Integrating Analytical Hierarchy Process and Hayami For Increasing the Value-Added Products

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Abstract

This study aims to calculate the value-added of processed cassava products and make efforts to increase value added product benefits as recommendations for improvement. The Analytical Hierarchy Process (AHP) and the Hayami method are integrated to find the best solution as several alternative strategies proposed to increase value added product. Data was collected through purposive sampling method which it interviewed four respondents to obtain data about Hayami's method and distributed questionnaires to five experts to fulfill the AHP analysis. This study was conducted in one of the business units that has the potential to drive the people's economy in West Sumatra Indonesia is processed cassava products. The cassava business unit in this case study has five types of 5 main products. The problem in this study is the existence of constraints on marketing and production, the uncertainty of raw material prices. There are still many expired products, and this business still uses simple equipment technology for product processing. This affects the level of value added and profit maximization received. This study found that the strategy in alternative one is the best alternative because it has the most significant evaluation weight value compared to the other alternatives. This strategy emphasizes that business units buy raw materials directly from farmers. The further study is suggested to adopt multiple case studies by selecting the same business unit clustering to obtain the main criteria for increasing value-added product of cassava processing business units.

Keywords
Business unit, cassava products, value added, profits, Indonesia.

1. Introduction
Small-medium enterprises (SMEs) have many limitations in developing their business units. The selection of raw materials with the lowest prices is one of the considerations for SMEs in carrying out their production processes (Serin *et al.*, 2016). Then, the food products' main problem is that they are not durable or have a fast expiration date. Thus, the risk of loss for food products is higher than for other products (Serin *et al.*, 2016). This limitation is the lack of mapping problems by business units. Not only raw materials and expired products are the main obstacles for SMEs, limited facilities or production technology make it difficult for business units to compete in the market. A study stated that SMEs' competition was influenced by technology adoption and implementation in the production system (Irjayanti and Azis, 2012). Therefore, the technology could speed up the production process and maintain product quality accepted by consumers. Indeed, the high challenges for SMEs become multi-criteria decision making in formulating business process improvement. A research review was conducted to determine the SME's development strategy (Hörte *et al.*, 2008). There are many approaches adopted to assist business actors in increasing profits. However, several studies suggest that it is necessary to calculate the additional value at an early stage before improvising business processes (Lestari *et al.*, 2022; Sujová and Marcineková, 2015). Thus, the determination of the added value becomes the basis for planning improvements and improvising strategies to increase profits. However, several studies also

explain that this method of increasing value-added is limited in considering the strategy of considering multi-criteria decision-making as a solution to solve the problem.

This research was conducted on a business unit of processed cassava products, a business engaged in processing products into food. This business unit produces five main products: Sanjay Balado, chopped yellow chips, white flavored chopped chips, cassava flour, and yellow Sanjay chips. However, The study focused on three products only involving Sanjay Balado, chopped yellow chips, and cassava flour as products A, B, and C because these products have a high level of consumer demand. In the production process, the cassava processed product business unit has several problems including the uncertainty of the price of raw materials for the product, many expired products, and the simple technology for product processing. It affects the effectiveness of the work in producing the product. This affects the added value and profits received by the business unit. This problem resulted in this business unit not getting the maximum profit from each produced. Therefore, an effort is needed to increase the added value of current products. Thus, the profits received from each product are maximized.

Ideally, this business unit obtains a higher added value and profit than the current value-added and profit. A study stated that the ideal condition of a business unit is when there is a difference in value after implementing the improvement compared to before implementing the improvement (Rashid *et al.*, 2019). In addition, there is an increase in the value received by a business unit, both added value and product benefits on an enduring basis. There are many methods in Multi-Criteria Decision Making (Jamwal *et al.*, 2021; Rezaei, 2015). The approach that needs to be used in this research is to increase the product's added value by using Multi-Criteria Decision Making to determine the appropriate alternative solution. This research aimed to increase the added value and profit received by the business unit from each type of product. There are several limitations of the problem in this research, including research focused on the analysis of the added value with three processed cassava products with high consumer demand levels. Then, the supporting data includes product sales data, remaining product sales, and expired products. This research is expected to provide alternative solutions for managing cassava processed business units in increasing the added value of their products.

2. Value-Added Products Applying Multi-Criteria Decision Making

Value-added compares the difference value between the Output less input and the processing of a product. In a study conducted on the added value of the corn supply chain, it was found that the added value received by corn entrepreneurs was much higher than the farmers (Witjaksono, 2017). It is because corn entrepreneurs have processed corn, resulting in a change in added value. In addition, the added value of products with the same raw materials also has different values. The added value of Agricultural Products and Agrifood Byproducts has different values (Besbes *et al.*, 2014). The determination of the product's added value considers the multidimensional construct to win the competition (Potra *et al.*, 2018). Thus, the manager must determine the detailed cost variables to maximize profits. The research above shows that the added value of a product is determined by multi-criteria Decision Making.

Multi-Criteria Decision Making is a method whose primary use is to support decision making. This method can describe complex multi-criteria problems into a hierarchy by obtaining appropriate problem-solving results. The use of Multi-Criteria Decision Making in finding the best problem-solution to solve a problem has been widely used by researchers. A methodology for selecting Multi-Criteria Decision Analysis Methods in Real Estate and Land Management Processes was conducted (Guarini *et al.*, 2018). The results show that many questions about evaluation in land and real estate management often arise. This study successfully outlined the procedure for selecting the most suitable method for specific evaluation questions, which usually arise when dealing with decision-making problems. Furthermore, A survey of applications of multi-criteria decision analysis methods in the mining industry (Mahase *et al.*, 2016). they were evaluating problems with more criteria and fewer alternatives using Multi-Criteria Decision Making to provide better solutions to management. The Multi-Criteria Decision Making was found that a system was created to provide recommendations regarding the best alternative.

Applying recommendations using the Multi-Criteria Decision Making can increase the added value and benefits of products from SMEs processing cassava products before implementing the recommendations using the Multi-Criteria Decision Making Method. Before implementing the recommendations, there were problems with uncertain product raw material prices, the number of expired products, and the use of simple technology for product processing. It affects the amount of added value and profits received. However, applying the recommendations using the Multi-Criteria Decision Making can cover losses in that section and increase the product's added value and profits. Several studies

apply Multi-Criteria Decision Making through AHP to get the best strategy (Rahman *et al.*, 2021; Tran, 2019). Several studies adopting the Analytical Hierarchy Process (AHP) need to determine the most critical criteria in selecting a product's value-added strategy. Thus, combining AHP with other methods to increase value-added products is necessary. An approach is used by several researchers in determining the added value of the product. Hayami can calculate cost variables to determine product added value (Hidayat *et al.*, 2018; Nuzuliyah, 2018). These cost variables will be used as Multi-Criteria Decision Making for the main criteria for increasing the added value of a product. Indeed, this study needs to integrate the Hayami method and the Analytical Hierarchy Process to increase added-value products.

3. Methods

This research needs to solve problems in a business unit. The study used a qualitative method with a case study approach. Qualitative research with a case study approach could explore situations and phenomena that make it easier to analyze and conclude research objectives (Baxter and Jack, 2008; Starman, 2013). Then, this research has experimented in a business unit engaged in the production of cassava processing into various processed products. This cassava processed product business unit is a business located in West Sumatra, Indonesia. In the process of cassava products, there are several problems regarding the production system including the uncertainty of the price of cassava raw materials. There are many expired products and simple technology for product processing. It causes the profits obtained not maximized yet, and the product's the added value that is not clear yet.

4. Data Collection

This study used a sampling technique with a purposive sampling method. Purposive sampling could determine samples based on particular criteria for the samples to be researched, especially from experts (Palinkas *et al.*, 2015). Then, the advantage of purposive sampling over other sampling is that the scope of the sample used is people who are experts in a field. Thus, researchers can determine how many samples will be needed so that the research carried out runs smoothly and gets the desired results. This study adopted the sampling method that the researchers used, namely purposive sampling with the number of respondents. There is four respondent from cassava processed products and five experts. The determination of this respondent is because it meets the criteria that the researcher expects, and the respondent is an expert in his field, has an education level as a doctor, and has experience and insight in working in the field of processing cassava products. With the insight and experience of the respondents, the answers given can already represent the answers to solve the research objectives. The data in this study are data that can be obtained directly. Research data is obtained through direct surveys in the field, results from interviews, and questionnaires for experts. The framework research can be seen in Figure 1.

4.1 Surveys and interviews

Direct field surveys are the initial method researchers do by observing the business unit of processed cassava products to obtain the required data. Observations made by researchers are on the production floor of the product, a study of production data, and product sales data. Then, the interview is a question-and-answer process carried out to obtain data related to the calculation of the Hayami Method. Interviews were conducted with four participants for processed cassava products. Interview questions had been prepared in advance to obtain data on the selling price of the product, the purchase price of raw materials, the amount of direct labor, labor wages, and product operational input costs. This data is used to calculate each product's added value and benefits. Table 1 is an interview instrument to obtain data related to the Hayami Method. Table 2 is the profile of the respondents. Then, Figure 1 shows the framework research.

Table 1. Interview instrument

No	Instrument
1	Name of business unit processed cassava products
2	Years of the establishment of business unit processed cassava products
3	Types of products that are produced by the business unit
4	Working hours for cassava processing business unit in a day and a week
5	Sources of cassava raw materials
6	Obstacles to getting cassava raw materials
7	The price of cassava raw materials from the supplier (IDR/Kg)
8	The selling price of each type of processed cassava product (IDR/kg)

9	Product sales output in a day in terms of sales volume and sales value (IDR & Kg)
10	The cassava is used during the day for the production of each type of processed cassava product (Kg)
11	Primary raw materials in the manufacture of each type of processed cassava product
12	The price and number of primary raw materials used in a day of production (IDR & Kg)
13	The number of direct workers in the business unit processed cassava products
14	The wage of Direct Labor (IDR)
15	Other inputs used in the production process and what are the costs incurred in one production (IDR)
16	Other input costs that are incurred in a day are related to other than production (IDR)

Table 2. Profile of respondents

No	Name	Occupation	Explanation
1	Respondent A	Owner of business unit cassava processed product	Resource persons have been in this profession and have established businesses for approximately 20 years.
2	Respondent B	Worker of making Flour at business unit cassava processed product	Resource persons have been in the profession of making sanjai products for more than five years. Chosen as a resource person because they have experience in making products and how to measure the raw materials for making products.
3	Respondent C	Worker of making Sanjay Balado product and chopped chips at business unit cassava processed product	Resource person has been in the profession of making sanjai products for more than five years. Chosen as a resource person because they have experience in making products and how to measure the raw materials for making products.
4	Respondent D	Worker of making Sanjay Balado product and chopped chips at business unit cassava processed product	Resource person has been in the profession of making sanjai products for more than five years. Chosen as a resource person because they have experience in making products and how to measure the raw materials for making products.

4.2 Questionnaire

In this study, questionnaires were distributed with a comparison scale on each criterion and alternative to obtain data for calculating the AHP method. This questionnaire was distributed to five respondents with the criteria of having an education level as a doctor, and other criteria, namely having experience and insight into working in processing cassava products. The parties involved in preparing this research questionnaire are researchers by consider input or opinions from experts as respondents regarding how the framework of the questionnaire is made. The making of the questionnaire and the indicators used were referred to previous research conducted (Lestari *et al.*, 2022; Papilo *et al.*, 2020). The indicators used are derived from the variables or attributes of the methods used previously by taking into account the prices of raw materials, direct labor, and selling prices of products in increasing the profits and added value of the product by optimizing the production process of obtaining cheaper raw materials and reducing the number of workers in the production process. Product manufacture. The researcher's criteria for selecting respondents are based on level of education and work experience. The respondent's educational level is the Doctor, and he has taught for more than ten years for education. Then, work experience is based on the person who worked on the job for at least five years. Table 3 is a description of the criteria that researchers use in selecting experts.

Table 3. Profile of experts

No	Respondent	Occupation	Age (Years Old)	Experience (Years)	Field
1	Respondent E	Lecturer	51	Has taught for more than ten years	The respondent's education level is Doctor, and the respondent is an *expert* in economics.
2	Respondent F	Lecturer	47	Has been teaching for more than ten years	The respondent's education level is Doctor, and the respondent is an *expert* in economics and accounting.

3	Respondent G	Owner of process business	48	Have been in this profession for more than ten years.	Chosen as respondents because they are experts in production processes, raw materials, labor, and product selling prices.
4	Respondent H	Cassava collector	36	Have been in this profession for about seven years.	Chosen as respondents because they are experts in making good product raw materials and the price of product raw materials.
5	Respondent I	Worker of business unit	35	Have been in this profession for about seven years.	Chosen as a respondent because he has experience in product manufacturing processes and how to measure the raw materials for making products.

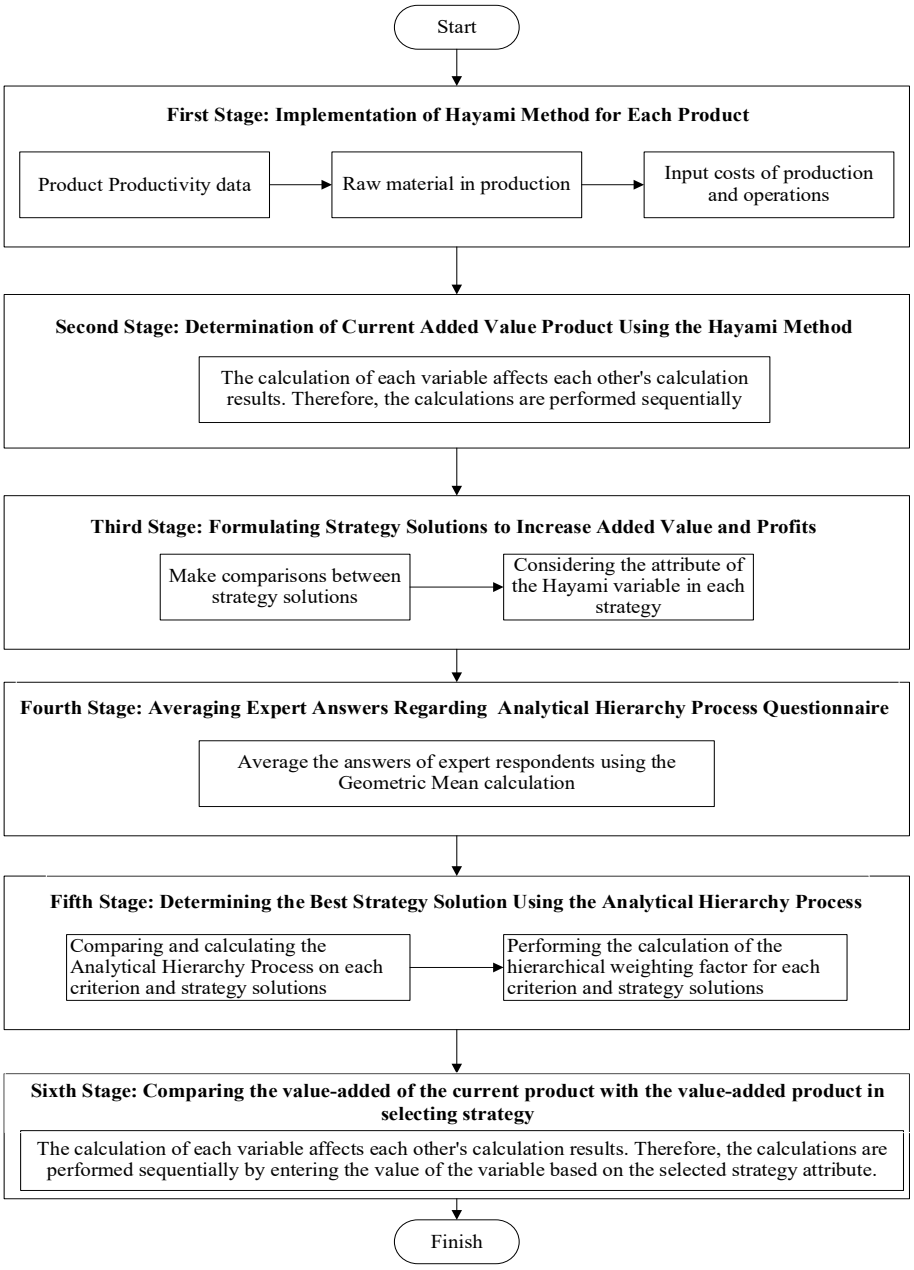

Figure 1. Framework research

5. Results and Discussion

5.1 Value-added product strategy using the Hayami method

Data processing using the Hayami Method or calculating the product's added value is currently being performed on three types of business unit processed cassava products. According to the added value product calculation, product C has the lowest added value. The low added value of product C is caused by its low selling price in comparison to processed products such as Product A and B. Product C had an added value ratio of 18.07%, while Product A and product B had ratios of 43.16% and 52.31%, respectively. In terms of profits, it is known that the company still earns 59.88% of its profits from Product A, 77.44% from Product B, and 50.60% from Product C. As a result, the business unit producing processed cassava products has benefited, but profits have not been maximized. If a business unit can earn higher profits than they do now, it will be very profitable for them to develop business unit processed cassava products in the future. The detailed current added value product can be seen in Table 4.

Table 4. Current Added Value Product

Variable	Unit	Product A	Product B	Product C
Supply chain interaction:				
1. Material purchase price	IDR/Kg	3. 800	3. 800	2.700
(Cassava)	IDR/Kg	40.000	30.000	7.000
2. Product Selling Price	IDR	36.200	26.200	4.300
3. Total Value-added per kg *output*				
Output, Input, and Price				
4. a. *Output* (sale volume)	Kg	2.130	2.970	3.900
b. *Output* (sale value)	IDR	85.200.000	89.100.000	27.300.000
5. Main Raw Material	IDR	23.785.000	28.897.000	17.550.000
6. Direct Labor (TKL)	People	12	12	2
Output, Input, and Price				
7. Conversion factor	-	3.58	3.08	1.55
8. Coefficient of Direct Labor	IDR	7.100.000	7.425.000	13.650.000
9. The wage of Direct Labor	IDR	23.400.000	23.400.000	4.500.000
Acceptance and Value-added				
10. a. Other input costs (production)	IDR	3.990.000	4.590.000	1.816.000
b. Other input costs (operational)	IDR	9.000.000	9.000.000	3.000.000
11. a. Value-added	IDR	36.775.000	46.613.000	4.934.000
b. Rasio Value-added	%	43.16	52.31	18.07
Remuneration of Business Factor Owner				
12. Margin	IDR	61.415.000	60.203.000	9.750.000
a. Contribution of Other input costs	%	21.15	22.57	49.39
b. Company profit	%	59.88	77.43	50.60

5.2 Identification of strategy solutions

Identification of the types of strategy solutions is carried out to determine the advantages and disadvantages of each strategy solution. Thus, the advantages and disadvantages of each strategy settlement can be identified. Table 5 is the comparison of each strategy solution.

Table 5. Comparison of each strategy solution

Strategy 1					
No	Hayami Attribute	Unit	Product A	Product B	Product C
1	Raw Material	IDR/Kg	2.800	2.800	1.800
2	Raw Material Price	IDR/Month	17.950.000	22.410.000	11.700.000
3	Direct Labor	People	8	8	2
4	Product Selling Price	IDR/Kg	45.000	35.000	12.000
5	Wage of Direct Labor	IDR/day	75.000	75.000	70.000

6	Cost Input operational	IDR/Month	4.500.000	4.500.000	2.100.000
Strategy 2					
No	Hayami Attribute	Unit	Product A	Product B	Product C
1	Raw Material	IDR/Kg	3.100	3.100	2.000
2	Raw Material Price	IDR/Month	20.155.000	24.495.000	13.000.000
3	Direct Labor	People	10	10	2
4	Product Selling Price	IDR/Kg	50.000	40.000	10.000
5	Wage of Direct Labor	IDR/day	75.000	75.000	70.000
6	Cost Input operational	IDR/Month	4.500.000	4.500.000	2.100.000
Strategy 3					
No	Hayami Attribute	Unit	Product A	Product B	Product C
1	Raw Material	IDR/Kg	3.200	3.200	2.000
2	Raw Material Price	IDR/Month	21.188.000	24.220.000	12.350.000
3	Direct Labor	People	9	9	2
4	Product Selling Price	IDR/Kg	45.000	40.000	15.000
5	Wage of Direct Labor	IDR/day	75.000	75.000	70.000
6	Cost Input operational	IDR/Month	4.500.000	4.500.000	2.100.000
Strategy 4					
No	Hayami Attribute	Unit	Product A	Product B	Product C
1	Raw Material	IDR/Kg	3.300	3.300	2.200
2	Raw Material Price	IDR/Month	20.788.000	24.353.000	14.300.000
3	Direct Labor	People	11	11	2
4	Product Selling Price	IDR/Kg	50.000	35.000	12.000
5	Wage of Direct Labor	IDR/day	70.000	70.000	70.000
6	Cost Input operational	IDR/Month	4.500.000	4.500.000	2.100.000

5.3 Strategy to Increase Added Value Product

Strategies to increase added value in processed cassava products are carried out using the Analytical Hierarchy Process method which starts by identifying strategy solutions through comparisons to each alternative sourced from Hayami's attributes.

a. The hierarchical weighting factor for main criteria and strategy

the calculation of the weighting factor on each criterion involves the criteria for raw materials and basic materials as well as alternatives to direct labor and product selling prices. It shows that the results of the calculation of the total Eigen Vector (EV) value are 1. This result indicates that the criteria for raw materials, basic material prices, direct labor, and product selling prices are correct, and there are no errors. The results other than 1 indicate that an error has occurred in the calculation process. Thus, a re-calculation must be carried out. In the consistency ratio (CR) section, all calculations on the weighting factors carried out on the criteria and alternatives for each criterion have consistent results. This is evidenced by the results of the CR value of all weighting factor calculations of CR <0.1 which indicates that the results are consistent and the perception regarding all criteria and alternatives to the criteria is acceptable. CR value > 0.1, on the other hand, indicates that the calculation for each weighting factor is inconsistent or rejected and must be recalculated, and new data collection must be carried out.

b. Ranking of criteria and strategy solutions

The following are the results of the calculation of the ranking of each strategy solution based on data processing using the Analytical Hierarchy Process approach.

Table 6. Strategy final ranking

Strategy	Total Evaluation Point	Rank
Strategy 1	0.601	1
Strategy 2	0.173	2
Strategy 3	0.127	3
Strategy 4	0.100	4

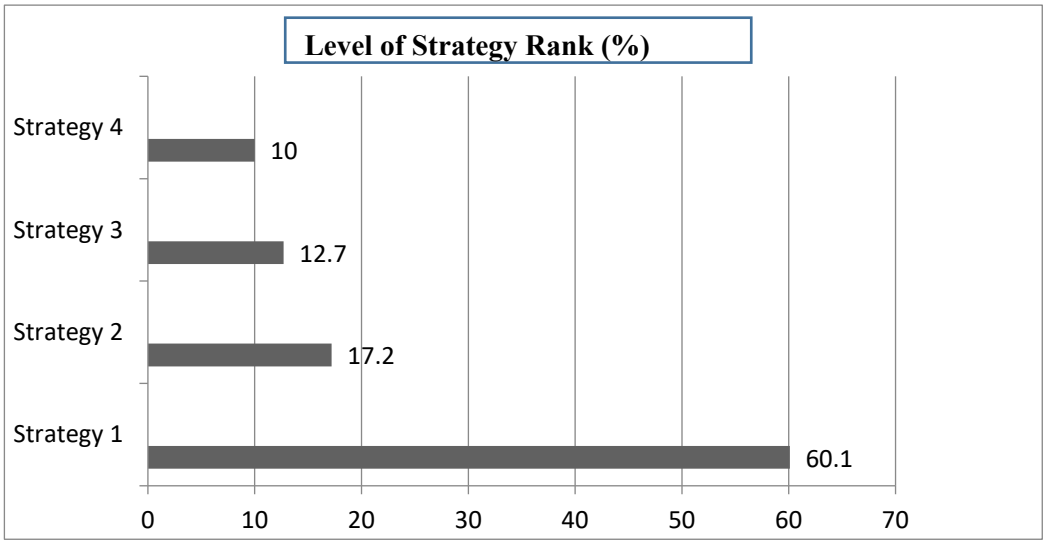

Figure 2. Strategy ranking

Table 6 and Figure 2 demonstrate that the first strategy is the best alternative because it has the highest evaluation weight value when compared to the other alternatives. Each alternative's total ranking value is as follows. Strategy 1 has an evaluation weight value of 0.601, Strategy 2 has an evaluation weight value of 0.173, Strategy 3 has an evaluation weight value of 0.127, and Strategy 4 has an evaluation weight value of 0.100. As a result, the calculation of the product's added value was repeated using strategy recommendations. It means that strategy 1 is the best alternative for increasing the added value and profit of the product for business unit processed cassava products.

5.4 Hayami method using selected strategy

Calculation of the Hayami Method by using the selected alternative, namely strategy 1, is expected to increase the added value of the product and the benefits for the business unit of processed cassava products. Table 7 is a description of the selected strategies. Calculation of the added value of the product with data from Strategy 1 as the best alternative will thus be carried out. Table 8 shows the comparison of the added value of the product before and after the application of alternative recommendations.

Table 7. Selected strategy Hayami attributes

No	Hayami Attribute	Unit	Strategy 1		
			Product A	Product B	Product C
1	Raw Material	IDR/Kg	2.800	2.800	1.800
2	Raw Material Price	IDR/Month	17.950.000	22.410.000	11.700.000
3	Direct Labor	People	8	8	2
4	Product Selling Price	IDR/Kg	45.000	35.000	12.000
5	Wage of Direct Labor	IDR/day	75.000	75.000	70.000
6	Cost of Operational Input	IDR/Month	4.500.000	4.500.000	2.100.000

where:
Product A = Sanjai Balado
Product B = Yellow Chopped Chips
Product C = Cassava flour
Strategy 1 = business unit buys raw materials directly from farmers

Table 8. Comparison of current value-added with value-added recommendations

Alternative		Current Value-added			Value-added on Strategy 1		
Variable	Unit	Product A	Product B	Product C	Product A	Product B	Product C
Supply Chain Interaction							
1. Material purchase price	IDR/Kg	3. 800	3. 800	2.700	2. 800	2. 800	1.800
2. Product Selling Price	IDR/Kg	40.000	30.000	7.000	45.000	35.000	12.000
3. Total Value-added per kg *output*	IDR	36.200	26.200	4.300	42.200	32.200	10.200
Output, Input, and Price							
4. a. *Output* (sale volume)	Kg	2.130	2.970	3.900	2.130	2.970	3.900
b. *Output* (sale value)	IDR	85.200.000	89.100.000	27.300.000	95.850.000	103.950.000	46.800.000
5. Main Raw Material	IDR	23.785.000	28.897.000	17.550.000	17.950.000	22.410.000	11.700.000
6. Direct Labor	People	12	12	2	8	8	2
7. Conversion factor	-	3.58	3.08	1.55	5.34	4.64	4
8. Coefficient of Direct Labor	IDR	7.100.000	7.425.000	13.650.000	11.981.250	12.993.750	23.400.000
9. Wage of Direct Labor	IDR	23.400.000	23.400.000	4.500.000	15.600.000	15.600.000	4.200.000
Acceptance and value-added							
10. a. Other input costs (production)	IDR	3.990.000	4.590.000	1.816.000	3.990.000	4.590.000	1.816.000
b. Other input costs (operational)	IDR	9.000.000	9.000.000	3.000.000	4.500.000	4.500.000	2.100.000
11. a. Value-added	IDR	36.775.000	46.613.000	4.934.000	69.410.000	72.450.000	31.184.000
b. Value-added Ratio	%	43.16	52.31	18.07	72.42	69.70	66.63
Remuneration of Business Factor Owner							
12. Margin	IDR	61.415.000	60.203.000	9.750.000	77.900.000	81.540.000	35.100.000
a. Contribution of Other input costs	%	21.15	22.57	49.39	10.90	11.15	11.16
b. Company profit	%	59.88	77.43	50.60	89.10	88.85	88.84

Figure 3 is a comparison ratio of the added value of the product before and after the application of alternative recommendations.

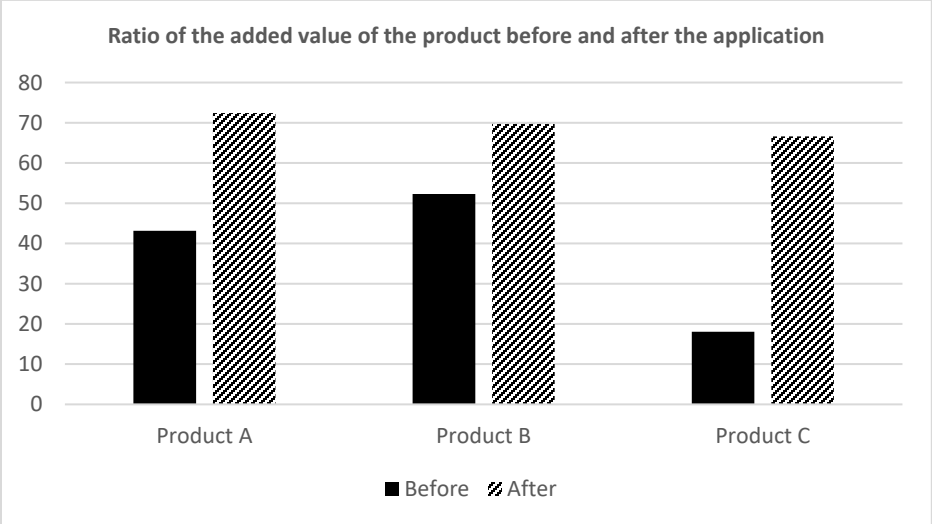

Figure 3. Comparison Ratio of Value-Added Product

The implementation of the criteria used to assess the success of this research can be described as follows:

1. The calculation of the added value of the product using the Hayami Method on the business unit for processed cassava products has succeeded in describing the changes in added value from the current condition. It is reflected in the constraints of unstable raw material prices, sales of products that are still left over, the existence of expired products, and the processing of products that are in short supply using simple equipment become a better situation because of the applicability of the method. However, of the three types of cassava processed products studied, not all products experienced significant added value and profits changes. This is due to several factors, one of which is raw materials from different types of products, so the prices are also different.
2. Meanwhile, profits received by the company experienced a drastic increase, averaging 80%. This increase in added value and profit is obtained based on applying the attributes in the alternative one as a recommendation to increase the added value and profits received.
3. The results of research using the Hayami Method on business unit processed cassava products that have been carried out reveal that the results are the same as the results of research conducted (Sari and Putri, 2020). This succeeded in calculating the added value of cassava into processed products so that the state of added value and profit of a business unit was obtained.

A study of a business unit producing processed cassava products successfully determined the added value of the current product for Products A, B, and C. It is possible to determine how to increase the profits received by business units from the processed cassava product by understanding the added value. As a result, the business unit can gain more value and profits from each cassava processed product than previously. A business unit can increase its added value and profits by implementing alternative ones as a recommendation. The first alternative in this case study suggests that the business unit obtains cheaper raw materials than before by buying directly from farmers. This can optimize the use of production raw materials that are usually excess and reduce the number of direct labor because there are fewer. Workers can carry out work, increase selling prices as recommended, and reduce the use of product delivery operational costs by warning workers not to use company vehicles for personal purposes.

6. Conclusion

This study focuses on a business unit of cassava processed products. As a result, it would be preferable if additional research was conducted to compare the added value of a business unit product to that of other business unit products. It aims to generalize the development of cassava processing businesses in an area using this comparison. Aside from the ability to increase the added value and profits of the product, future research is also recommended to compare the added value product of a business unit with other SMEs to make a business unit more advanced and developed in the future.

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