors. Feasibility was further evaluated using Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP) metrics, alongside incremental IRR analysis to determine the most advantageous expansion alternative. A Minimum Attractive Rate of Return (MARR) of 16.36% was established, reflecting the average return rates in similar industries and accounting for market risk premiums, risk-free rates, and equity costs. This value was calculated using the Weighted Average Cost

of Capital (WACC), incorporating market-specific variables to capture the risks accurately and expected returns inherent to the tofu production sector, ensuring alignment with industry profitability standards. Key inputs for the calculation include:

a) Owner Equity (E) = IDR1.551.129.586
b) Loan (D) = 0
c) Market Risk of Return = 10,11% (Source: Market Risk Premia, May 2023)
d) Current Risk-Free Rate (Rf) = 6,39% (Source: Market Risk Premia, May 2023)
e) Asset Beta = 1
f) Interest Rate (Rd) = 6,25% (Source: Bank Indonesia, May 2024)

$$MARR = \left(Rd \times (1 - T) \times \frac{D}{D + E}\right) + \left(Ri \times \frac{E}{D + E}\right) \quad (1)$$

$$MARR = \left(6{,}25\% \times (1 - 0\%) \times \frac{0}{0 + 1.551.129.586}\right) + \left(10{,}11\% \times \frac{1.549.595.178}{0 + 1.551.129.586}\right)$$

$$MARR = 16{,}36\%$$

The resulting MARR of **16.36%** serves as the benchmark for evaluating the feasibility of the expansion project, ensuring that it meets industry-standard risk and return expectations.

Verification and Validation Stage

This stage systematically examines the proposed solution to ensure compliance with relevant standards and references. Verification includes checking labor salaries, the economic lifespan of equipment, and the feasibility analysis results (NPV, IRR, PP). Additionally, validation is carried out through feedback from stakeholders to ensure the solution fits the problem and can be implemented. The owner provides factual data related to operational costs, including raw material prices, employee wages, and overhead costs, which are used to ensure that cost calculations reflect actual conditions. Production capacity and demand projections are also validated based on operational experience and existing technical constraints.

Conclusion and Suggestion Stage

This stage presents the analysis results, concludes concisely, and provides suggestions based on the research findings. It also presents information regarding whether or not it is feasible to expand the factory to increase production capacity at the Cicalengka Tofu Factory.

Results and Discussion

Alternative Scenario

Table 1 Alternative Scenario

No.	Alternative Scenario	Alternative 1	Alternative 2
1.	Production Capacity	No additions	50% increase
2.	Factory Area	No additions	Expansion
3.	Production Equipment and Facilities	No additions	Additional equipment
4.	Labor	No additions	Additional workers

Table 1 shows that in alternative 1, analysis and calculations are carried out by maintaining current operations without changes to production capacity, factory area, production equipment and facilities, and workforce. Meanwhile, alternative 2 focuses on expanding the factory by increasing production capacity by 50% according to the wishes of the factory owner. These two alternatives are compared to determine which is the best and which will provide higher profits for the factory.

Market Aspect Analysis

In the market aspect analysis, two forecasts were carried out for the next three years: tofu sales at the Cicalengka Tofu Factory and tofu demand in the Greater Bandung area, which includes West Bandung, Bandung City, and Cimahi City. The forecasting was carried out using five time series methods: linear regression, single moving average, weight moving average, single exponential, and double exponential.

Forecasting the need for tofu was obtained from population data in Greater Bandung and the average per capita consumption of tofu[24]. Table 2 shows data on the demand for tofu in West Bandung Regency, Bandung City, and Cimahi City, which is the sales area for the Cicalengka Tofu Factory, in the 2020-2022 period.

Table 2 Tofu Demand in Greater Bandung Area (2020-2022)

Years	Region	Number of Population (People)	Average Per Capita Tofu Consumption per Year (Kg)	Total Tofu Needs in Greater Bandung per Year (Kg)
2020	Bandung Barat	1.788.336	10,088	56.606.958
	Bandung City	2.444.160	12,792	
	Cimahi City	568.400	12,844	
2021	Bandung Barat	1.814.226	10,348	64.316.098
	Bandung City	2.452.943	15,028	
	Cimahi City	571.632	15,184	
2022	Bandung Barat	1.846.969	10,920	58.806.742
	Bandung City	2.545.005	12,220	
	Cimahi City	575.235	13,104	

Table 3 displays the estimated tofu demand in Greater Bandung in 2024-2026. Of the five methods used, the linear regression method was chosen because it has the smallest error rate. The forecasting results of the estimated need for tofu in Greater Bandung are shown in table 3.

Table 3 Estimated Need to Know for the Greater Bandung Area

Years	Estimated Need to Know (Kg)
2024	58.810.041
2025	59.909.933
2026	61.009.825

To forecast tofu sales based on historical monthly tofu sales data from April 2020 to March 2023. The single-moving average method was selected due to its lowest error rate among the five forecasting methods. The forecast results indicate Alternative 1's estimated average monthly tofu sales over the next three years will be 5,846 planks. Meanwhile, in alternative 2, the estimated average monthly tofu sales in the next three years are 8,769 tofu boards.

Market share is a measure of a company's sales about total market sales. Analysis of tofu sales from 2024 to 2026 shows that although sales are increasing each year, the company's market share only experienced a slight increase, stabilizing at around 0.61%. This indicates that the factory's sales growth mirrors the overall growth in market demand. Despite the rise in sales, the market share remains stagnant because the company's growth aligns with the broader market expansion. This means that although sales volumes are increasing, the company has not been able to outperform competitors or capture a larger share of the overall market. Factors such as increased general market demand and intense competition contribute to market share stability despite sales growth.

To improve market penetration, the following strategies could be implemented:

1. **Diversifying Products**: Developing new product variants that align with market trends or meet more specific consumer needs. This can attract new market segments or offer additional choices to existing consumers.
2. **Expanding the Market**: Extending geographical reach or entering untapped markets. Expanding distribution to broader regions or exploring international markets can achieve this if feasible.
3. **Enhancing Brand Awareness**: Running more aggressive marketing campaigns to increase brand recognition and attract a more extensive customer base. This could include social media, advertisements, or strategic promotions.

Analysis of Technical Aspects

The owner of the Cicalengka Tofu Factory plans to increase production capacity by 50% compared to the current maximum production. Once the maximum production data is obtained, calculations will be performed to determine the necessary steps for increasing production capacity.

Table 4 Additional Production Capacity

Ascension	Soybeans Processed per Day (Sacks)	Soybeans Processed per Day (Kg)	Tofu Production per Day (Plank)	Tofu Production per Day (Pcs)
At the moment	44	572	264	26400
50%	66	858	396	39600

Raw material requirements are calculated using data from the tofu sales forecast prepared during the market analysis to support the increased production capacity. Table 5 below estimates raw material requirements for alternative 1 and alternative 2 in the next three years.

Table 5 Estimated Raw Material Requirements

No	Raw material	Year	Alternative		Unit
			1	2	
1	Soybeans	2024	9986	14979	Bag
		2025	12022	18032	
		2026	13068	19601	
2	Salt	2024	4993	7490	Kg
		2025	6011	9016	
		2026	6534	9801	
3	Turmeric	2024	6657	9986	Kg
		2025	8014	12022	
		2026	8712	13068	
4	Palm	2024	8322	12483	Kg
		2025	10018	15027	
		2026	10890	16334	
5	Gas	2024	2090	3135	Kg
		2025	2516	3774	
		2026	2735	4103	

Improvements to equipment and production facilities are needed to increase the effectiveness and efficiency of the Cicalengka Tofu Factory's performance. Production equipment and facility requirements are calculated by comparing current capacity with the equipment and facilities needed to achieve the desired increase in production capacity. Table 6 shows detailed equipment and production facility requirements for alternatives 1 and 2.

Table 6 Production Equipment and Facilities Requirements

No	Item	Alternative Equipment Requirements 1 (Units)	Alternative Equipment Requirements 2 (Units)
1	Soybean Grinding Machine	1	2
2	Turmeric Grinding Machine	1	2
3	Boiling Furnace (Grinded Products)	2	3
3	Boiling Furnace (Turmeric)	1	2
4	Tangok (Filter Tool)	2	3
5	Print Takus (Printing Tool)	48	72
6	Plates/Boards	66	99
7	Appear Ancak	66	99
8	Clumping / Holding Tub	4	6
9	Drum/Bucket	44	66
10	Container Boxes	44	66
11	Serokan Tofu	1	2
12	Tofu Workbench (Packaging)	2	3

13	Printing Rack	3	4
14	Water Pump Machine (Sibel)	1	1
15	Lamp	5	10
16	Knife	3	6
17	Work Desk	1	1
18	Work Chair	2	2
19	Water Tower	1	1
20	Car	1	2
21	Storage cabinets	0	3

It is also important to ensure adequate labor availability. Therefore, an estimate of labor requirements is calculated based on each worker's productivity, adjusted to achieve the desired production capacity in Alternative 2. Table 7 below presents the number of workers required.

Table 7 Manpower Requirements

Labor Needs			
No	**Spesifikasi**	**Alternatif 1**	**Alternatif 2**
1	Head of Production	1	1
2	Secretary	1	1
3	Operational Employees	1	2
4	Production Employees	12	18
Total		15	22

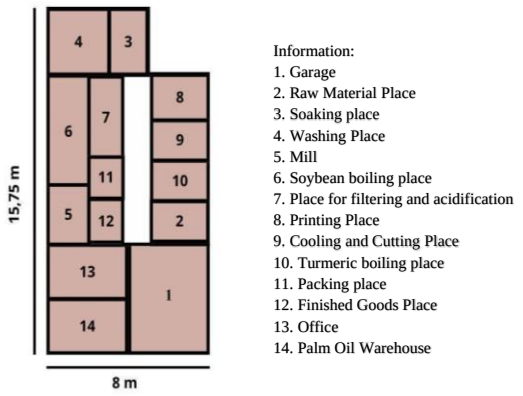

Figure 1 Alternative Factory Layout 1

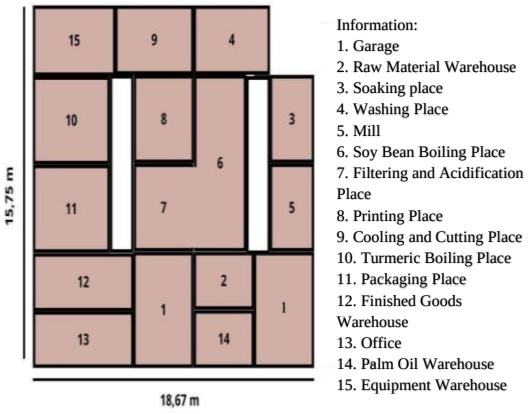

Figure 2 Alternative Factory Layout 2 (Proposed)

The factory expansion will promote sustainability by reducing reliance on overtime and improving overall production efficiency. By adding labor and operational equipment and adjusting the factory layout, the factory will achieve a more balanced workload distribution, reducing the need for excessive working hours. Additionally, increasing production capacity will be supported by better resource management, helping to reduce waste and promote more efficient energy use at each production stage.

Financial Aspect Analysis

The estimated costs for increasing capacity at the Cicalengka Tofu Factory consist of two main components: investment costs and operational costs. Investment costs include expenses for equipment and buildings, where each equipment has a different economic life and will be replaced after reaching that time. Estimated investment costs can be seen in Table 8

Table 8 Estimated Investment Costs

Estimated Investment Costs			
No	**Specifications**	**Alternative 1**	**Alternative 2**
1	Machinery and Equipment Investment Costs	IDR0	IDR213.113.802
2	Building Investment Costs	IDR0	IDR420.000.000
Total Investment Cost		IDR0	IDR633.113.802

Table 8 shows the estimated investment costs. Alternative 1 has no additional investment costs because the current production equipment and facilities are still used, so the investment costs are zero. In contrast, in alternative 2, investment costs include additional expenditure for purchasing a shortage of machinery and equipment to support increased production capacity.

Operational costs are required to run the business and are divided into direct and indirect costs (factory overhead costs). These operational costs also consider an estimated annual increase of 2.86%. One operational risk for the factory is the rising cost of raw materials, which can affect profitability due to price fluctuations. To mitigate this, the factory could establish long-term contracts with suppliers to lock in prices and ensure a stable supply of materials. Diversifying suppliers and fostering strong relationships would also provide flexibility in managing these cost increases, which will help stabilize operational expenses and maintain predictable cash flow while supporting the expanded capacity.

Direct costs include raw material and labor costs directly related to production. Raw material costs are calculated by multiplying the price of raw materials by the quantity required, as determined in the technical aspect of data processing. Table 9 shows the estimated raw material costs for the next three years.

Table 9 Estimated Raw Material Costs

Years	Estimated Investment Costs	
	Alternative 1	**Alternative 2**
2024	IDR1.705.553.296	IDR2.558.329.943
2025	IDR2.111.888.383	IDR3.167.832.574
2026	IDR2.361.301.350	IDR3.541.952.025

Based on information on labor wages and estimates of labor requirements which have been analyzed in technical aspects, estimated labor costs are calculated by multiplying the labor wages per person by the number of workers required. Estimated labor costs for the next three years can be seen in table 10.

Table 10 Estimated Labor Costs

Years	Estimated Labor Costs	
	Alternative 1	**Alternative 2**
2024	IDR709.354.512	IDR1.037.890.315
2025	IDR729.546.948	IDR1.065.705.776
2026	IDR749.098.806	IDR1.094.266.690

Factory overhead costs other than the depreciation of machinery and equipment from the Cicalengka Tofu Factory consist of electricity, gasoline, and consumable costs. Electricity costs are calculated based on electricity requirements multiplied by the cost per kWh. The following is an estimate of electricity costs for the next three years.

Table 11 Estimated Electricity Costs

Years	Electricity Cost Estimation	
	Alternative 1	**Alternative 2**
2023	IDR 8.993.722	IDR 13.729.137
2024	IDR 9.250.943	IDR 14.121.791
2025	IDR 9.515.520	IDR 14.525.674
2026	IDR 9.787.664	IDR 14.941.109

The Cicalengka Tofu Factory's monthly petrol costs are around IDR 600,000. Therefore, the total annual petrol costs reach around IDR 7,200,000. Table 12 below presents projected gasoline costs for the next three years.

Table 12 Estimated Gasoline Costs

Years	Estimated Gasoline Costs	
	Alternatif 1	**Alternative 2**
2024	IDR 7.405.920	IDR 14.811.840
2025	IDR 7.617.729	IDR 15.235.459
2026	IDR 7.835.596	IDR 15.671.193

Consumable costs include purchasing equipment planned to be used up according to its intended purpose, such as plastic packaging. Table 13 presents projections of consumable costs for the next three years.

Table 13 Estimated Consumable Costs

Years	Estimated Consumable Costs	
	Alternative 1	**Alternative 2**
2024	IDR 31.272.830	IDR 46.909.245
2025	IDR 32.167.233	IDR 48.250.850
2026	IDR 33.087.216	IDR 49.630.824

The calculation of funding requirements is based on the investment costs and working capital needed to support factory operations during the first three months. Table 14 shows the estimated funding requirements for factory expansion from the Cicalengka Tofu Factory.

Table 14 Expansion Fund Requirements

Funding Requirements	Alternative 1	Alternative 2
Investment Costs	IDR0	IDR633.113.802
Cost of Working Capitals	IDR0	IDR918.015.784
Total	**IDR0**	**IDR1.551.129.586**

Estimated income is derived from product sales, with a selling price of approximately IDR 46,000 per board, assuming a 2.86% annual price increase.

Table 15 Estimated Annual Income

Years	Estimated Annual Income	
	Alternative 1	**Alternative 2**
2024	IDR2.835.030.920	IDR4.252.546.380
2025	IDR3.510.455.451	IDR5.265.683.177
2026	IDR3.925.038.494	IDR5.887.557.741

Depreciation costs are essential in financial calculations when investing in factory equipment and production facilities. Depreciation costs are calculated using the straight-line method for old and new equipment, using economic life per applicable regulations.

Table 16 Depreciation Costs

Information	2024	2025	2026
Alternative 1			
Total Depreciation	IDR52.651.662	IDR52.651.662	IDR52.651.662
Accumulated Depreciation	IDR52.651.662	IDR105.303.324	IDR157.954.986
Residual value	**IDR405.240.824**		
Alternative 2			
Total Depreciation	IDR86.961.967	IDR86.961.967	IDR86.961.967
Accumulated Depreciation	IDR86.961.967	IDR173.923.934	IDR260.885.901
Residual value	**IDR662.614.725**		

Feasibility Analysis

A feasibility analysis was conducted to assess the tofu factory expansion plan, involving NPV, IRR, and PP calculations. With a MARR of 16.36%, both scenarios are feasible because IRR > MARR. The expansion scenario demonstrates superior NPV, IRR, and Payback Period (PP) outcomes, as shown below:

Table 17 Feasibility Analysis

Metric	Alternative 1 (No Expansion)	Alternative 2 (With Expansion)
NPV	825.211.554	IDR972.087.040
IRR	121%	43%
Payback Period	1,07 years	2,35 years

Incremental Analysis

Based on the calculation results in the feasibility analysis, it was concluded that the two alternatives could be feasible to implement. Thus, incremental analysis is carried out to select alternatives that provide better benefits. This analysis uses the IRR incremental analysis method, where the first and second alternatives are compared by considering the difference in cash flows between the two. The difference is evaluated based on the calculated IRR value. If the IRR value is more significant than MARR (Minimum Acceptable Rate of Return), the alternative with more significant investment costs is considered the best choice. However, if the IRR value is less than MARR, the option with a more minor investment cost is considered better. The incremental IRR analysis calculations obtained an IRR value of 22%. Assuming MARR is 16.36%, it can be concluded that an IRR value greater than MARR indicates that the second alternative was chosen as the best alternative because it has the most significant investment value.

Table 18 Incremental IRR Calculation

INCREMENTAL IRR					
Years		**2023**	**2024**	**2025**	**2026**
Period		**0**	**1**	**2**	**3**
Initial Cash Flow (Cash Out)		IDR1.220.334.664	IDR0	IDR0	IDR0
Operational Cash Flow (Cash In)			IDR199.590.850	IDR267.252.218	IDR219.900.151
Residual value					IDR257.373.901
Working Capital					IDR918.015.784
Net Cash		-IDR 1.220.334.664	IDR 199.590.850	IDR 267.252.218	IDR 1.572.789.837
p/f Factor	16,36%	1	0,859401856	0,738571551	0,634729762
NPV		-IDR1.220.334.664	IDR171.528.747	IDR197.384.885	IDR998.296.518
NPV Cumulative		-IDR1.220.334.664	-IDR1.048.805.918	-IDR851.421.033	IDR146.875.485
MARR		16,36%			
NPV		IDR146.875.485			
Payback Periode		2,85			
IRR		22%			

The incremental IRR method supports long-term strategic goals, such as business sustainability and market expansion, by prioritizing investments that yield the highest returns above the MARR. This approach ensures financial feasibility while enhancing profitability, operational efficiency, and production capacity to meet market demand and expand market share, fostering sustainable business growth.

Verification

The verification stage involves systematically checking proposed solutions for errors based on applicable standards or references and references related to the chosen problem-solving method.

1. Labor

The basic monthly salary for various positions at the Cicalengka Tofu Factory has been determined with the following details: head of production at IDR 4,288,000, secretary at IDR 4,038,000, operational employees at IDR 3,788,000, and production employees at IDR 3,788,000. This salary has been verified and is higher than the West Bandung Regency Minimum Wage (UMK) which is IDR 3,508,677, following the Decree of the Governor of West Java No. 561/Kep.768-Kesra/2023. Therefore, these parameters are well verified.

2. Economical Life of Equipment

The economic life of production equipment and facilities at the Cicalengka Tofu Factory is divided into non-building and building. Non-building assets are included in Group 1, with an economic life of 4 years, and in Group 2, with an economic life of 8 years. Permanent buildings have an economic life of 20 years. This distribution is by the Regulation of the Minister of Finance of the Republic of Indonesia Number 72 of 2023, so this parameter is also verified.

Validation

The validation stage is an inspection process involving stakeholders' feedback to ensure that the design results are based on the studied problems and can be implemented.

Table 19 Validation

Category	Validation Targets	Validation Subject	Fulfillment Validation
Stakeholder Requirements	Calculation of the number of workers required	Owner of the Cicalengka Tofu Factory	Validated
	Calculation of the amount of equipment and production facilities required		Validated
	Proposed factory layout		Validated
	Estimated amount of funds needed		Validated
	Estimated labor salary costs		Validated

Conclusion

Based on the market, technical, and financial analysis, the following conclusions were drawn from the design results. On the market aspect, tofu sales projections were made using time-series forecasting techniques based on historical sales data from the Cicalengka Tofu Factory, targeting a 0.61% share of tofu demand in the company's operating area for 2024–2026. For the technical aspect, the production capacity was recalculated, increasing the current maximum production capacity from 264 tofu planks per day to 396 tofu planks, requiring a total expansion cost of IDR 1,551,129,586, which includes IDR 633,113,802 in investment costs and IDR 918,015,784 in working capital costs. On the financial aspect, feasibility was evaluated for two alternatives, with alternative 1 yielding an NPV of IDR 825,211,554 and an IRR of 121%. In contrast, alternative 2 resulted in an NPV of IDR 972,087,040, an IRR of 43%, and a payback period of 2.35 years. Both alternatives were deemed feasible as their NPV > 0 and IRR > MARR, with the MARR set at 16.36%. For decision-making, incremental IRR analysis revealed an IRR of 22%, exceeding the MARR, making Alternative 2 the preferred choice due to its higher investment value than Alternative 1.

In terms of actionable recommendations, it is suggested that the facility redesign be completed by Q1 2024, with machinery procurement finalized in Q2 2024. The production area should be reconfigured by Q3 2024, enabling increased production capacity starting in Q4 2024. Performance targets should include reaching a production level of 396 tofu boards daily and achieving a 10% cost-efficiency improvement within the first year. Additionally, periodic evaluations, including monthly production reviews and quarterly financial assessments, should be conducted to monitor and ensure the achievement of these targets.

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