

Proposed contract manufacturing strategy for Baby Food Industry using Kepner-Tregoe and Analytic Hierarchy Process (AHP) Approach

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Article History

Received on 15 January 2024

1st Revision on 5 February 2024

Accepted on 20 February 2024

Abstract

Purpose: This study aims to determine the most appropriate contract manufacturing strategy for PT. SA to ensure sustainable fulfillment of its MA baby food products, amidst regulatory changes and operational risks from overseas production.

Methods: A mixed-method approach was employed, integrating qualitative methods (interviews and FGDs with Subject Matter Experts using Kepner-Tregoe and Why Tree analysis) and quantitative techniques through the Analytic Hierarchy Process (AHP). The criteria used for decision-making included cost, schedule, delivery, capacity, capability, and quality.

Results: The AHP analysis identified schedule (32.95%) and cost (30.31%) as the most influential criteria. For short-term resolution, the strategy “Produce in existing contract manufacturing and distribute using a 3rd party trader” scored the highest (49.56%). For long-term sustainability, “Terminate existing manufacturing and produce in alternative local contract manufacturers in Indonesia” was the optimal choice (31.55%).

Conclusion: Selecting the right strategy helps mitigate sales loss risk (up to IDR 97 billion annually), ensures product availability, and aligns with government import restrictions. Each alternative was evaluated for feasibility, risks, and potential savings.

Limitation: This study is specific to PT. SA’s baby food segment and may not fully generalize to other industries or products with different supply chain dynamics or regulatory constraints.

Contribution: The study contributes a structured decision-making model using Kepner-Tregoe and AHP to optimize contract manufacturing strategies, supporting firms in navigating supply chain disruptions under regulatory pressure.

Keywords: *Analytical Hierarchy Process, Contract Manufacturing, Decision Making, Kepner-tragoe, Why Tree Diagram*

How to Cite: Zahara, D. P., & Yudoko, G. (2024). Proposed contract manufacturing strategy for Baby Food Industry using Kepner-Tregoe and Analytic Hierarchy Process (AHP) Approach. *International. Journal of Accounting and Management Information Systems*, 2(1), 1-23.

1. Introduction

In 2023, amid a slowdown in the global economy, Indonesia’s economic growth increased by 5.05 percent (y-on-y). The highest distribution according to expenditure was household spending at 53,18 percent and growing by 4.82 percent by 2023. In the last five years, household spending has been the source of the highest growth at 2.55 percent. Household spending continues to grow as inflation and people's purchasing power are controlled. One of the strategic steps taken by the Ministry of Trade and the Ministry of Industry in an effort to reduce the value of imports is to issue policies on the Minister of Trade Regulation of the Republic of Indonesia Number 2021 concerning Import Policies and

Regulations to limit import commodities for consumer goods and products that have been produced domestically and begin a 35 % import substitution policy in 2022 with the aim of increasing the balance of national trade. This is a risk and challenge for the manufacturing industry in Indonesia, especially the fast-moving consumer goods industry. This creates a multiplier effect due to issues related to government policies to reduce import values as a strategy to increase Indonesia's GDP as well as opportunities to increase the domestic fast-moving consumer goods (FMCG) business, which can increase consumption values and help increase GDP in Indonesia.

PT. SA, which is a part of KA, is the largest pharmaceutical company in Southeast Asia. PT. SA, which focuses on developing health nutrition, also captures these risks and opportunities; therefore, a new strategy is required to ensure sustainable growth in the future. One of PT. SA's strategy is cost leadership, especially in the manufacturing and supply chain sectors, to deliver products to customers with the most efficient cost and quality. By reducing manufacturing and supply chain costs, PT.SA can achieve higher profit margins or become more successful in competitive markets. One of PT. SA products that make a major contribution to its business are MA brands, a baby food product that contributes 33% to PT.SA's total business. The market projection of baby food in Indonesia in the next five years will increase the CAGR by 7.7%. MA brand growth is 33.8%, with a market share of 33%, making it the second largest baby food brand in Indonesia. Therefore, the baby food market, especially the MA brand, has the potential to develop in Indonesia and has a positive impact on PT. SA's business.

The new regulation from the government to reduce imported products is to reduce the FG import quota from the previous 20% (complementary products) to 5% (market test), which will have an impact on two overseas contract manufacturing, namely in Thailand and Chile. MA Crackers in China will not be affected by this regulation because their products are not in the final product category, but rather Work In progress (WIP) products. With the current import quota regulations, the government will provide an import quota of 20% of the total MA volume of 2,834 tons, namely, 567 tons. However, with the new regulations, the government only provides an import quota of 5% of the total 2,834 tons, that is, 142 tons by 2025. The total volume of MA Puff and MA Puree products was 411 tons. Thus, there is a risk of losing sales of 270 tons or the equivalent of a sales loss of 97 billion a year from an MA's total business value of 530 billion (18% sales loss), and order fulfillment is only 34% fulfilled by 2025. Overall, this problem will have a significant impact on the MA brand of baby food at PT.SA.

1.1. Research Questions and Research Objectives

In order to find a solution for the business issue of the company, this research would like to address the following research questions throughout this paper as below:

1. What are the main criteria that should be considered when choosing an alternative contract manufacturing strategy for the MA baby food industry in PT? SA?
2. What are the best solutions to ensure the sustainable fulfillment of the MA baby food industry at PT? S.A in the short and long terms?
3. How can the solutions be implemented in an implementation plan for PT? SA?

This study aimed to provide a solution that meets the following objectives:

1. To identify the main criteria that should be considered when choosing an alternative contract manufacturing strategy for the MA baby food industry in PT. SA.
2. Select the best solution to ensure sustainable fulfillment of the MA baby food industry at PT. S.A in the short and long terms.
3. To provide recommendations and implementations based on the results of the study using Kepner Trago and AHP.

2. Literature review

2.1. Theoretical Foundation

2.1.1. Contract Manufacturing (CM)

Contract manufacturing (CM) is an outsourced manufacturer that produces products for a brand. Contract manufacturing (CM) is a business approach wherein manufacturers leverage their reputation for high-quality, cost-effective production to provide resources for the manufacturing of customer

products under contractual agreements, with the resulting products carrying the buyer's brand (Rahim, Voon, & Mahdi, 2016). Recently, many companies worldwide have relied on this contract manufacturing (CM) business model, which is expanding globally in various industries, including electronics, pharmaceuticals, automotive, and food and beverage production (Wu, Tannen, Anyu, Ivanov, & Xu, 2022).

Previous research has explored various reasons why a company decides to undertake this type of contract manufacturing (CM) business, including scale economies, production costs, operational risks, and asymmetric cost information (Duvvuru, Balachandra, Zeid, & Kamarthi, 2012). Contract manufacturing (CM) is emerging as a major alternative to increase capacity utilization, as it allows the collection of demand from potential customers. By leveraging economies of scale strategies and the benefits of bulk material procurement at lower prices, unused capacity can be made attractive (Rahim et al., 2016). In addition, the contract manufacturing (CM) model can also pose some business risks, such as a lack of product control, quality concerns, intellectual property loss, loss of flexibility and responsiveness, and others (Kepner & Tregoe, 1997; Pandya & Shah, 2013). Therefore, cooperation agreements with contract manufacturing (CM) must be made well to be able to mitigate these risks. Therefore, contract manufacturing (CM) is a long-term strategy planned by manufacturers to move to higher levels in the supply chain in various ways (Pandya & Shah, 2013).

2.1.2. Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) is a decision making framework developed by Saaty and Vargas (2012). Since its invention, the Analytic Hierarchy Process (AHP) has been a tool in the hands of decision makers and researchers, and it is one of the most widely used multiple-criteria decision-making tools (Palma-Mendoza, 2014). AHP is a multiple-criteria technique based on the need for complex problems branching into a hierarchical structure of specific elements that are objective (goal), criteria (sub-criteria), and alternatives (Canco, Kruja, & Iancu, 2021). AHP is widely used in various fields, including business, engineering, healthcare, and public policy, to prioritize alternatives and make informed decisions. This structured and hierarchical nature of AHP has been effectively applied in strategic decision-making for village-owned enterprises, highlighting its practical utility in multi-criteria stakeholder evaluations (Ubed & Raharjo, 2024). It provides a systematic and structured approach to decision making, allowing decision makers to consider multiple criteria and stakeholders' preferences in a rational and transparent manner (Sahoo & Goswami, 2023; Tavana, Soltanifar, & Santos-Arteaga, 2023). In the healthcare sector, AHP has been extensively applied to prioritize patient needs and evaluate clinical decision alternatives through a transparent, hierarchical process (Schmidt, Aumann, Hollander, Damm, & von der Schulenburg, 2015). Analytic hierarchy process (AHP) algorithm is composed of the following two steps:

1. Determine the relative weights of the decision criteria
2. Determine the relative rankings (priorities) of the alternatives

Both qualitative and quantitative information can be compared by using informed judgments to derive weights and priorities (Putri & Utama, 2024). AHP is widely used in various fields, including business, engineering, healthcare, and public policy, to prioritize alternatives and make informed decisions. AHP provides a systematic and structured approach to decision making, allowing decision makers to consider multiple criteria and stakeholders' preferences in a rational and transparent manner (Goepel, 2018; Petrillo, Salomon, & Tramarico, 2023). It helps break down complex decisions into smaller, more manageable components, facilitating better understanding and communication among stakeholders (Puspitasari & Febriani, 2024). The simple hierarchical structure of AHP is shown in Figure 1. below.

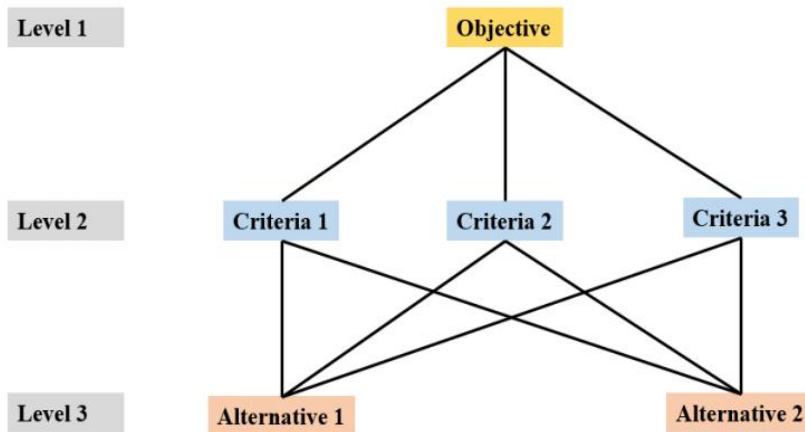


Figure 1. Hierarchy Structure of AHP

2.2 Conceptual Framework

The conceptual framework in this research identifies important variables that are required to identify the root causes of a problem, eliminate and minimize the possibility of problems occurring, and propose business solutions (Govindaraju & Sinulingga, 2017; Saaty & Vargas, 2012). The conceptual framework approach used in this research is shown in Figure 2.

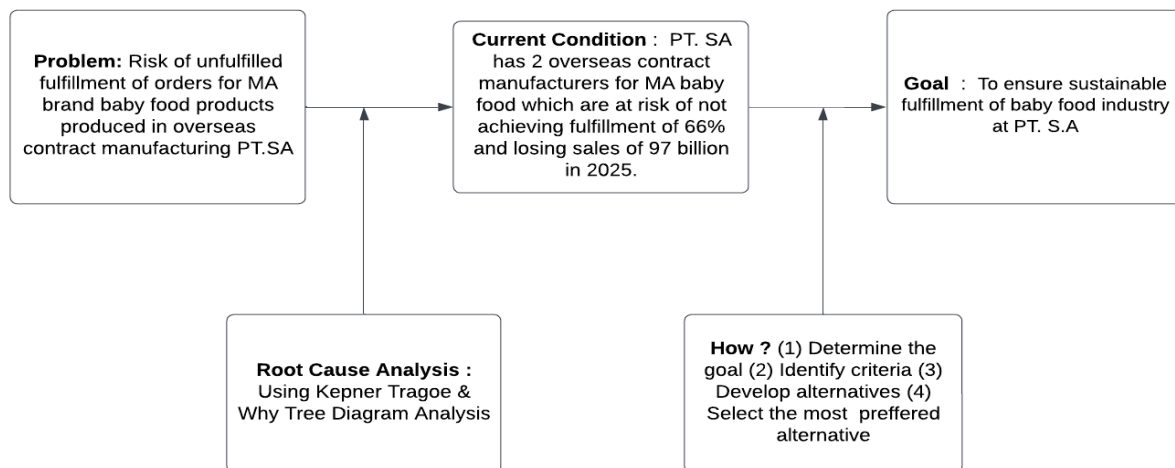


Figure 2. Conceptual Framework

Source: Author, 2024

From the conceptual framework above, this research aims to find the root causes of problems that occur in overseas baby food manufacturing contracts that have the risk of not being able to achieve target fulfillment and sales losses that are detrimental to the company (Serrat, 2017; Taherdoost & Brard, 2019; Tzeng & Huang, 2011). We then propose contract manufacturing's best strategy to ensure sustainable fulfillment of the MA baby food industry at PT. S.A.

The proposed conceptual framework for selecting a contract manufacturer strategy using the Analytic Hierarchy Process (AHP) is shown in Figure 3.

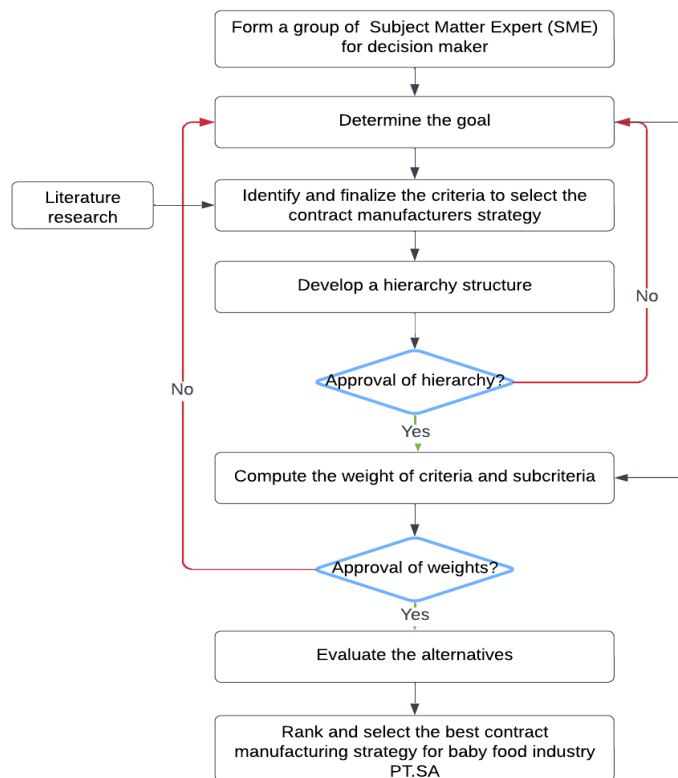


Figure 3. Contract Manufacturing Strategy Selection using AHP Framework
(Source: Author, 2024)

3. Methodology

3.1. Research Design

The research design for this study was a mixed-method approach. This approach integrates both qualitative and quantitative research methods to gain a comprehensive and holistic understanding of the decision-making process regarding finding a contract manufacturing strategy for PT. SA. The qualitative approach involves conducting interviews and forum group discussions (FGD) with Subject Matter Experts (Rosmeli) from different departments to gain a wider understanding of this research. To understand the current business situation that the company faced and to determine the criteria and alternative solutions to ensure sustainable fulfillment of the MA baby food industry at PT. S.A.

The quantitative approach is to use the Analytical Hierarchy Process (AHP) method to rank the proposed solution in terms of importance and to select the best contract manufacturing strategy for the MA baby food industry at PT.SA. The research design sequence is shown in Tabel 1.

3.2. Data Collection Method

Forum Group Discussion (FGD) will be used to conduct Root Cause Analysis (RCA) using Kepner Tragoe and Why Tree Diagram Analysis is used to determine the root cause of the problems. The participants of this FGD are defined as follows: the Supply Chain Department, External Plant Department, Sales and Marketing Department, Finance Department, Quality Department.

Table 1. Interview Question

No	Interview Question	Related to Research Objectives
1	What are the alternative solutions to ensure sustainable fulfillment of MA baby food business?	To obtain alternative solutions for contract manufacturing strategy to ensure sustainable fulfillment of MA baby food business obtained from root cause analysis. Alternative solutions will

		be evaluated using per-determined criteria and sub-criteria.
2	What is the goal of this project in selecting the right contract manufacturing strategy for MA baby food business?	To get the objectives of this project, such as what kind of contract manufacturing strategy fits the company's long-term goals for MA baby food business at PT. SA.
3	What are the criteria and sub criteria considered in determining the alternative contract manufacturing for MA baby food business?	To identify the criteria and sub criteria that should be considered to choose alternative manufacturing strategy for MA baby food business at PT. SA.
4	How do you prioritize these criteria and sub criteria, starting from the most important?	To finalize and decide the most important criteria and sub criteria that should be considered to choose alternative manufacturing strategy for MA baby food business at PT. SA.
5	What is the best solution for contract manufacturing strategy to ensure sustainable fulfillment of MA baby food business in the short term and long term?	To priority and choose the best solutions of contract manufacturing strategy to ensure sustainable fulfillment of MA baby food business at PT. SA in the short and long term.

3.2.1. Qualitative Data Analysis

Qualitative data analysis (QDA) involves systematically examining non-numerical data to identify patterns, themes, and insights graded according to the level of quality in the subject matter (Wu et al., 2022). Qualitative data analysis emphasizes understanding complex phenomena and gaining in-depth insights from data (Noviyanti & Tricahyono, 2024). The interview and focus group discussion data that were collected were analyzed using thematic analysis to identify, analyze, and report patterns (themes) within the data. Furthermore, this research is analyzed using the Kepner-Tregoe (KT) approach to define Problem Analysis (PA), Decision Analysis (DA), and Potential Problem Analysis (PPA). In this research, Kepner-Tregoe (KT) will not use Situation Appraisal (SA) because of the business problem faced by PT.SA, as written in Subsection I.2 on Business Issue (Chaube et al., 2024).

Problem Analysis (PA) will be evaluated to define the problem through Why Tree Diagram Analysis is used to analyze the root cause of business problems/issues. Then, for Decision Analysis (DA), the AHP approach was used as the main research method (Ariawan & Yudoko, 2023). Qualitative and quantitative data obtained from interviews and other resources will be used to define criteria and sub-criteria, construct and distribute pairwise comparison questionnaires to respondents, and conduct performance analysis to rank and select the best solutions to overcome the problems. To ensure the consistency of pairwise judgments, AHP provides a measure called consistency ratio (CR). The consistency ratio (CR) was calculated using the free AHP software. Once the best solution is selected, a Potential Problem Analysis (PPA) is conducted to evaluate the final decision/best solution for the risk and identify possible and necessary preventive actions to minimize the risk in the future.

4. Results and discussions

4.1. Business Analysis

Business problems relate to the risk of unfulfilled orders for baby food products (MA brands) produced by overseas contract manufacturers. PT. SA has three overseas contract manufacturers for MA baby food, which are at risk of not achieving fulfillment by 67% and losing sales by 143 billion for the baby food business in 2024. The aim is to find the root cause of the problem and alternative solutions to ensure sustainable growth and increase the fulfillment of MA baby food at PT. S.A.

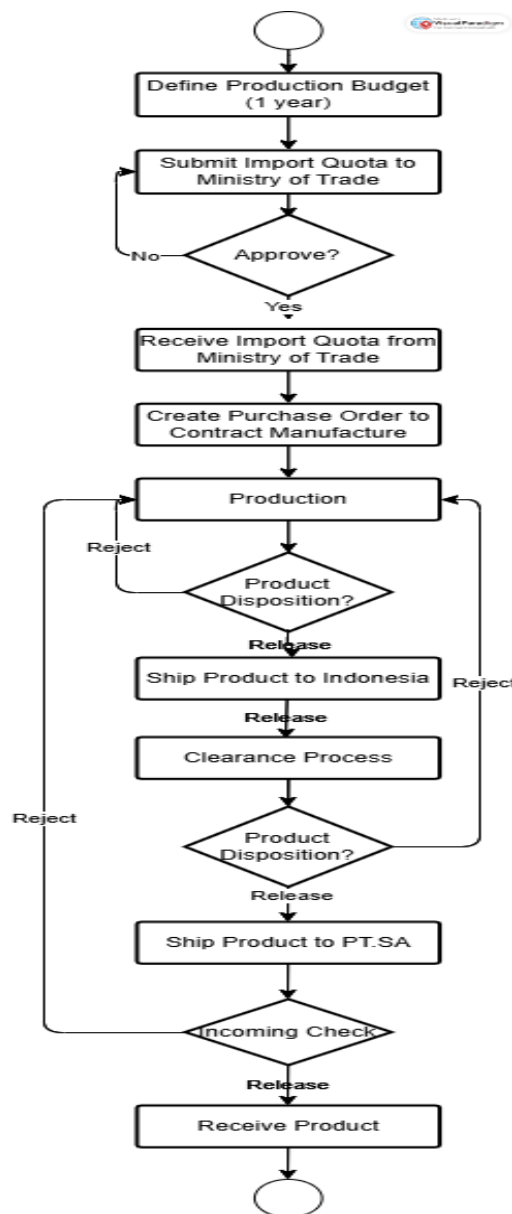


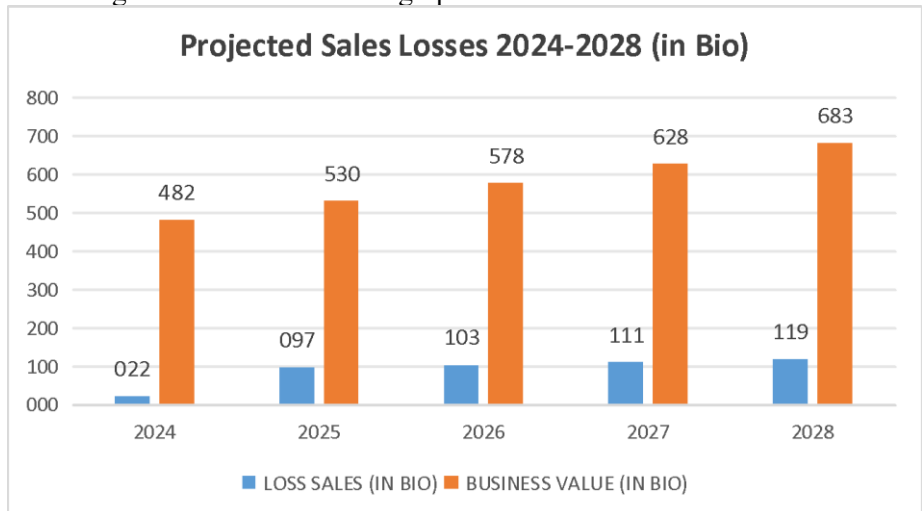
Figure 4. Flow Chart of Supply Chain for Overseas Contract Manufacture

The end-to-end supply chain process flowchart for MA's imported baby food products produced by overseas contract manufacturing is shown in Figure 4.

4.1.1. Kepner-Tragoe Problem Analysis

This research uses Kepner-Tragoe Problem Analysis to define the problem (using 5 W + 1 H), to specify the problem, identify the possible causes, test possible causes against specification, and verify the true cause. The first step of the Kepner-Tragoe Problem Analysis is to define the problem using the 5 W + 1 H question. The details of the Business Issue of this research are already defined in Chapter 1 of the Business Issue sub-chapter. The summary of Kepner - Tragoe Problem Analysis Step 1 (Define the Problem) is shown in Table 2 below:

Table 2 Define The Problem

No	Question	Answer																		
1	What is the problem?	Fulfillment of baby food products (MA brand) was not achieved																		
2	Where is the problem found?	Problems were found in baby food products under the MA brand at PT. SA which were produced in overseas contract manufactures (outside Indonesia), namely MA Puff produced by PT. SI, Thailand and MA Puree produced by PT. FR, Chile that can be seen in Table I.2 List of MA (Baby Food) Manufacturing Sites.																		
3	Who found the problem?	The problem was discovered by the Procurement Team (Import) when submitting the import quota for finished goods brand MA Puff to the Indonesian Ministry of Trade and Ministry of Industry.																		
4	When was the problem found?	Q4 2023, at the time of submission of import quota for 2025.																		
5	Why is this a problem?	<p>Because it raises the risk of not fulfilling the MA brand baby food products at PT.SA and will result in long-term loss sales in the market.</p> <ol style="list-style-type: none"> 1. Impact on the baby food business which contributes 33% to the total business of PT.SA. 2. Impact on 2 of the total 7 manufacturing contracts of the baby food business which contributes 38% to the total baby food business. 3. Experiencing losses from sales losses of 97 billion from a total business value of 530 billion (loss equivalent to 18% of the total business value MA brand) and Fulfillment was only achieved at 34% in the projection for 2025. 4. There is no possibility for growth for Import Product, namely MA Puff, MA Puree, and MA Crackers, whereas average growth based on forecast LTDP is around 10%/year due to risk of unfulfilled order. 5. Projected sales losses for the next 5 years (2024-2028) if the risk is not mitigated can be seen in the graph below. 																		
6	How big/severe is this problem?	 <p>Projected Sales Losses 2024-2028 (in Bio)</p> <table border="1"> <thead> <tr> <th>Year</th> <th>Loss Sales (IN BIO)</th> <th>Business Value (IN BIO)</th> </tr> </thead> <tbody> <tr> <td>2024</td> <td>022</td> <td>482</td> </tr> <tr> <td>2025</td> <td>097</td> <td>530</td> </tr> <tr> <td>2026</td> <td>103</td> <td>578</td> </tr> <tr> <td>2027</td> <td>111</td> <td>628</td> </tr> <tr> <td>2028</td> <td>119</td> <td>683</td> </tr> </tbody> </table>	Year	Loss Sales (IN BIO)	Business Value (IN BIO)	2024	022	482	2025	097	530	2026	103	578	2027	111	628	2028	119	683
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After conducting the problem definition step, the second and third steps are to specify the problem using four dimensions to find and explore the answer to all questions in the first step and to identify possible causes. The details specify the problem and identify its possible causes, as shown in Table 2.

Table 3. Specify The Problem & Identify The Possible Cause

PROBLEM : The risk of unfulfilled orders for baby food products (MA brand) that produced in overseas contract manufactures.				
SPECIFICATION	IS	IS NOT	DISTINCTION	CAUSE
WHAT	What is the problem?	What is not the problem?	What is the difference between is and not?	What is possible cause?
	The risk of unfulfilled orders for baby food products (MA brand) that produced in overseas contract manufactures.	The fulfillment of the need for baby food products (MA brand) produced in local contract factories was achieved.	Fulfillment rate of baby food product (MA brand).	Unable to fulfill due to uncertainty import regulation from Indonesia's government
WHERE	Where does the problem occur?	Where does the problem not occur?	What is the difference between location?	What is possible cause?
	Baby food product (MA brand) that has finished good category and produced in overseas contract manufactures	Baby food product (MA brand) that produced in local contract manufactures in Indonesia	Different production location. The production location for baby food is divided by 2 location, namely : local and overseas contract manufacture.	Unable to fulfill due to complex supply chain process
WHEN	When does the problem occur?	When does the problem not occur?	What is the difference between timing?	What is possible cause?
	Q4 2023	Before Q4 2023	Occurred in Q4 2023, at the time of submission of import quota for 2024 Before Q4 2023 there is no issue when submission of import quota.	Unable to fulfill due to uncertainty import regulation from Indonesia's government
EXTEND	How many people/units are affected?	How many people/units are not affected?	What is the difference between the number of unit/people that are affected?	What is possible cause?
How many contract manufactures	2 contract manufactures (SI, FR)	6 contract manufactures (SA, AI, MP, MM, AL, GY)	Different Capability, Quality, and Cost of Goods Manufacturing (COGM)	Under performed contract manufactures

Using the Kepner-Tregoe Problem Analysis in Table 3, the author identified the possible causes of unfulfilled orders for baby food products (MA brand) as follows:

1. Unable to fulfill due to complex supply chain process
2. Unable to fulfill due to uncertainty import regulation from Indonesia's government
3. Under performed contract manufactures

Verification and testing were carried out using the Why Tree Diagram Analysis to verify the root or true cause from the most possible causes above.

4.1.2. Why Tree Diagram Analysis

To identify the root causes of the main event, this research uses a Why Tree Diagram Analysis to find the root causes of the fulfillment problem of MA brand baby food produced by contract manufacturers outside Indonesia. Forum Group Discussion (FGD) was used to determine the root cause of the problems. The participants of this FGD are defined as follows: the Supply Chain Department, External Plant Department, Sales and Marketing Department, Finance Department, and Quality Department. This study focuses on the following possible causes to determine the actual root cause of the **problems**:

1. Unable to fulfill because of the complex supply chain process.
2. Unable to fulfill due to uncertainty in import regulations from the Indonesian government.
3. Under-performed contract manufacturing.

4.1.3. Interview Result for Alternative Solutions

After knowing the root of the problem that has been identified using Kepner-Tragoe Problem Analysis and Why Tree Diagram Analysis, the next process is to obtain alternative solutions for contract manufacturing strategy to ensure sustainable fulfillment of MA baby food business obtained from root cause analysis. In this study, semi-structured interviews were used to determine several recommendations and alternative solutions by involving subject matter experts from five main departments. Table 4 presents the alternative solutions for the root cause problem as shown below:

Table 4. SME Recommendation for Root Cause of Problem

No	Root Cause Description	Alternative Solution
1	Unable to import products owing to PT. SA's status is API-P (Importer Identification Number For Producers)	1. To produce in existing contract manufacture and find alternative 3 rd party trader with API - U (Importer Identification Number For General Category) to ship the product . PT. KA has a GC division as a distributor and one of the trading companies in Indonesia.
2	Limited contract manufacturing options in Indonesia	2. To import the product in WIP (Work in Process) type and filling-packing in existing contract manufacture in Indonesia. This alternative solution will not be affected by the import quota limit regulation.
3	Force majeure (post pandemic, global wars, vessel shortage).	3. To terminate the existing contract manufacturer and find alternative local contract manufacturers in Indonesia.
4	Unreliable management, manpower, and processes in contract manufacturers.	The goal is to reduce problems caused by force majeure such as post-pandemic, global warming, and shortage of ships so that fulfillment is not achieved. In addition, the goal is to be able to control contract manufactures without any time and distance constraints.

As a consideration for the alternative solutions above, the Subject Matter Expert (Rosmeli) also defined the objectives of this project in choosing a contract manufacturing strategy and considered the advantages and disadvantages (pro - cons) of the 3 (three) alternative solutions. The goal is to choose the best solution that can improve the fulfillment of baby food products with the most competitive cost and least risk. The Pro-Cons Analysis of Alternative Solutions is shown in Table 5.

Table 5. Pro Cons Analysis of Alternative Solution Result From SMEs

No	Alternative Solutions	Pro	Cons
1	To produce in existing contract manufacture and find alternative 3rd party trader with API - U (Importer Identification Number For General Category) to ship the product .	<ul style="list-style-type: none"> • It takes less time because there is no need to find and develop new contract manufacture. • The risk of product quality not complying with standards is low (existing contract manufacture) 	<ul style="list-style-type: none"> • It still has long delivery time • There are still the impacts of Force majeure (post-pandemic, global war, ship shortages) and unreliable existing contract manufacture. • High potential impact cost which will be burdened (margin from distributors)
2	To import the product in WIP (Work in Process) type and filling-packing in existing contract manufacture in Indonesia.	<ul style="list-style-type: none"> • It takes less time because there is no need to find and develop new contract manufacture. 	<ul style="list-style-type: none"> • It still has long delivery time • There are still the impacts of Force majeure (post-pandemic, global war, ship shortages) and unreliable existing contract manufacture. • The risk of product quality not complying with standards is high • High potential impact cost which will be burdened (complex process with 2 contract manufactures involved) • More complex due more administrative processes, like import clearance process.
3	To terminate the existing contract manufacturer and find alternative local contract manufacturers in Indonesia.	<ul style="list-style-type: none"> • It has short delivery time • Able to control contract manufacturing performance more easily without time and distance constraints. • Less potential impact cost which will be burdened • Less complex due to fewer administrative processes, like import clearance process. 	<ul style="list-style-type: none"> • It takes longer to find and develop new contract manufacture. There is a risk of losing sales if the timeline does not match the target schedule given. • More complex in product development because it's need to create product specifications that are similar to existing ones. • It takes effort and time to find alternative manufacturing contracts because there is not much similar technology in manufacturing contracts in Indonesia.

4.1.4. Interview Result for Criteria and Sub-Criteria Selection

To determine the criteria and sub-criteria, interviews were conducted with Subject Matter Experts (Rosmeli) and secondary information sources in the form of literature reviews were used to support the analysis. The aim is to identify the criteria and sub-criteria that should be considered when choosing the best alternative manufacturing strategy for the MA baby food business in PT. SA. Subject Matter Experts (Rosmeli) classified the criteria into six (6) criteria, as follows: (1) cost, (2) schedule, (3) delivery, (4) capacity, (5) capability, and (6) quality. The defined criteria for selecting the best manufacturing contract strategy to improve the fulfillment of baby food products are listed in Table 6 below.

Table 6. Criteria Selection for AHP by SME's Recommendation

Criteria	Description
Cost	<p>Cost of Good Sold (COGS) is the direct costs of producing the goods sold by a company which includes the product price from contract manufacture, freight, conversion cost (PT.SA factory overhead, depreciation, etc) and other additional cost.</p> <p>Target : The most competitive COGS compared to existing prices which can provide the greatest cost savings for the company.</p>
Schedule	<p>The ability to fulfill the project on time according to the schedule targets set by PT.SA's management.</p> <p>Target : It must not be more than Q4 2024 as a grace period given by the Ministry of Trade to PT.SA before the next import quota submission period.</p>
Delivery	<p>The ability to meet the delivery schedule according to the target specified in the purchase order (PO) starting from production, release, to delivery from the contract manufacture to PT.SA.</p> <p>Target : The faster the delivery time, the better the contract manufacturing performance, because it is more responsive.</p>
Capability	<p>The technological capability of a contract manufacture and ability to acquire new technologies and technical resources for research and development practices and processes in the future.</p> <p>Target : The more complete the product and technology portfolio in contract manufacturing, the better it is for PT.SA's new business in the future in creating strategic partners.</p>
Capacity	<p>The volume of product that can be produced by the contract manufacturer using current resources based on forecast f demand and production requirements provided by PT.SA.</p> <p>Target : Not more than 75% of installed capacity</p>
Quality	<p>The ability of the contract manufacture to meet quality specifications consistently which include production quality, quality system, and continuous improvement. PT. SA has 5 audit ratings from highest to lowest, namely (A) Excellent, B (Satisfactory), C (Average), D (Not Satisfactory), and E (Poor).</p> <p>Target : The minimum rating requirement is D (Not Statistical) which has no major findings and can be improved together.</p>

4.2. Analytical Hierarchy Process (AHP)

4.2.1. Analytical Hierarchy Process (AHP) Structure

The objectives of this analysis are to select the best alternative solution from the contract manufacturing strategy related to increased fulfillment of the MA baby food business at PT. SA. There are 3 (three) alternative solutions recommended by SMEs to solve business issues :

1. Produce in existing contract manufacturing and find alternative 3rd party trader using API - U.
2. Import the Work in Process (Work in Process) products and fill packing in existing contract manufacturing in Indonesia.
3. Terminate the existing contract manufacturer and find alternative local contract manufacturers in Indonesia.

There were six decision criteria: Cost, Schedule, Delivery, Capacity, Capability, and Quality. These criteria were recommended by SMEs and taken from the frequently used criteria in the literature review by selecting suppliers or contract manufacturers. The structure of the hierarchy of AHP models used in this research is shown in Figure 5.

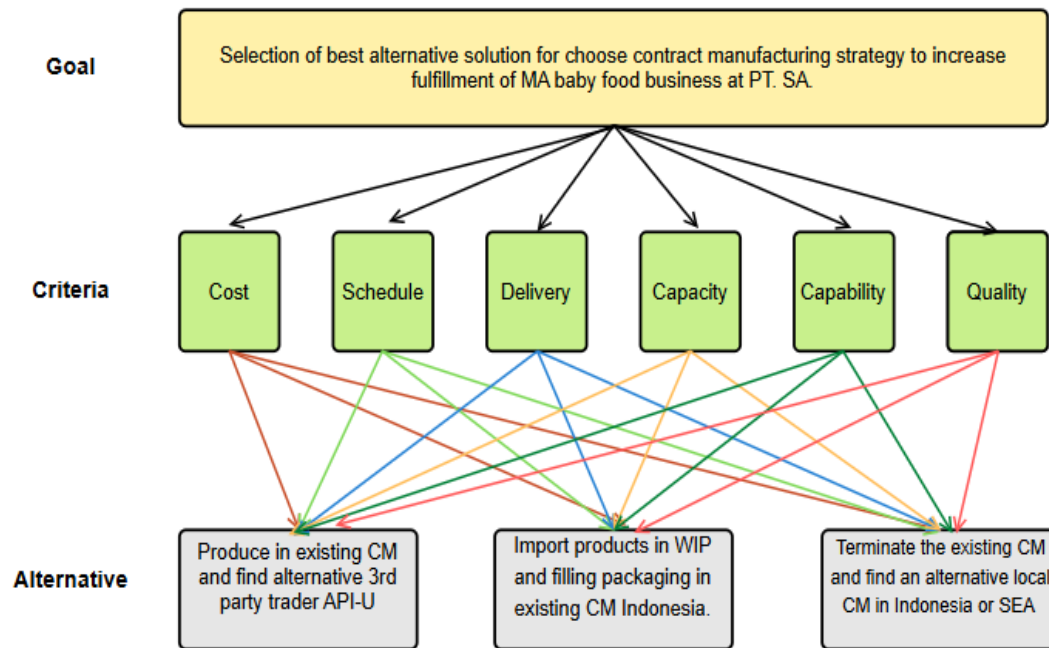


Figure 5 The Structure of AHP Model for Selection of Contract Manufacturing Strategy

4.2.2. Pairwise Comparison of AHP Model

The pairwise comparison between the above criteria was transformed into a questionnaire through interviews that addressed five selected Subject Matter Experts (Rosmeli) from the supply chain, finance, sales and marketing, external plants, and quality departments. The comparison scale of the questionnaire refers to Saaty, whose intensity of importance is labeled with a certain number, as shown in Table 7.

Table 7. The Fundamental Scale of Pairwise Comparison Questionnaire Scoring

Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Essential importance
7	Very strong important
9	Extreme important
2,4,6,8	Intermediate values

Source: Saaty and Vargas (2012)

Five Subject Matter Experts (SMEs) can answer using a fundamental value scale (Pairwise Numerical Rating) to represent the intensity of importance of the criteria shown in Figure 4 and alternative solutions for each criterion shown in.

4.3. Synthesize the result to Determine the Best Alternative Solution

After receiving the result of pairwise comparison of the five SMEs in Table IV.7 and Table IV.8, the next step is to synthesize the calculation to obtain the priority vector (eigenvector). The synthesis procedure is used in the pairwise comparison matrix, consisting of a matrix of criteria (Level 1) and a matrix of alternative solutions (Level 2). The calculation for each correspondent was done using two calculation methods using Microsoft Excel and using AHP EVM multiple input spreadsheet tools (version 15.09.2018) 11 developed by Klaus D. Goepel from Business Performance Management Singapore (BPMSG) for validation. Complete synthesizing calculation can be seen in Appendix C.

4.3.1. Matrix of Criteria (Level 1)

The results of the priority vector (eigenvector) calculation for the pairwise comparison matrix of the criteria matrix (level 1) are presented in Table 8.

Table 8. The Priority Factor (Eigen Factor) Calculation of Criteria Matrix (Level 1) (Microsoft Excel)

Criteria	Eigen	Eigen (%)
Cost	0,3031	30,31%
Schedule	0,3295	32,95%
Delivery	0,1644	16,44%
Capacity	0,0866	8,66%
Capability	0,0679	6,79%
Quality	0,0486	4,86%

The table above shows that the schedule (32.95%) and cost (30.31%) criteria dominated the overall weight and were the criteria that most influenced the decision-making process. Other criteria were delivery (16.44%), capacity (8.66%), capability (6.79%), and quality (4.86%).

For data validation, calculations were performed using AHP EVM multiple input spreadsheet tools (version 15.09.2018) 11 developed by Klaus D. Goepel. The data are presented in Figure 6 below. Based on the calculation, the result is similar to that of the Microsoft Excel Calculation, and the top two most important criteria are Schedule and Cost.

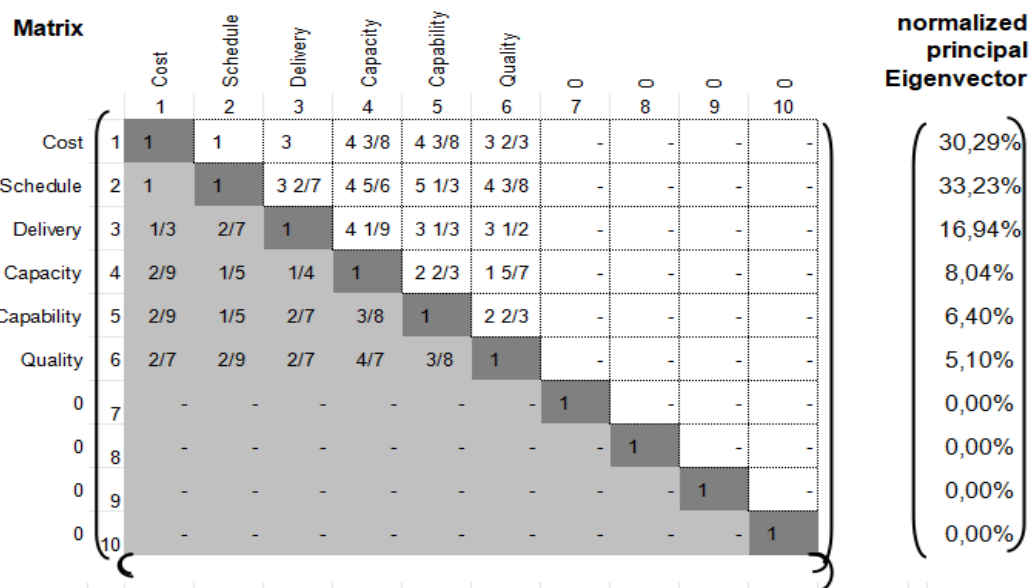


Figure 6 The Priority Factor (Eigen Factor) Calculation of Criteria Matrix (Level 1) (Klaus D. Goepel)

4.3.2. Matrix of Alternative Solution (Level 2)

The results of the priority vector (eigenvector) calculation for the pairwise comparison matrix of the alternative solution matrix (Level 2) for each criterion are listed in Table 9.

Table 9. The Priority Factor (Eigen Factor) Calculation of Criteria Alternative Solution (Level 2)

	Cost	Schedule	Delivery	Capacity	Capability	Quality
Produce in existing CM & distribute using 3rd party trader	0,1841	0,6901	0,5134	0,6667	0,6319	0,5642

Produce WIP in existing CM & filling packing in existing CM in Indonesia	0,0740	0,2335	0,3762	0,1134	0,1850	0,1093
Terminate existing CM & Produce in alternative local CM in Indonesia	0,7419	0,0764	0,1104	0,2199	0,1830	0,3265

4.4. Consistency Ratio

The consistency of Subject Matter Experts (Rosmeli) is verified using the Consistency Ratio (CR), which combines Eigenvalues and Consistency Index. Consistency verification was performed to measure the level of consistency between pairwise comparisons, based on their consistency ratios. In this research, there are 2 (two) categories of consistency ratio calculations: pairwise comparisons of criteria (level 1) and pairwise comparisons of Alternative Solutions (level 2). Detailed calculations can be seen in Appendix E.

Table 10. Consistency Ratio for Pairwise Comparisons of Criteria (Level 1)

Criteria	CI	CR
Cost	0,121	0,098
Schedule		
Delivery		
Capacity		
Capability		
Quality		

Table 11. Consistency Ratio for Pairwise Comparisons of Alternative Solution (Level 2)

	Cost		Schedule		Delivery		Capacity		Capability		Quality	
	CI	CR	CI	CR	CI	CR	CI	CR	CI	CR	CI	CR
Produce in existing CM & distribute using 3rd party trader												
Produce WIP in existing CM & filling packing in existing CM in Indonesia	0,049	0,085	0,049	0,084	0,027	0,047	0,042	0,073	0,056	0,096	0,027	0,046
Terminate existing CM & Produce in alternative local CM in Indonesia												

Based on the results in the table above, the consistency ratios for both the criteria and alternative solutions are acceptable for this pairwise comparison, because they are less than 0.1 (Saaty, 1980).

4.5. Development Priority Ranking

4.5.1. Priority Ranking of Criteria (Level 1)

To make the priority ranking of criteria, we need to calculate the priority factor (Eigen Factor) of criteria from Table IV.14 and priority factor (Eigen Factor) of the alternative solution from Table IV.15. The weight of all criteria and alternative solutions will be obtained and finalized, and will be decided what is the most important criteria that should be considered are determined. Then, we can choose the best solutions of the contract manufacturing strategy to ensure sustainable fulfillment of the MA baby food business at PT. SA. The structure of the hierarchy based on the weights of all criteria and alternatives is shown in Figure 7.

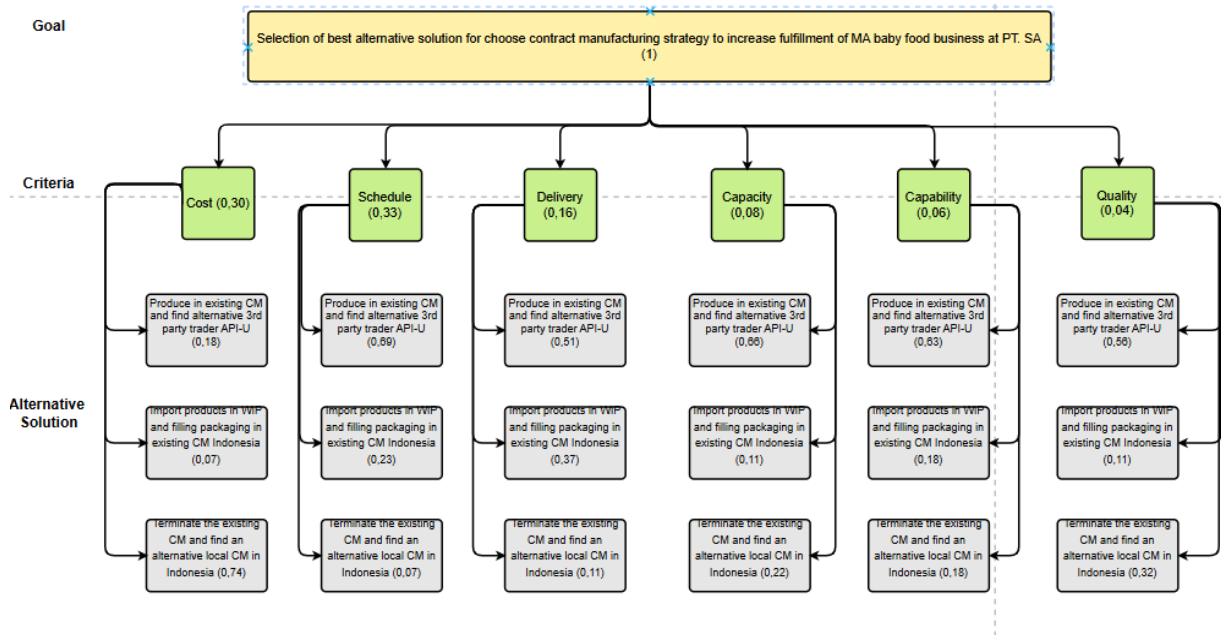


Figure 7. The Hierarchy Structure of AHP based on Weight

Based on the above data, the schedule (32.95%) and cost (30.31%) criteria are the most influential criteria for this decision-making process. The following are the results of interviews with Subject Matter Experts (SMEs) regarding the reasons why these two (2) criteria are considered the most important for selecting the best contract manufacturing strategy to improve the fulfillment of baby food products at PT. SA.

- Schedule:** In the decision-making process in this research, the Schedule Criteria or the ability to fulfill the project on time according to the target of the schedule is important because a solution is needed before Q4 2024. This is because the Ministry of Trade has given PT.SA a warning and grace period until the period of import quota submission in 2025. If the problem is not resolved immediately, there is a risk that the import quota obtained will be only 5% of the total MA brand baby food business. This will result in a loss of 97 billion from a total business value of 530 billion (a loss equivalent to 18% of the total MA brand business value), and fulfillment will only be achieved by 34% in the 2025 projection.
- Cost:** In the decision-making process in this research, cost criteria become important because the more competitive the COGS is compared to the existing ones, it can provide the greatest cost savings for the company. In terms of costs, MA products produced in overseas contract manufacturers provide a higher Cost of Goods Sold (COGS) than the average for other local MA products. The average Cost of Goods Sold (COGS) data for 2023 can be seen in Figure I.9. This makes the puff, puree, and crackers baby food categories provide uncompetitive prices compared with similar competitors.

4.5.2. Priority Ranking of Alternative Solution (Level 2)

The priority ranking of the alternative solution is calculated using the priority factor (Eigen Factor) of criteria from Table IV.14 and priority factor (Eigen Factor) of the alternative solution from Table IV.15. The results of the best alternative solution are listed in Table IV.18. The complete calculation can be shown in Appendix C.

Table 12 The Selection of Best Alternative Solution

Alternative Solution	Result	Ranking
Produce in existing Contract Manufacture & distribute using 3rd party trader	49,56%	First
Produce WIP in existing Contract Manufacture & filling packing in existing Contract Manufacture in Indonesia	18,89%	Third
Terminate existing Contract Manufacture & Produce in alternative local Contract Manufacturing in Indonesia	31,55%	Second

From Table 12, the first ranking of the alternative solution is “Produce in Existing Contract Manufacture & Distribute using 3rd Party Trader”, which gives the highest score of 49.56% compared to other solutions. Based on Table IV.15, this alternative solution provides the highest score in five out of the six selected criteria: Schedule (69,01%), Delivery (51,34%), capacity (66.67%), Capability (63,19%), and Quality (56,42%).

4.6. Business Solution

The final question that discussed with Subject Matter Experts is “*What is the best solution for contract manufacturing strategy to ensure sustainable fulfillment of MA baby food business in the short term and long term?*”.

To answer this question, this study conducted a problem analysis using the Kepner Tragoe and why tree diagrams were used to determine the root cause of the problem. Subsequently, a decision analysis was conducted using the Analytical Hierarchy Process (AHP) to prioritize criteria and alternative solutions and then obtain the best alternative solutions to ensure sustainable fulfillment of the MA baby food business at PT. SA in the short and long term.

Based on the Kepner Tragoe and Why Tree Diagram, the root cause of the risk of unfulfilled baby food products produced in overseas contract manufacturing is as follows:

1. Unable to import products owing to PT. SA’s status is API-P (producer).
2. Limited contract manufacturing options in Indonesia.
3. Force majeure (post pandemic, global wars, vessel shortage).
4. Unreliable management, manpower, and processes in contract manufacturers.

Based on the interview from Subject Matter Expert (Rosmeli), the alternative solutions that can answer the root cause of the problem are:

1. Produce in existing contract manufacturing and distribute using 3rd party trader.
2. Produce WIP in existing manufacturing and fill packing in contract manufacturing in Indonesia.
3. Terminate existing manufacturing and produce in alternative local manufacturing in Indonesia.

Based on the Analytical Hierarchy Process (AHP), the following are the criteria that influence decision-making: (1) cost, (2) schedule, (3) delivery, (4) capacity, (5) capability, and (5) quality. The schedule has the highest priority vector of 32.95% and cost of 30.31%, so both are the top two criteria that have the most influence in determining the best solution.

There is a deviation in the six criteria between the three alternative solutions to this problem. This research needs to answer the best alternative solution for the short- and long-term to ensure sustainable fulfillment of the MA baby food business.

The AHP model was used to analyze the best alternative solutions by considering the decision-making selection criteria involving a specified Subject Matter Expert (Rosmeli).

Based on Analytical Hierarchy Process (AHP) method which has been conducted, “Produce in Existing Contract Manufacture & Distribute using 3rd Party Trader” is the best alternative solution to ensure sustainable fulfillment of MA baby food business which dominates the score, namely 49.56% of other alternative solutions. The following is an analysis of the best alternative solution against the targets of each criterion, arranged from the most to the least important criteria.

Table 13. The Analysis of MA Puff Contract Manufacturing in Thailand

Alternative Solution:		Production in Existing Manufacturing Contract & Distribute using 3rd Party Trader		
Criteria	Priority Factor	Target	Best Alternative Solution	Result
Schedule	32,95%	No more than October Q4 2024	Total : 3 Months 1. Agreement = 1 Months 2. BPOM Approval = 2 Months Target = Start July until September 2024 (Start using Trader in December 2024)	Meet Target
Cost	30,31%	The most competitive COGM compared to existing prices	COGS : 77.90% COGS Existing : 67.90% Margin Trader : 10%	Do not Meet Target
Delivery	16,44%	The faster the delivery time than existing	SI : 18 Days (Same as before) Production : 1 Days, Release : 7 Days, Shipment to INA : 5 Days, Clearance : 4 Days, Shipment to SA : 1 Days	Do not Meet Target
Capability	8,66%	The more complete the product and technology portfolio	More complete. Product : Extrude, Rice & Grains, Noodle, Cereal Filling Packing : Pouch, Sachet, Bottle	Meet Target
Capacity	6,79%	Not more than 75% of installed capacity	Dedicated Line, 75% of total installed capacity -225 MT/year	Meet Target
Quality	4,86%	The minimum rating requirement is D (Not Statistical)	Audit Score : 92.5 (Excellent-A) Certification : FSSC 22000, CICOT, USDA	Meet Target

4.7. Implementation Plan & Justification

4.7.1. Control

The implementation plan explains how each project may be taken subsequently. The top management and all stakeholders involved have agreed that to ensure and increase the fulfillment of the MA baby food business produced in overseas contract manufacturing, the alternative solutions to be taken are as follows:

1. Produce in existing contract manufacturing and distribute using 3rd party trader (58,09%) = For Short Term.
2. Terminate existing Manufacturing and Produce in Alternative Local Contract Manufacture in Indonesia (31,55%) = For Long Term.

The proposed short-term implementation plan is shown in Figure 8.

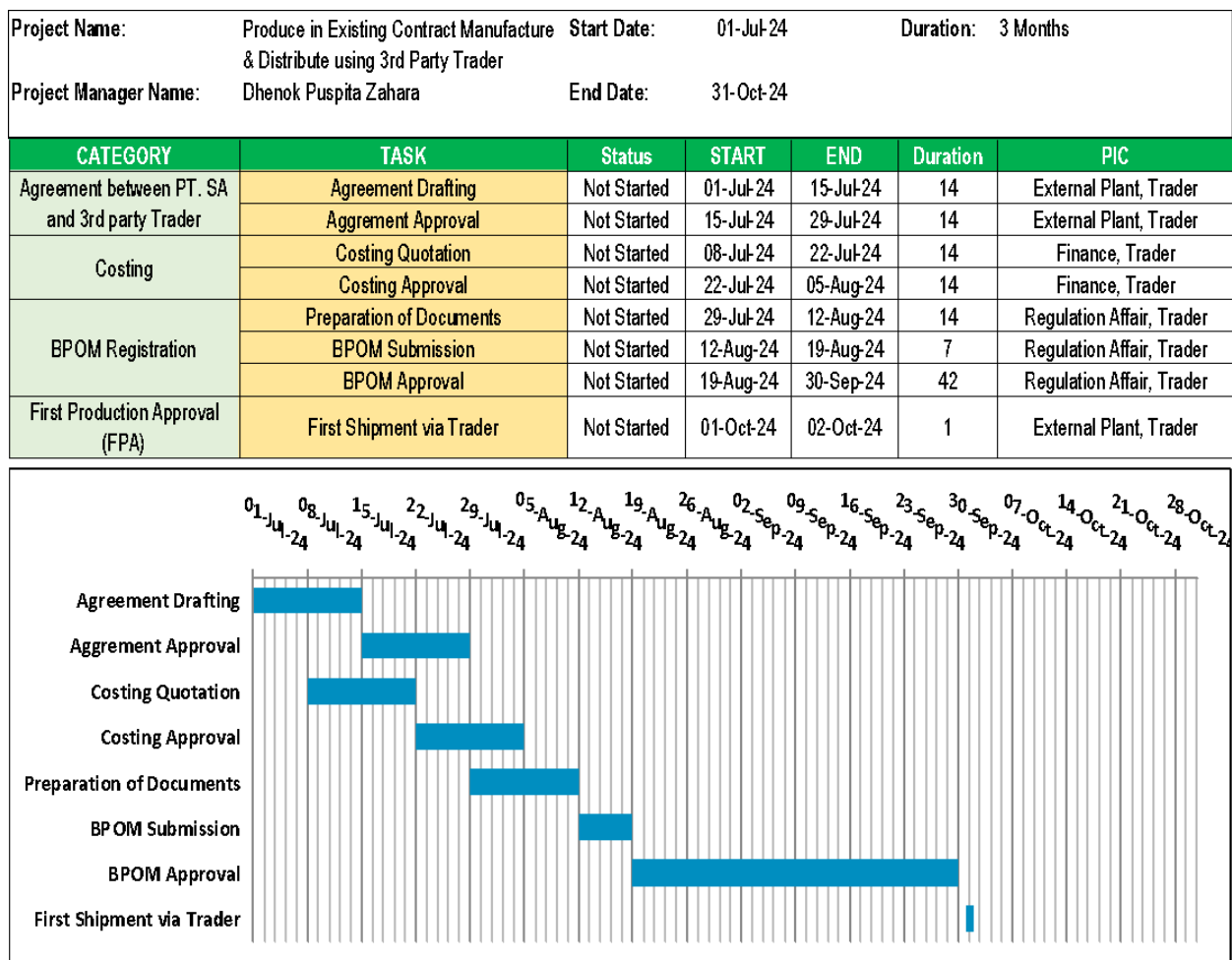


Figure 8. The The Implementation For Short Term Alternative Solution

The proposed long-term implementation plan is shown in Figure 9.

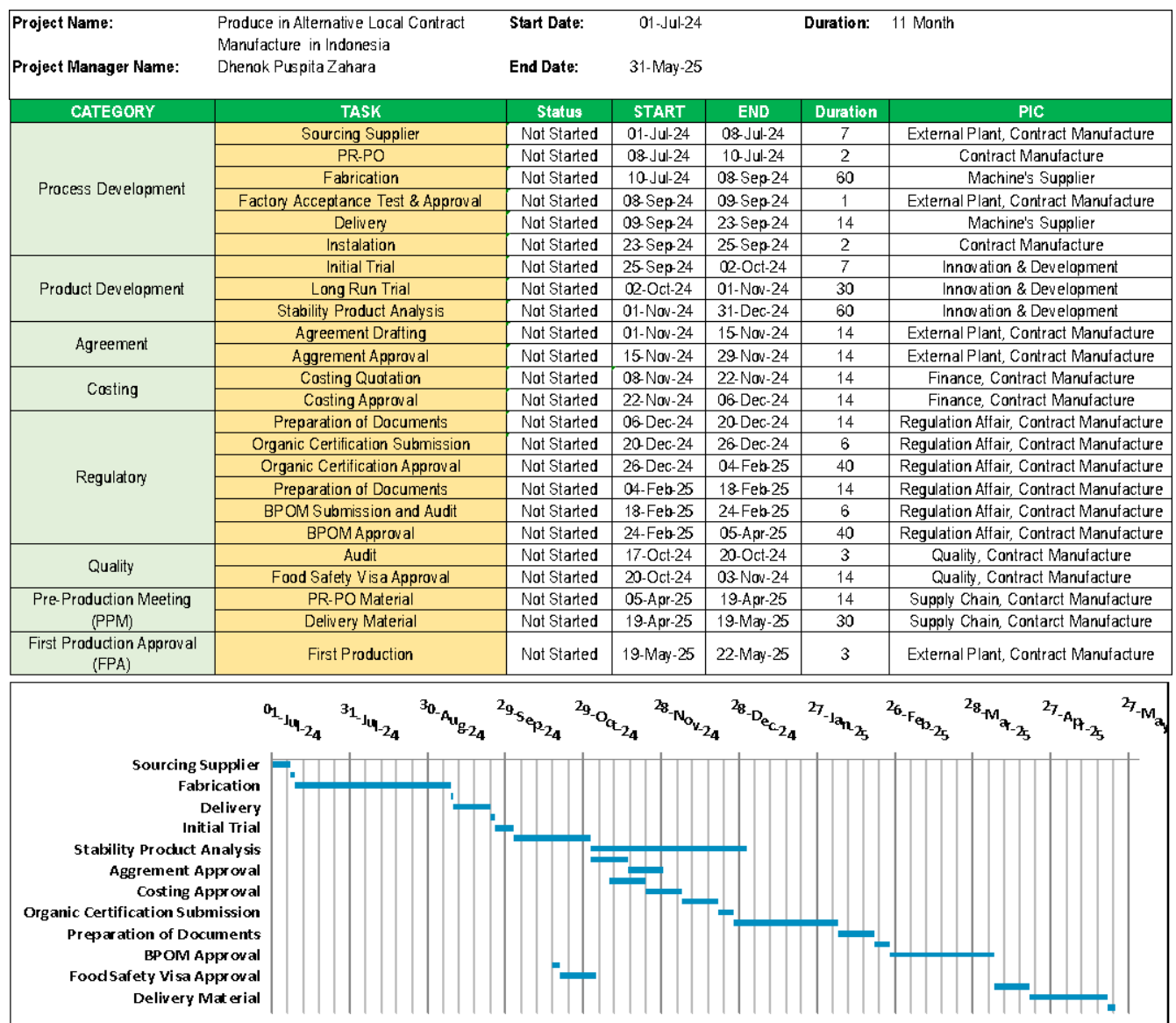


Figure 9. The Implementation For Long Term Alternative Solution

In the implementation plan, the project implementation process involved six internal departments and three external stakeholders, including traders, contract manufacturers, and suppliers. Each department has its own responsibilities and roles. In Figure IV.7 for the short-term solution, the activities carried out are less complicated and only require three months because the trader appointed by PT.SA is a division of the parent company PT.SA. Meanwhile, in Figure IV.8, for the long-term solution, the activities carried out are more complicated and require 11 months until the product can be produced by a new contract manufacturer in Indonesia.

5. Conclusion

5.1. Conclusion

The aim of this research is to find the best alternative contract manufacturing strategy to ensure the sustainable fulfillment of the MA baby food industry at PT.SA in the short and long term. Based on the business issues raised by the author in the first chapter and an in-depth analysis carried out to answer the existing problems, a conclusion was obtained that can answer the following three research questions :

What are the main criteria that should be considered when choosing an alternative contract manufacturing strategy for the MA baby food industry in PT? SA?

To identify and determine the main criteria that should be considered when choosing the best alternative solution, the author used a qualitative method, namely interviews with five Subject Matter Experts (SMEs), and a literature review method. The decision criteria selected by SMEs are classified into six categories: (1) cost, (2) schedule, (3) delivery, (4) capacity, (5) capability, and (6) quality.

To determine the most important criteria that can influence the decision-making process, an Analytical Hierarchy Process (AHP) was used through questionnaires and interviews with SMEs. The following are the results of the analysis carried out: the most important criteria that influence decision making are Schedule Criteria (32.95%), Cost (30.31%), Delivery (16.44%), Capacity (8.66%), Ability (6.79%) and Quality (4.86%).

What are the best solutions to ensure the sustainable fulfillment of the MA baby food industry at PT? S.A in the short and long terms?

Based on the AHP method and interviews with SMEs that have been conducted, the best alternative solutions to resolve business issues are as follows:

1. Produce in existing Contract Manufacture and distribute using 3rd party trader (58,09%) = For short-term alternative solutions.
2. Terminate existing Manufacturing & Produce in Alternative Local Contract Manufacture in Indonesia (31,55%) = For long-term alternative solutions.

How can the solutions be implemented in an implementation plan for PT? SA?

The selected alternative solutions are included in the PT.SA project list. The project involved six internal departments and three external stakeholders: traders, contract manufacturers, and suppliers. The implementation plan and resource requirement analysis were conducted by the project team and approved by PT.SA and Contract Manufacture's management.

Physical resources are required to support long-term alternative solutions. This is because the production process for Puree and Puff products is a technology that is rarely owned by contract manufacturers in Indonesia. These physical resources are included in the product price (depreciation), which is proposed by the contract manufacturer and agreed upon jointly by PT.SA and the contract manufacturer.

The budget estimate for this project is submitted to the Director of the New Contract Manufacture. The investment budget for this machine will be included in the calculation of the product price from contract manufacturing and will begin to be calculated from the first production in May 2025. With financial calculations, the payback period will be obtained within nine months, assuming a 10% COGS saving and 19 months assuming a 5% COGS saving. With the first savings to be obtained in the first year of implementation, namely, 2025. The complete calculation of feasibility study can be seen in Appendix E.

5.2. Recommendation

Based on the above conclusions, there are recommendations for PT. SA as follows:

1. To conduct further feasibility studies and decision making using the AHP method before choosing new contract manufacturing for PT.SA's long-term business in the future.
2. To bring the production location closer to the consumer. For example, continue producing PT.SA products that will be distributed to local consumers in an internal plant or domestic contract manufacturing. Obtain a more competitive cost of goods sold and reduce potential risks that may happen.

The recommendation for future research is the system dynamics model for contract manufacturing selection in Indonesia. The goal is to choose the right contract manufacturer with a causal loop diagram consisting of key strategic variables that influence decisions.

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