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Sensitivity Analysis in the Design of the Establishment of *Mosaccha* Tempeh Agroindustry in Bandar Lampung

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Abstract:
Mosaccha tempeh is a fermented soybean product produced using *Rhizopus oligosporus* as a starter culture with the addition of Saccharomyces cerevisiae, and it has strong development potential. This study conducted financial and sensitivity analyses to evaluate the feasibility of establishing a *Mosaccha* tempeh agroindustry and its responsiveness to changes in key variables affecting business viability. The research aimed to assess the impact of various scenarios on business feasibility. The methods employed included surveys, observations, and interviews using a purposive sampling technique. Premium tempeh producers in Bandar Lampung were selected as prototypes, with UMKM Tempeh Cap Mobil serving as a reference to align the data with current conditions. Data were processed using Microsoft Excel and analyzed under several scenarios: increases in raw material prices (10%, 20%, and 30%), decreases in selling prices (10%, 20%, and 30%), and combinations of both factors at the same percentage levels. Under normal assumptions, the establishment of a *Mosaccha* tempeh agroindustry in Bandar Lampung is considered feasible, with an NPV of Rp 2,450,599,432.50, an IRR of 76%, a B/C ratio of 1.49, and a payback period of 1.67 years. Sensitivity analysis results indicate that increases in raw material costs of up to 30%, decreases in selling prices of up to 20%, and a combined 10% increase in raw material costs with a 10% decrease in selling prices do not significantly affect feasibility. However, simultaneous increases in raw material prices and decreases in selling prices are the most sensitive factors influencing the financial viability of the *Mosaccha* tempeh agroindustry in Bandar Lampung.

Keywords: Agroindustry, feasibility study, purposive sampling, tempeh *Mosaccha*

1. Introduction

Tempeh is a typical Indonesian fermented soybean food that has benefits and high nutritional value, with protein as the main nutrient. According to Astawan et al. (2013), the nutritional content of tempeh is 46.68%-52.70% protein, 6.57%-6.12% carbohydrates, 6.21%-6.77% crude fiber, and 2.01%-2.47% ash content. Tempeh is popular among the public because it has high nutritional value; a delicious taste; is easy to process; and has a relatively low price. The average Indonesian person consumes 0.14 kg of tempeh per week per capita (BPS, 2019).

Tempeh modified by *Saccharomyces cerevisiae* (*Mosaccha*) is a fermented tempeh using two types of starters namely *Rhizopus oligosporus* with the addition of *Saccharomyces cerevisiae*, which will produce beta-glucan compounds as essential compounds (Rizal & Kustyawati, 2019). These beta-glucan compounds are

compounds that play a role in the immune system by acting as biological defence modifiers (Di Domenico et al., 2017). The existence of these benefits makes the development of *Mosaccha* tempeh into an agroindustry in Bandar Lampung City potentially feasible.

Planning an agroindustry requires a financial analysis as a necessary consideration. This aims to determine whether the agroindustry is capable of generating profits from the business activities to be undertaken (Rosalina, 2015). According to Nurahmi et al. (2021), conducting a financial analysis in business establishment planning aims to compare revenues and expenses and determine whether the industry is capable of growing and competing in the specified market. This financial analysis is one of the business planning efforts in collecting data according to the current situation (Wulandari et al., 2018). Based on financial analysis using various indicators such as NPV, IRR, B/C ratio, and payback period, the feasibility of establishing a business can be determined.

After a business feasibility analysis is deemed feasible, it is necessary to identify factors suspected of influencing an industry's business activities. Fluctuations in the price and availability of raw materials, labor, assumptions regarding production technology selection, and operational cost sensitivity can all impact business activities. Therefore, further analysis, in the form of a sensitivity analysis, is necessary to provide an overview of the extent to which the chosen decision will be robust enough to withstand the possibility of different conditions (Wulandari, et al., 2018). By conducting a business sensitivity analysis, the sensitivity of the project's feasibility level can be determined if there are changing and influential variables (Nurahmi et al., 2021). Variables that can change and influence feasibility in financial analysis include increases in production costs and volume, product selling prices, and production implementation. These factors can be changed, and their sensitivity or influence on the acceptance of alternative investments can be analyzed (Handayani, 2016; Hasugian et al., 2020; Susilowati et al., 2018).

Research conducted by Muhammad et al. (2023) on the feasibility and sensitivity analysis of the tempeh industry in Central Lampung analyzed the influence of variables such as a 4.5% increase in raw material costs and a 4.5% decrease in revenue. The results showed that these two variables were not sensitive to the feasibility of the tempeh industry in Central Lampung but resulted in lower profit values. Research by Dewi (2021) on the feasibility and sensitivity of tempeh MSMEs in North Teluk Betung, Bandar Lamping, showed that a 4.33% increase in soybean prices and a 2% decrease in revenue were not sensitive to the feasibility of the business. Based on this, in planning the establishment of the *Mosaccha* tempeh agroindustry, a sensitivity analysis is necessary to project its feasibility if there are changes in variable conditions. If there are changes in variables in *Mosaccha* tempeh production activities, it is suspected that they can affect the profit receipt and feasibility of the business. Therefore, this study was conducted to determine the effect of several scenarios on the sensitivity of the feasibility of the *Mosaccha* tempeh agroindustry in Bandar Lampung City.

2. Research Methods

This research was conducted in Bandar Lampung City as the chosen location for establishing the *Mosaccha* tempeh agroindustry. The assumption of choosing the location for establishing the *Mosaccha* tempeh agroindustry in Bandar Lampung is due to the selection of marketing segmentation. *Mosaccha* tempeh products are classified as premium tempeh with dual health benefits, so the chosen market segmentation is the people of Lampung Province, who have a higher awareness of health and are classified as the middle to upper economic class. This research was conducted from July to September 2023.

The primary data collection method used was conducting interviews, direct observation, and surveys conducted with a purposive sampling technique on the tempeh industry that was already running based on criteria. The criteria used were tempeh industries that had implemented tempeh production hygiene standards and had produced tempeh with a minimum capacity of 150 kg of soybean raw materials/day. In this study, the Cap Mobil tempeh industry and the Rumah Tempeh Indonesia (RTI) tempeh industry were designated as prototypes or references in designing the *Mosaccha* tempeh industry. Secondary data collection was carried out by searching for data on the Central Statistics Agency website to find out tempeh consumption in Bandar Lampung, journals, articles, and books. The processing and characteristics of the ingredients used in making *Mosaccha* tempeh refer to research (Rizal & Kustyawati, 2019), which describes the dry method used for making tempeh. The flow diagram for *Mosaccha* tempeh production is presented in Figure 1.

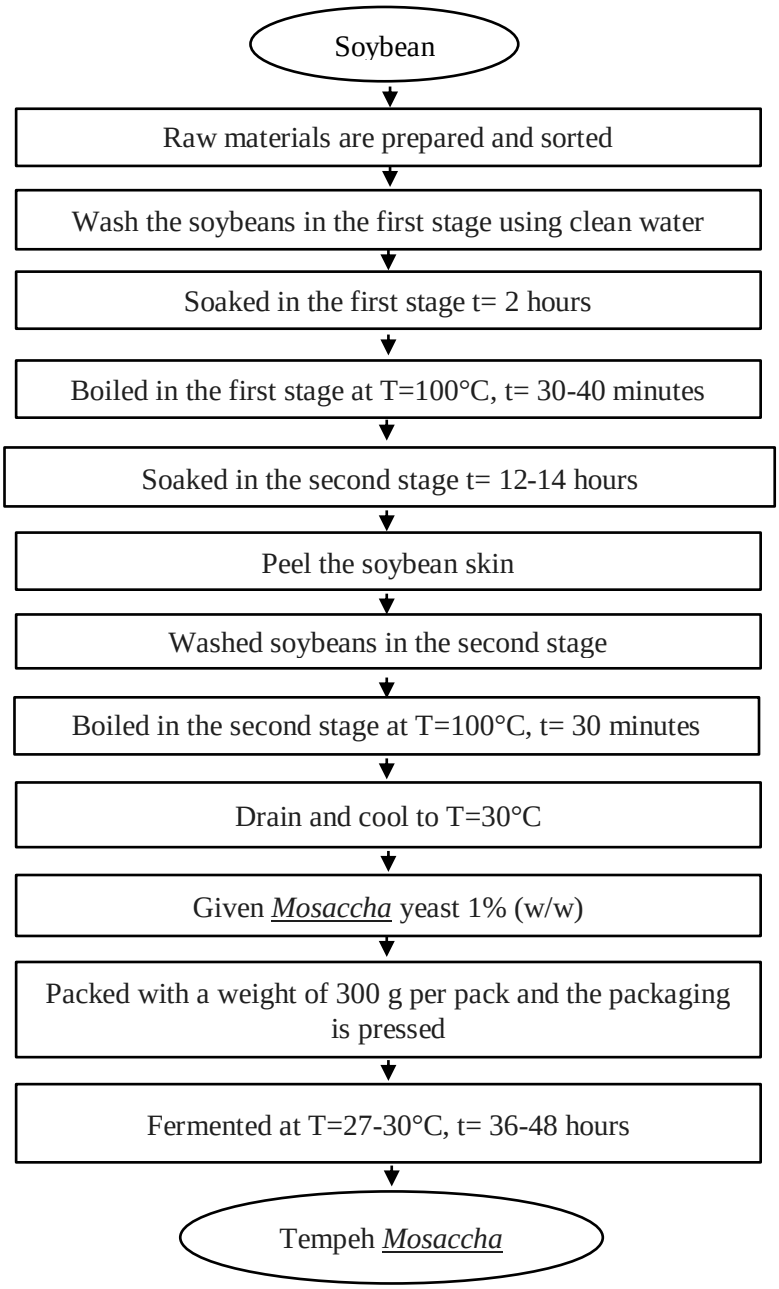

Figure 1. Modified *Mosaccha* tempeh production flow diagram

Mosaccha tempeh is fermented from soybeans using two starter cultures: *mold* and *yeast*. The mold inoculum is derived from *Rhizopus oligosporus*, and the yeast is derived from *Saccharomyces cerevisiae*. It is called *Mosaccha* tempeh because it has an added advantage, as the addition of *Saccharomyces cerevisiae* yeast increases beta-glucan compounds (Rizal & Kustyawati, 2019). *Saccharomyces cerevisiae*, composed of beta-glucan cell walls, can boost the body's immunity. The resulting *Mosaccha* tempeh has the nutritional content of tempeh as presented in Table 1.

Table 1. Nutritional content of *Mosaccha* tempeh

Content	Persetase
Water (db)	64.44%
Ash (db)	1.21%
Protein (db)	16.7%
Fat (db)	8.93%
Carbohydrate (wb)	8.73%
Beta-glucan (wb)	0.707 %

Source: Rizal *et al*. (2020).

The analytical method used is quantitative analysis. Quantitative analysis is conducted to analyze the financial aspects of the establishment of the *Mosaccha* tempeh agroindustry and to project the possibility of variables that influence the sensitivity of the *Mosaccha* tempeh agroindustry's economic activities. The information and data obtained will be tabulated using a laptop using Microsoft Excel software and presented in an analysis table. Based on the various data obtained, an analysis can be carried out on investment costs, operational costs, net cash flow, and selling price determination. Then, an analysis can be carried out on the feasibility of establishing the *Mosaccha* tempeh agroindustry with investment criteria, namely Net Present Value (NPV), Internal Rate of Return (IRR), Net B/C, and Payback Period. Furthermore, based on these, it can be analyzed and concluded whether the establishment of the *Mosaccha* tempeh agroindustry is feasible or not. If the results obtained are concluded as feasible, a sensitivity analysis will be carried out, which aims to determine the effects that will occur if there are changing conditions. Analysis that is done includes marketing analysis and analytics and financial as follows:

Financial analysis

Financial analysis is carried out by determining the production capacity and selling price of *Mosaccha* medicated tempeh to find the Break-Even Point (BEP), Net Present Value (NPV), Internal Rate of Return (IRR), Benefit-Cost Ratio (B/C Ratio), and Payback Period (PBP) with the following formula:

a. Net Present Value (NPV)

$$NPV = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+i)^2} \quad (1)$$

Information:
Ct = Cost on year t
Bt = Revenue in year t
t = Year t
I = Interest rate used
n = age economy
Business feasibility criteria with NPV value:

- If NPV < 0, then the business is not worth running.
- If NPV = 0, then the business is neither profitable nor detrimental.
- If NPV > 0, then business worthy executed.

b. Internal Rate Return (IRR)

$$IRR = i + \frac{NPV}{NPV - NPV'}\,(i' - i) \quad (2)$$

Information:
NPV = NPV is positive
NPV'= NPV worth negative
i = Discount rate Which generate NPV positive
i' = Discount rate that produces a negative NPV

Business feasibility criteria with IRR value:
- If the IRR < the applicable interest rate, then the business is not worth running.
- If IRR = the prevailing interest rate, then the business is neither profitable nor detrimental.
- If IRR > interest rate applicable interest, then business worthy executed.

c. Net Benefit and Cost (Net B/C)

$$Net\ B/C = \sum_{i=1}^{n} \frac{NBi(+)}{NBi\ (-)} \quad (3)$$

Information:
NBi (-) = Net benefit that has been discounted negatively
NBi (+) = Net benefit Which has been in positive discount
Business feasibility criteria with B/C value:
- If B/C < 0, then the business is not worth running.
- If B/C = 0, then the business is neither profitable nor detrimental.
- If B/C > 0, then the business is worth running.

d. Payback Period (Level Return Investment)

$$Payback\ periode = \frac{Investasi\ awal}{Penerimaan\ periode}\ x\ 1\ tahun \quad (4)$$

e. Sensitivity Analysis

Sensitivity analysis examines investment risks. This sensitivity analysis can be used to determine the impact of potential changes in risky variables on the feasibility of establishing a business (Muhammad et al., 2023). The sensitivity analysis conducted refers to research by Hidayati et al. (2020), Mahyudi & Husinsyah (2018), and Muhammad et al. (2023). This analysis is used to see the level of sensitivity of business activities if there is a change in cash flow conditions (net cash flow) in conditions of increased output, decreased input, and/or increased input and decreased output that occur simultaneously. The scenarios in projecting sensitivity analysis in this study are the following:

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1. The price of soybean raw materials increased (10%, 20%, and 30%).
2. *Mosaccha* tempeh fell (10%, 20%, and 30%).
3. The price of soybean raw materials rose and the selling price of *Mosaccha* tempeh fell (10%, 20%, and 30%).

3. Results and Discussion

Cash flow

Cash inflows consist of sales of *Mosaccha* tempeh and soybean husk waste. Sales of *Mosaccha* tempeh and soybean husk waste with production capacity in the first year of 50%, the second year of 70%, the third year of 90%, and the fourth year to 100% with an assumed loan interest of 12% generate total revenue of Rp. 10,163,223,478. Based on Table 2, the investment cost or fixed cost for establishing the *Mosaccha* tempeh agroindustry in Bandar Lampung City with a capacity of 200 kg/day is Rp. 1,020,929,000. This cash outflow consists of the cost of acquiring land for buildings, purchasing production machinery, transportation equipment, office equipment, and other necessities. The cash outflow from the cost of purchasing production machinery and office facilities in the *Mosaccha* tempeh agroindustry is based on the assumption that several tools and machines will be repurchased based on their economic life. Therefore, within a certain period of

time, costs will be incurred for repurchasing them, and in the final year of the project, if the items still have a sale value, it will be assumed as cash inflow. The cash outflow consists of operational costs in the form of costs of raw materials, labor wages, utilities, machine tool maintenance repairs, taxes, work allowances, marketing promotions, and transportation. The operational costs for running the *Mosaccha* tempeh agroindustry for 10 years of the project amounted to Rp. 6,840,396,274.

The net cash flow obtained annually during the life of the *Mosaccha* tempeh agroindustry project experienced fluctuating values. Because the capacity of tempeh production during the first three years was still below the set production capacity of 200 kg of soybean raw materials/day. Fluctuating net cash flow was also caused by the repurchase of production machinery and office facilities that had an economic life below the project life. The highest cash flow was in the 10 years because production capacity was already at its maximum and the assumption was that equipment that still had an economic life would be auctioned or sold so that the funds would be included in income in the 10 years.

Financial feasibility analysis

The feasibility analysis of the establishment of the *Mosaccha* tempeh agroindustry aims to determine whether this industry is feasible to run based on the criteria of NPV, IRR, Net B/C, and Payback Period. This feasibility analysis is based on the calculation of all costs and business assumptions during the project life of the next 10 years. NPV is the net cash value that will be obtained in the future by the company after deducting all costs discounted by the discount factor so that this NPV value can be used as an indicator of the feasibility of establishing a business. According to Zakiyah (2018), the advantage of business feasibility analysis with NPV criteria is because it uses the concept of time value of money. Therefore, when analyzing the NPV value, it is necessary to know the cash inflows and outflows that will occur in the future. Based on the feasibility analysis calculations for establishing the *Mosaccha* tempeh agroindustry, the NPV value was obtained > 0, namely Rp. 2,450,599,432. This positive NPV value indicates that the establishment of the *Mosaccha* tempeh agroindustry is acceptable or feasible to be developed.

The IRR value in this study was 76%, which indicates a business project's ability to generate a rate of return or the level of profit that will be achieved during the project (Nurahmi et al., 2021). The IRR value also indicates the efficiency of a business investment. A business project is considered feasible if the rate of return on investment is greater than the assumed required interest rate (Zakiyah, 2018). In this study, the establishment of the *Mosaccha* tempeh agroindustry used an assumed loan interest rate of 12%. Therefore, the *Mosaccha* tempeh business is considered feasible because the IRR value is 76% > the assumed loan interest rate of 12%.

Net B/C is the ratio between cash inflow and cash outflow (Muhammad et al., 2023). The net B/C value for the establishment of the *Mosaccha* tempeh agroindustry is > 1, which is 1.49. This indicates that the establishment of the *Mosaccha* tempeh agroindustry is feasible. This net B/C value is obtained from the total income divided by the total expenses over the 10-year project life. The payback period is the time period to return the investment from establishing a project with the resulting cash inflow (Kencani et al., 2014). Based on this indicator, it can be seen how quickly a business can return its capital in months or years. The establishment of the *Mosaccha* tempeh agroindustry with a production capacity of 200 kg of soybeans/day with a project life of 10 years has a payback period or return on investment of 1.67 years, or equivalent to 1 year, 8 months, and 2 days. Based on this, the establishment of the *Mosaccha* tempeh agroindustry is feasible and feasible to be developed because the return on investment is faster than the project lifetime. According to Muhammad et al. (2023), the faster the return on investment of a project, the better because it indicates that the capital turnover is running well.

Table 2. Cash inflows under normal assumptions

No.	Description	Year to ('000 IDR)									
		1 (50%)	**2 (70%)**	**3 (90%)**	**4 (100%)**	**5 (100%)**	**6 (100%)**	**7 (100%)**	**8 (100%)**	**9 (100%)**	**10 (100%)**
1.	Cash Inflow										
	- Tempeh	1,019,700	1,427,580	1,835,460	2,039,400	2,039,400	2,039,400	2,039,400	2,039,400	2,039,400	2,039,400
	- Soybean Husk Waste *Mosaccha*	18,750	26,250	33,750	37,500	37,500	37,500	37,500	37,500	37,500	37,500
	Total	**1,038,450**	**1,453,830**	**1,869,210**	**2,076,900**	**2,076,900**	**2,076,900**	**2,076,900**	**2,076,900**	**2,076,900**	**2,076,900**
2.	Outflow										
	- Investment Costs	916,399	679	3,574	6,379	3,574	77,779	9,274	679	3,574	-982
	- Operating costs	883,092	991,709	1,224,047	1,351,463	1,351,463	1,351,463	1,351,463	1,351,463	1,351,463	1,351,463
	Total	**1,799,491**	**992,388**	**1,227,621**	**1,357,842**	**1,355,037**	**1,429,242**	**1,360,737**	**1,352,142**	**1,355,037**	**1,350,481**
Net Cash Flow		**-761,041**	**462,441**	**641,588**	**725,436**	**725,436**	**647,658**	**716,163**	**724,758**	**721,863**	**726,419**

Sensitivity Analysis

The sensitivity analysis was conducted with 3 scenarios in the form of an increase in raw materials of 10%, 20%, and 30%, respectively; a decrease in selling prices of 10%, 20%, and 30%, respectively; and a combination of both, namely an increase in raw materials and a decrease in selling prices of 10%, 20%, and 30%. Based on the analysis that has been done with the scenario of increasing the price of soybean raw materials reaching 30%, it produces NPV, IRR, and net B/C values that are feasible to run. The increase in raw material prices, reaching 10%, 20%, and 30%, makes the NPV value decrease by ± 13.1%, 26.2%, and 39.2% with NPV values of Rp. 2,129,536,460, Rp. 1,808,473,488, and Rp. 1,487,410,515, respectively. The IRR values for increases in soybean raw material prices of 10%, 20%, and 30% resulted in IRR values of 67%, 58%, and 50%, respectively, still greater than the loan interest assumption (12%). The resulting net B/C values were greater than 1, namely 1.42, 1.36, and 1.3. This indicates that an increase of up to 30% does not change the feasibility of establishing a *Mosaccha* tempeh agroindustry. The increase in soybean raw material output costs of up to 30% with fixed input costs resulted in a decrease in net profit, which is indicated by a decreasing NPV value. The results of the sensitivity analysis that has been carried out are presented in Table 3.

Table 3. Results of sensitivity analysis of *Mosaccha* tempeh business in Bandar Lampung City

Parameter	Investment Criteria	Sensitivity analysis results			
		Normal	10%	20%	30%
Normal	NPV (IDR)	2,450,599,433	-	-	-
	IRR (%)	76%	-	-	-
	Net B/C	1.49	-	-	-
Raw Material Improvement	NPV (IDR)	-	2,129,536,460	1,808,473,488	1,487,410,515
	IRR (%)	-	67%	58%	50%
	Net B/C	-	1.42	1.36	1.3
Price reduction	NPV (IDR)	-	1,542,445,022	634,290,612	–273,863,798
	IRR (%)	-	51%	28%	4%
	Net B/C	-	1.36	1.23	1.1
Increase in raw materials and decrease in prices	NPV (IDR)	-	1,221,382,050	–7,835,332	–1,237,052,714
	IRR (%)	-	43%	12%	0%
	Net B/C	-	1.3	1.11	0.96

The scenario of decreasing selling price of *Mosaccha* tempeh is presented in Table 3. The decreasing selling price of *Mosaccha* tempeh by 10% and 20% still results in the analysis result of establishing this agroindustry being feasible based on the positive NPV indicator of Rp. 1,542,445,022 and Rp. 634,290,612, IRR values of 51% and 28% > 12% (interest rate assumption), and net B/C > 1 of 1.36 and 1.23. Although the decrease in input costs in the form of a decrease in selling price reaching 20% reduces the NPV value, which indicates a decrease in profits, it does not make the establishment of this *Mosaccha* tempeh agroindustry unfeasible to run. The *Mosaccha* tempeh agroindustry is not feasible to run if it experiences a decrease in selling price reaching 30%, which is indicated by a negative NPV value of Rp. – 273,863,798 and an IRR value of 4% < 12% (loan interest assumption).

The final scenario is an increase in output costs in the form of an increase in the price of soybean raw materials by 10%, 20%, and 30% and a decrease in input prices in the form of a decrease in the selling price of *Mosaccha* tempeh by 10%, 20%, and 30%. The scenario of a 10% increase in the selling price of soybeans and a 10% decrease in the selling price of *Mosaccha* tempeh is still categorized as feasible to run because it produces a positive NPV value, the IRR value is > the assumed loan interest, and the net B/C is > 1. Meanwhile, the scenario of increasing soybean selling price and decreasing *Mosaccha* tempeh selling price by 10% and 20%, respectively, besides affecting the net profit received, also affects the feasibility of establishing the business. The business feasibility indicators in the scenario of increasing output costs and decreasing input

prices by 20% are a negative NPV value of Rp. -7,835,332, IRR value assuming a loan cost of 12%, and net B/C of 1.11. The scenario of increasing output costs and decreasing input prices by 30% is a negative NPV value of Rp. -1,237,052,714, an IRR error value, and a net B/C < 1, namely 0.96. This indicates that the scenario of increasing output costs and decreasing input prices by 20% and 30% makes the establishment of the *Mosaccha* tempeh agroindustry unfeasible.

Sensitivity analysis is necessary because running a business or project is often accompanied by ambiguity and uncertainty (Hutasoit et al., 2022). Future events can potentially impact business activities. This research utilized sensitivity analysis to assess the sensitivity of investment indicators, including NPV, IRR, net B/C, and payback period, to changes in cash flow in the *Mosaccha* tempeh agroindustry. This sensitivity analysis provides information on the extent to which a project or business remains viable despite changes in certain parameters.

The tempeh agroindustry is not solely sensitive to a single factor. According to Nurahmi et al. (2021), several possibilities that can influence the feasibility decision include increases in production costs and volume, changes in product selling prices, and production delays. The increase in the price of soybean raw materials can reduce the quality and quantity of *Mosaccha* tempeh production, so one strategy commonly employed by producers is to lower the selling price. This price reduction is expected to maintain consumer interest in purchasing tempeh products. This sensitivity analysis can provide information on the maximum limit if conditions change in the *Mosaccha* tempeh business. This maximum limit can be used as a reference for developing a plan if changes occur, either decreasing input prices or increasing output costs, so that the business remains feasible (Sulasminingsih et al., 2022).

Based on the sensitivity analysis that has been carried out, it can be seen that the increase in the price of soybean raw materials is only sensitive to the net profit obtained but is still feasible to run. A decrease in the selling price of *Mosaccha* tempeh of up to 20% still makes this *Mosaccha* tempeh business feasible to run, but a decrease of up to 30% affects the feasibility of the *Mosaccha* tempeh business. An increase in the price of raw materials and a decrease in the selling price of *Mosaccha* tempeh in the level of 10% still makes this industry feasible to run, but levels of 20% and 30% make the *Mosaccha* tempeh business unfeasible to run and will result in losses. This is in accordance with research by Pahlevi et al. (2014) that an increase in both production costs and declining selling prices can impact the agroindustry. A similar study on the sensitivity analysis of the tempeh industry in Central Lampung, with a 4.5% increase in raw material costs and a 4.5% decrease in revenue, found no sensitivity or significant impact on the home tempeh industry (Muhammad et al., 2023).

4. Conclusion

The sensitivity analysis indicates that an increase of up to 30% in soybean raw material costs in the Mosaccha tempeh agroindustry does not significantly affect the feasibility of the business; however, it does reduce the expected profits. In contrast, a 30% decrease in the selling price of *Mosaccha* tempeh significantly affects the feasibility of establishing the agroindustry. Furthermore, a combined scenario involving an increase in soybean raw material prices and a decrease in the selling price of *Mosaccha* tempeh by 20% and 30% renders the business unfeasible based on standard feasibility indicators.

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