

Development Strategy for Fish Processing MSMEs in Tegal City Using the Delphi-ISM-Prosperspective Analysis Approach

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ABSTRACT

Micro, Small, and Medium Enterprises (MSMEs) in the fish processing sector in Tegal City face a production gap compared to large-scale enterprises, despite dominating in terms of the number of business units and employment absorption. This study aims to identify the development factors of fish-processing MSMEs in Tegal City. The research methodology consisted of three phases: (1) validation of relevant factors using a two-round Delphi method involving 10 key informants; (2) development of a hierarchical model using Interpretive Structural Modelling (ISM) and prospective analysis; and (3) formulation of development strategies. Based on 24 initial factors across the economic, environmental, social, institutional, technological, and inclusivity dimensions, the Delphi process resulted in 20 relevant factors that met the consensus threshold of the Average Percentage of Majority Opinions (APMO) and the stability threshold of the Coefficient of Variance (CV). The ISM and prospective analyses revealed a four-level hierarchical structure. Levels 1 and 2 were categorized as dependent variables, characterized by low driving power and high dependence power. These levels consisted of groups of factors that tend to be influenced by factors at lower levels. Level 3 was categorized as linkage variables, possessing both high driving

power and high dependence power. At Level 4, the factors were categorized as independent variables due to their high driving power and low dependence power. Furthermore, the researchers formulated 14 alternative strategies based on the results of the ISM and prospective analyses, followed by a Focus Group Discussion (FGD) that produced three-time horizons with different priority levels. The findings contribute to the achievement of SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure) through a priority-based and multidimensionally sustainable MSME development approach.

Keywords: Economic Dimension, Environmental Dimension, Inclusivity Dimension, Government Support, Access to Business Financing

INTRODUCTION

Indonesia is a maritime country with a coastline stretching approximately 108,000 km (BPS, 2025b), giving it abundant marine and coastal resources. The island of Java serves as one of the main regions contributing significantly to the national fisheries and coastal potential, particularly in Central Java. One of the cities in this province, Tegal, is recognized as a center for capture fisheries and aquaculture activities with one of the highest

productivity levels. Tegalsari Fishing Port in Tegal City was recorded as the largest fish landing site in Central Java during the January–June 2024 period, with total catches reaching 65,495,037 kg (RRI, 2024). This position was followed by Bajomulyo Fishing Port in Pati Regency with 52,035,058 kg, and Tasikagung Fishing Port in Rembang Regency with 38,164,090 kg.

The fisheries potential in Tegal City has encouraged the growth of fish-processing enterprises ranging from small to large scale (Kurnia et al., 2023). The number of micro, small, and medium-sized fish-processing enterprises in Tegal City is far greater than that of large-scale enterprises. There are 138 MSME-scale fish-processing businesses, while only 10 businesses operate on a large scale. Fish-processing MSMEs in Tegal City are able to employ up to 921 workers, whereas large-scale processing industries employ around 604 workers (Department of Manpower and Industry of Tegal City, 2025).

Although the number of MSME business actors and workers is considerably larger, their production capacity still lags behind that of large-scale enterprises. In 2024, the production value of large industries reached IDR 258,859,400,000, while MSMEs generated only IDR 104,340,373,440 (Department of Manpower and Industry of Tegal City, 2025). The relatively low production and sales performance of fish-processing MSMEs in Tegal City is mainly due to their predominant focus on local markets.

The implementation of sustainability principles in the context of business development has been proven to improve resource efficiency, strengthen competitiveness, and expand market access for fish-processing MSMEs (V. Lestari & Junianto, 2025; Oduro & Haylemariam, 2025). These sustainability practices not only function to maintain long-term business continuity, but also serve as a foundation for MSMEs to strengthen local economic resilience amid increasingly

competitive market dynamics. This is because sustainability principles consider multiple dimensions (Fandeli et al., 2025). The dimensions of sustainability principles include economic, social, and environmental dimensions (Troise et al., 2023). In addition to these three dimensions, sustainability in the MSME sector is also influenced by institutional and technological dimensions (Nordin & Koe, 2024). Recent research conducted by Riptanti et al., (2024) also incorporated the inclusivity dimension into sustainability practices in business activities.

The objectives of this study are to determine the development factors of fish-processing MSMEs based on sustainability practices, to map the structural relationships among these factors, and to formulate sustainable development strategies for fish-processing MSMEs in Tegal City. The novelty of this research lies in the use of sustainability practices as the basis for formulating development strategies for fish-processing MSMEs. The contribution of this study is the formulation of strategies that can be implemented by all stakeholders involved in the development of fish-processing MSMEs in Tegal City in order to support the achievement of SDG 8, namely Decent Work and Economic Growth, and SDG 9, namely Industry, Innovation, and Infrastructure.

MATERIALS & METHODS

This study employed a mixed-method approach, which integrates qualitative and quantitative research methods in a complementary manner (Taherdoost, 2022). The implementation of this method was divided into three phases consisting of: Phase 1: Validation of relevant factors, Phase 2: Development of a hierarchical model among factors, and Phase 3: Strategy formulation. The entire process is illustrated in the research flowchart presented in Figure 1. The explanation of each phase is described as follows.

a. Phase 1: Validation of Relevant Factors

This phase began with a literature review of journals and books to identify factors relevant to the development of fish-processing MSMEs. In addition, the researchers conducted a pre-research interview with a business actor to assess whether the identified factors were sufficient or if additional factors were needed to reflect the business climate of fish-processing enterprises in Tegal. The purpose of the literature review and pre-

research interview was to serve as an initial step in identifying important variables underlying a phenomenon so that relationships among variables could be identified (Dzulhijj & Albina, 2025). Following the literature review and pre-interview, the researchers identified 24 initial factors grouped into six dimensions: economic, environmental, social, institutional, technological, and inclusivity dimensions, as presented in Table 1.

Table 1. Relevant Factors for the Development of Fish-Processing MSMEs

Dimension	Cod e	Factor	Sources
Initial Factors			
Economic	1.1	Business Economic Performance and Efficiency	(Adnan & Seman, 2023; Febrianti & Fikriyah, 2023; Karim et al., 2020)(Adnan & Seman, 2023; Febrianti & Fikriyah, 2023; Karim et al., 2020)
	1.2	Production Capacity and Sustainability	(Karim et al., 2020; Sitompul et al., 2025)
	1.3	Market Conditions and Competitiveness	(Adnan & Seman, 2023; Febrianti & Fikriyah, 2023)
	1.4	Business Financing and Access to Capital	(Adnan & Seman, 2023; Sitompul et al., 2025; Wawancara)
	1.5	Product Diversification and Market Innovation	(Adnan & Seman, 2023; Febrianti & Fikriyah, 2023; Porter & Kramer, 2011)
Environmental	2.1	Environmental Management and Cleaner Production	(Daferighe et al., 2017; Karim et al., 2020; Wawancara)
	2.2	Consideration of Environmental Impacts within the Supply Chain	(Pradabwong & Chaipacharaporn, 2024)
	2.3	Awareness of and Compliance with Environmental Regulations	(Daferighe et al., 2017; Karim et al., 2020)
	2.4	Adaptation to Climate Change and Seasonal Variability	(Barange et al., 2018; Karim et al., 2020; Sitompul et al., 2025)
Social	3.1	Welfare and Social Relationships within the Business Community	(Garlock et al., 2022; Pacyao, 2021)
	3.2	Collaboration and Business Partnership Networks	(Febrianti & Fikriyah, 2023; Pradabwong & Chaipacharaporn, 2024)
	3.3	Changes in Lifestyle and Consumer Behavior	(Febrianti & Fikriyah, 2023; Pradabwong & Chaipacharaporn, 2024)
	3.4	Local Community Engagement and Cultural Preservation	(Garlock et al., 2022; Pacyao, 2021; Wawancara)
Institutional	4.1	Government Support and Business Regulations	(Do, 2021; Salehe et al., 2024)
	4.2	Capacity and Quality of Business Actors	(Nam & Luu, 2022; Salehe et al., 2024; Salong & Ansiska, 2025)
	4.3	Institutional Facilities	(Pacyao, 2021; Salehe et al., 2024)
	4.4	Collaboration among Institutions and Associations	(Anggraeni et al., 2018; Pradabwong & Chaipacharaporn, 2024)
	4.5	Access to Training and Capacity Building	(Anggraeni et al., 2018; Do, 2021; Salehe et al., 2024)

Technological	5.1	Capability and Readiness for Technology Adoption	(Alam et al., 2020; Anggraeni et al., 2018)
	5.2	Accessibility and Utilization of Digital Technology	(Perdana et al., 2025; Pradabwong & Chaipacharaporn, 2024)
	5.3	Sustainable Technological Innovation (Blue/Clean Tech)	(Alam et al., 2020; Karim et al., 2020)
	5.4	Safety and Reliability of Production Technology	(Alam et al., 2020; Anggraeni et al., 2018; BPOM, 2023)
Inclusivity	6.1	Equality and Workforce Inclusion	(Kurnia et al., 2023; Riptanti et al., 2024; Salehe et al., 2024)
	6.2	Access to Economic Justice and Value Chains	(Kurnia et al., 2023; OECD, 2018; Salehe et al., 2024)
Additional Factors from Delphi Round 1			
Economic	1.6	Fish-Processing MSMEs Business Ecosystem	<i>Key informant</i>
	1.7	Raw Material Price Stability	<i>Key informant</i>
	1.8	Access to Raw Materials	<i>Key informant</i>

After the factors had been collected, the researchers designed the first-round Delphi questionnaire. This questionnaire consisted of two types of questions: open-ended and closed-ended questions. The purpose of the questionnaire was to gather as much information as possible from the respondent group in order to examine the issue under discussion (Yuda et al., 2026). In the open-ended questions, the researchers sought to understand the condition of fish-processing MSMEs in Tegal City, identify the most influential factors within each dimension, and obtain suggestions from the selected key informants regarding the 24 presented

factors, including possible modifications, additions, or reductions. Meanwhile, the closed-ended questions used a Likert scale ranging from 1 (strongly irrelevant) to 5 (strongly relevant) to assess the relevance of the 24 initial factors that had been reviewed. These scores were subsequently compiled and calculated using the Average Percentage of Majority Opinions (APMO) method. According to Pau-parra et al. (2025), the Average Percentage of Majority Opinions (APMO) generates a cut-off value to determine whether consensus has been achieved. The APMO value is calculated using the following formula:

$$\text{APMO Cut-off} = (\sum \text{majority agreements} + \sum \text{majority disagreements}) / \sum \text{opinions expressed} \quad (\text{Equation 1})$$

where an opinion is categorized as a majority agreement or majority disagreement if its proportion reaches $\geq 50\%$ of the total key informants (Zunder et al., 2023). Prior to the analysis, the researchers grouped the responses into three categories: agreement, disagreement, and unable to answer, which were directly derived from the Likert scale used in the Delphi questionnaire. Agreement referred to key informant responses with scores of 4 and 5, while disagreement referred to responses with scores of 1 and 2. Responses with a score of 3 were classified as unable to answer (Schifano & Niederberger, 2025).

After categorizing the responses, the researchers calculated majority agreement by summing all responses within the agreement category that reached $\geq 50\%$. Similarly, majority disagreement was calculated by summing all responses within the disagreement category that reached $\geq 50\%$. Subsequently, the researchers calculated the opinion expressed, representing all expert opinions collected during this round, which was then applied in Equation 1. In addition to these calculations, the stability of the assessments was also evaluated using the Coefficient of Variance (CV), with the stability criterion defined as

$0 < CV \leq 0.5$ (Sun et al., 2024). The formula for CV is as follows:

$$CV = (\sigma / \mu) \dots \dots \dots (\text{Equation 2})$$

σ = Standard Deviation

μ = Mean of Responses

Factors that had reached consensus and were considered stable were excluded from the subsequent round (Khan, 2024). Meanwhile, factors that had not yet achieved consensus or were considered unstable were resubmitted for further evaluation.

In the second Delphi round, the questionnaire was designed as a closed-ended questionnaire by including information on the analysis results of factors that had not reached consensus, were considered unstable, or showed significant differences in respondents' opinions (Permata & Viendra, 2018). This aimed to provide an opportunity for the key informants to reflect on and refine their previous responses. In addition, suggestions for modifications, additions, or reductions proposed by the key informants were incorporated into this round. After obtaining the results, the researchers analyzed the data using the same methods applied in the first round, namely the APMO calculation to determine consensus and the CV calculation to assess stability. Consequently, only factors that met the threshold values for both APMO and CV calculations were carried forward to the hierarchical model development phase.

To ensure the quality of the Delphi method results, the process involved 10 key informants who were selectively chosen, each possessing more than five years of experience in their respective fields (Landeta, 2024). These key informants consisted of five representatives of fish-processing MSMEs, one academic lecturer, three government representatives, and one representative from the banking sector. This structured and iterative approach enabled the Delphi method to be implemented systematically by integrating diverse expert perspectives, identifying relevant factors more clearly, and conducting in-depth

analysis, thereby producing findings that are more robust and reliable.

b. Phase 2: Development of a Hierarchical Model Among Factors

After obtaining the selected factors through the Delphi method, the next step was to develop a hierarchical model among the factors using a combined analytical approach, namely Interpretive Structural Modelling (ISM) and prospective analysis. The explanation is as follows:

1. ISM

The first step in developing the hierarchical model was constructing the Structural Self-Interaction Matrix (SSIM). SSIM is a matrix used to translate direct relationships into symbols (Chuaphun & Samanchuen, 2024). When a relationship indicates a direct influence from factor i to factor j , it is represented by the symbol "V". Conversely, if the relationship indicates a direct influence from factor j to factor i , it is represented by the symbol "A". Furthermore, when two factors directly influence each other, the relationship is represented by the symbol "X". Finally, when two factors do not directly influence one another, the relationship is represented by the symbol "O" (Moelyanto et al., 2021). At this stage, the researchers designed a new questionnaire, hereafter referred to as the SSIM questionnaire. The questionnaire was distributed to nine key informants consisting of five representatives of MSMEs, one academic lecturer, and three government representatives. The selection of key informants was conducted selectively among experts who had been actively engaged in their respective fields for at least five years (Memon et al., 2025; Nida & Chandra, 2024). In the SSIM questionnaire, the researchers included a total of $n(n-1)/2$ questions, where n represents the number of proposed factors. From the opinions of the key informants, the researchers synthesized the responses into a single consensus by following the principle of "minority gives way to the majority," as recommended by Shen et al. (2016) and (Gan et al., 2018). A

final relationship was established when five or more experts agreed on the relationship, thereby determining the final SSIM.

After obtaining the final SSIM, the next step was to construct the Reachability Matrix (RM), which consisted of two stages: the Initial Reachability Matrix (IRM) and the Final Reachability Matrix (FRM) (Mangubat, 2026). This matrix was formed by converting the relationships among factors into binary values (1 or 0). In the conversion process, if a cell (i, j) in the SSIM was assigned the symbol "V", then the corresponding cell in the RM was assigned a value of 1, while cell (j, i) was assigned a value of 0, indicating a one-way influence from factor i to factor j. If a cell (i, j) in the SSIM was assigned the symbol "A", then cell (i, j) in the RM was assigned a value of 0, while cell (j, i) was assigned a value of 1, indicating that factor j influences factor i. When a cell in the SSIM was assigned the symbol "X", both corresponding cells in the RM, namely (i, j) and (j, i), were assigned a value of 1, indicating a bidirectional relationship between the two factors. Meanwhile, if a cell in the SSIM was assigned the symbol "O", then both corresponding cells in the RM, namely (i, j) and (j, i), were assigned a value of 0, indicating the absence of a relationship between the two factors (Aini & Chen, 2025; Bansal et al., 2024). As a result, a total of n^2 binary values were generated, where n represents the total number of factors. At this stage, the resulting matrix was referred to as the IRM. Subsequently, the IRM was refined by applying the transitivity rule, which ensures that if factor A is directly related to factor B, and factor B is directly related to factor C, then factor A has an indirect relationship with factor C (Wuni et al., 2025). Therefore, it was necessary to change the value from 0 to 1* in the corresponding cell to indicate the indirect relationship between factor A and factor C (Tseng et al., 2025). After all indirect relationships had been identified, the matrix became known as the FRM (Almoshaogeh et al., 2025).

The next step was to determine the reachability set and antecedent set for each factor. The reachability set consists of all factors that can be reached from a particular factor (row), whereas the antecedent set consists of all factors that can influence that factor (column) (Bao et al., 2025). Subsequently, the reachability set and antecedent set were used to determine the intersection set (Sadeghian et al., 2020). Factors whose intersection set was identical to their reachability set were categorized as Level 1 and placed at the top position in the hierarchy (Pathania & Tanwar, 2024). Factors whose hierarchical levels had already been identified were then eliminated from subsequent iterations (Ahmad & Qashmash, 2021). This process required repeated iterations to eliminate each factor until all factors were assigned hierarchical levels. The researchers carried out the calculations manually and subsequently verified them using the SmartISM tool developed by Ahmad & Qashmash (2021).

2. Prospective Analysis

The binary values obtained from the FRM were summed across both rows and columns (Mustahidda et al., 2025). The row totals represented the driving power, while the column totals represented the dependence power (Wardono et al., 2019). After determining the driving power and dependence power of each factor, the next step was to plot the coordinates using a Cartesian diagram. The coordinates were formed by assigning driving power as the y-axis coordinate and dependence power as the x-axis coordinate (Adinda & Sriwana, 2024). Through this process, the category of each factor could be identified. These categories were divided into four groups, as previously explained. The purpose of this analysis was to validate and determine the position of each factor within the hierarchical model that had been developed (Mustahidda et al., 2025). The application of ISM analysis followed by prospective analysis resulted in a hierarchical model that was both valid and reliable.

To ensure the quality of the results, the researchers involved experts with more than five years of experience as key informants (Memon et al., 2025; Nida & Chandra, 2024). These experts consisted of five representatives of MSMEs, three government representatives, and one academic. All experts involved were confirmed to possess adequate knowledge regarding the development of fish-processing MSMEs in Tegal, ensuring that each opinion provided was reliable and accountable.

c. Phase 3: Strategy Formulation

The researchers formulated alternative strategies based on the results of the analyses that had been conducted, followed by a Focus Group Discussion (FGD) to determine the priority scale and implementation time frame together with the experts. FGD has been conceptualized as a series of carefully planned discussions aimed at obtaining perceptions regarding a predetermined area of interest within a permissive and non-threatening

environment (Prosser et al., 2024). Through these directed discussions, the experts assessed the feasibility, urgency, and implementation time frame of each alternative strategy, while also agreeing upon the priority strategies considered most effective and realistic for promoting the sustainable development of fish-processing MSMEs in Tegal. Thus, the FGD played an important role as a stage for confirming and refining the strategies, ensuring that the formulated alternative strategies were not merely formalities but also practical and aligned with regional conditions and needs. A total of 12 experts were invited to participate in the FGD, consisting of five representatives of fish-processing MSMEs, three government representatives, three academics, and one representative from the banking sector. Each selected expert possessed more than five years of experience in their respective fields, ensuring that the alternative strategies developed had credible and accountable foundations.

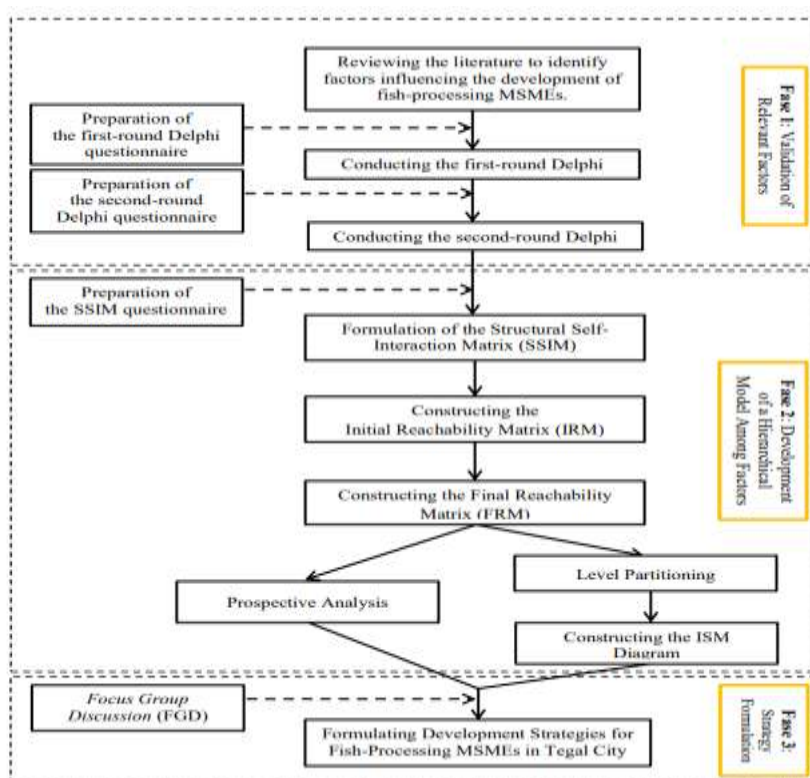


Figure 1. Research Framework

RESULT & DISCUSSION

a. Identification of Relevant Factors

1. First Delphi Round

Based on the results of the first Delphi round, an initial overview was obtained regarding the factors considered influential in the development of fish-processing MSMEs in Tegal from various dimensions. The findings indicated that several factors had reached consensus and were considered stable, while differences in perspectives

among the key informants were still evident for certain factors. In addition, new factors emerged that were considered relevant for strengthening the sustainability analysis of the business sector. The APMO value obtained in the first round was 0.583, meaning that each factor had to achieve an agreement percentage of more than 58.3% to be considered as having reached consensus.

Table 2. Results of Delphi Round 1

Factors	Agreement (%)	Coefficient of Variance
1.1	80.00%	0.289
1.2	60.00%	0.282
1.3	70.00%	0.346
1.4	50.00%	0.475
1.5	60.00%	0.504
2.1	50.00%	0.326
2.2	50.00%	0.268
2.3	30.00%	0.379
2.4	90.00%	0.157
3.1	80.00%	0.311
3.2	90.00%	0.220
3.3	80.00%	0.236
3.4	30.00%	0.686
4.1	90.00%	0.220
4.2	70.00%	0.255
4.3	60.00%	0.424
4.4	80.00%	0.191
4.5	50.00%	0.438
5.1	50.00%	0.363
5.2	40.00%	0.461
5.3	40.00%	0.553
5.4	30.00%	0.413
6.1	30.00%	0.321
6.2	60.00%	0.313
<i>Agreement ≥ 58.3% indicates that the factor is considered to have reached consensus.</i>		
<i>0 ≤ CV ≤ 0.5 indicates that the factor is considered stable</i>		

Within the economic dimension, three factors achieved consensus and were considered stable: business economic performance and efficiency, production capacity and sustainability, and market conditions and competitiveness. These three factors were viewed as the most relevant because they are directly related to the fundamental ability of fish-processing MSMEs to maintain business continuity. Economic performance and efficiency determine the ability of businesses to manage production costs and generate

sustainable profits. Production capacity and sustainability are important because fish-processing enterprises are highly dependent on maintaining production continuity amid fluctuations in raw material supply and market demand. Meanwhile, market conditions and competitiveness were considered crucial because they determine the ability of MSME products to compete in terms of price, quality, and consumer acceptance. The factor of access to business financing did not reach consensus due to differing perspectives between small-scale

business actors and government representatives regarding the accessibility of financing facilities, while product diversification and market innovation were considered unstable and therefore resubmitted for the next round. These findings are both consistent with and distinct from the study conducted by Suseno et al. (2026), which also applied the Delphi method involving 13 multi-sectoral experts and identified production capacity and market position as key variables in the development performance of fish-processing MSMEs in Indonesia. However, that study positioned certification and alignment among institutions, markets, and regulations as the primary drivers of performance, whereas the present study indicates that business actors place greater priority on operational efficiency and direct market access without relying heavily on institutional standardization.

Within the environmental dimension, only the factor of adaptation to climate and seasonal changes reached consensus, with the highest level of agreement and the lowest variation in opinions. Meanwhile, the factors of environmental management and cleaner production, consideration of environmental impacts within the supply chain, and awareness of and compliance with environmental regulations failed to reach consensus due to differing perspectives among stakeholders. Government representatives, academics, and banking representatives considered these factors important because proper environmental management supports the sustainability of MSMEs, whereas business actors perceived environmental factors as having less direct influence on their operations, creating a gap that hindered consensus. These findings are consistent with the study by Mulyasari et al. (2023), which analyzed perceptions and adaptive responses to climate change among small-scale fishers on the northern coast of Bengkulu, Indonesia, and found that adaptation to changing seasonal patterns was the most common response adopted by

fisheries business actors as a survival strategy in dealing with climate uncertainty. Within the social dimension, three out of four factors reached consensus, namely community welfare and social relationships within the business community, collaboration and business partnership networks, and changes in consumer lifestyles and behavior. The key informants agreed that the fish-processing sector contributes to local employment absorption and that business partnerships are essential for improving competitiveness. Meanwhile, the factor of local community involvement and cultural preservation did not reach consensus because it was considered to have no direct impact on business development. For example, the sedekah laut tradition was viewed merely as a symbol of community gratitude without being followed by increased product demand. These findings are both consistent with and different from the study conducted by Alexander & Kelling (2024), which examined social sustainability within seafood systems and identified community welfare and social networks as relevant social factors influencing business sustainability. However, the difference lies in the fact that their study emphasized that cultural aspects and socio-psychological needs are often overlooked in existing sustainability indicators, whereas the present study demonstrates that business actors empirically perceive local cultural aspects such as sedekah laut as irrelevant to business growth. This indicates a gap between academic perspectives and the practical realities of fish-processing MSMEs in Tegal.

Within the institutional dimension, four out of five factors reached consensus. Three factors were considered stable, namely government support and business regulations, the capacity and quality of business actors, and collaboration among institutions and associations. Government support through licensing, training programs, and equipment assistance was considered important, although its

utilization has not yet been optimal. The institutional facilities factor reached consensus but was considered to overlap in meaning with the factor of government support and business regulations, and therefore needed to be reconsidered in the following round. Meanwhile, access to training and capacity building failed to reach consensus because the existing training materials were perceived by MSME actors as already mastered and therefore no longer providing additional value. The study conducted by Tarihoran et al. (2024) developed a sustainable institutional model for export-oriented fisheries businesses in Indonesia using an ISM approach based on multisectoral expert assessments and similarly found that stakeholder collaboration and government support were the most strategic institutional elements. However, that study focused solely on the institutional dimension without considering other dimensions in constructing the ISM model, resulting in policy recommendations that tended to be limited to institutional actors alone.

None of the factors within the technological dimension reached consensus, indicating a perception gap between government representatives and academics on one side and business actors on the other regarding technological readiness and implementation. In addition, there was a suggestion to refine the wording of the factor concerning the capability and readiness for technology adoption by adding the word “machinery” in order to avoid multiple interpretations. In line with the findings of Fauziana (2025), which examined the determinants of technology adoption among food supply chain MSMEs in Indonesia using a qualitative expert verification method, a gap was also identified between business actors’ readiness and external stakeholders’ expectations regarding technology adoption. However, the difference is that the study found competitive pressure and management support to significantly encourage technology adoption, whereas the present study indicates that fish-processing

MSME actors in Tegal have not yet perceived the same level of urgency. Consequently, none of the technological factors succeeded in reaching consensus.

Within the inclusivity dimension, the factor of labor equality and inclusion failed to reach consensus because the involvement of women and vulnerable groups was considered not yet influential for their businesses. Business actors tended to focus on employee performance outputs without considering gender or vulnerability aspects. Meanwhile, the factor of access to economic justice and value chains reached consensus and was considered stable, although profit distribution along the value chain still needs to be strengthened through more inclusive policies. Widiastuti et al. (2024) applied the Delphi Analytical Network Process (D-ANP) method to identify barriers to strengthening the role of women in Indonesia and found that gender equality and labor inclusion are strategic dimensions determining the success of business empowerment. In contrast, the present study found that fish-processing MSME actors do not perceive gender equality as a relevant factor in business development, indicating a perception gap between academic-policy perspectives and the practical realities faced by business actors in the field.

In addition to the previously identified factors, the academic representative proposed a new factor, namely the business ecosystem of fish-processing MSMEs, because it was considered influential in ensuring the availability and stability of raw materials, strengthening supply chains, and improving market access and distribution. Representatives of MSMEs also proposed the additional factors of raw material price stability and access to raw materials, as both directly affect production costs, selling price determination, and profit margins.

Based on the results of the first Delphi round, 11 factors had reached consensus, were considered stable, and required no revisions; therefore, they were eliminated from the subsequent round and were ready to proceed to the relationship mapping

stage. Meanwhile, 16 factors were resubmitted in the second Delphi round, consisting of 11 factors that had not yet reached consensus, one factor that had reached consensus but was considered unstable, one factor that required refinement in meaning, and three newly added factors, namely the business ecosystem of fish-processing MSMEs (1.6), raw material price stability (1.7), and access to raw materials (1.8). These three additional factors were incorporated into the economic dimension because they are directly related to the business resources of fish-processing MSMEs. The second round was conducted to narrow the differences in perspectives among the key informants while simultaneously verifying the stability of the assessments of these factors.

2. Second Delphi Round

The APMO value obtained in the second round was 0.6125, increasing from the first round (0.583), which indicates a higher convergence of opinions among the key informants. Thus, each factor was required to achieve an agreement percentage exceeding 61.25% to be considered as having reached consensus. The stability criterion in the second round was tightened to $0 < CV \leq 0.4$ in order to measure the level of convergence in the responses of the key informants, which would later serve as a basis for determining the termination of the Delphi rounds (Andrades-Gonzales & Molina-Mula, 2022). Out of the 16 factors examined, 9 factors successfully reached consensus, while the remaining 7 factors did not. Nevertheless, all 16 factors were considered stable based on CV values that were entirely below the 0.4 threshold, indicating that no factor needed to be reassessed due to instability.

Table 3. Results of Delphi Round 2

Factors	Agreement (%)	Coefficient of Variance
1,4	90,00%	0,157
1,5	60,00%	0,225
1,6	70,00%	0,204
1,7	100,00%	0,088
1,8	100,00%	0,088
2,1	70,00%	0,214
2,2	60,00%	0,225
2,3	40,00%	0,299
3,4	60,00%	0,375
4,3	70,00%	0,204
4,5	60,00%	0,272
5,1	80,00%	0,188
5,2	50,00%	0,286
5,3	90,00%	0,216
5,4	70,00%	0,221
6,1	40,00%	0,234
<i>Agreement $\geq 61.25\%$ indicates that the factor is considered to have reached consensus</i>		
<i>$0 \leq CV \leq 0.4$ indicates that the factor is considered stable</i>		

Within the economic dimension, four out of five factors successfully reached consensus in the second round. The factor of access to and financing for businesses reversed the results of the first round, reflecting a convergence of views that financing is a crucial factor for business sustainability. These findings are consistent with the study

by K uchler et al. (2023) on food manufacturing MSMEs, which identified financial resource limitations as a major barrier to business sustainability, where experts agreed on the need for financing solutions to encourage sustainable business performance improvement. The stability of raw material prices and access to raw

materials achieved the highest level of agreement with the lowest variation in opinions, consistent with the findings of Sukiyono et al. (2023), who showed that the main risks faced by producers are raw material availability, input price fluctuations, and output prices. The MSME business ecosystem factor also reached consensus, with interactions among business actors considered an important element of sustainability. This is aligned with the findings of Suchek & Franco (2023) in their systematic literature review, which concluded that MSMEs can overcome sustainability barriers by collaborating with other organizations, and that inter-organizational cooperation is a key element in achieving economic, social, and environmental objectives. The only factor that consistently failed to reach consensus was product diversification and market innovation, reflecting the innovation capacity gap between small business actors and stakeholders from government and academia. This finding is in line with (Bertello et al., 2022), who demonstrated that traditional MSMEs (low- and medium-low-tech) face substantial challenges in innovation collaboration with universities and government institutions due to goal incongruence, limited resources, and differing stakeholder perspectives.

Within the environmental dimension, only environmental management and cleaner production successfully reached consensus, while consideration of environmental impacts within the supply chain and awareness of and compliance with environmental regulations continued to fail to reach consensus even in the second round. A similar pattern was identified by Castillo-Díaz et al. (2024) in their Delphi study on agri-food systems, where environmental indicators received the greatest emphasis and became the area most widely agreed upon by the panel of experts, indicating that environmental management aspects at the production level are relatively easier to achieve consensus on. However, unlike the study by Castillo-Díaz et al.

(2024), which focused on large-scale food industries in Europe and successfully developed a comprehensive and standardized environmental indicator framework, the context of fish-processing MSMEs in Tegal showed that aspects related to supply chains and regulatory compliance failed to achieve consensus. This indicates that the complexity of environmental implementation beyond direct production activities remains a particular challenge for small-scale business actors.

Within the social dimension, the factor of local community involvement and cultural preservation once again failed to reach consensus, with experts remaining divided between those who viewed cultural involvement as strategically important for the social legitimacy of businesses and those who considered it unrelated to production capacity. These findings are consistent with Galarza-maría et al. (2024), whose fuzzy Delphi study found that expert panels acknowledged the relevance of socio-cultural changes in business sustainability; however, these aspects were still considered to be at incipient stage to be operationally agreed upon.

Within the institutional dimension, the factor of institutional facilities reached consensus, with production centers and business communities being considered important for MSMEs. Meanwhile, access to training and capacity building continued to fail to reach consensus due to differing perceptions between business actors, who considered training programs to have no significant impact, and government representatives, who viewed training as the spearhead of fish-processing MSME development in Tegal. In contrast to these findings, the three-round Delphi study conducted by Lamm et al. (2024), which involved experts from industry, policymaking, and academia, successfully reached consensus that education, training, and workforce development are among the most critical issues in the food industry. This difference indicates that consensus

regarding training is more easily achieved when the participating experts originate from a single sector with relatively uniform orientations. In the present study, however, the heterogeneity of positions between business actors, who were skeptical about the impact of training, and government representatives, who viewed training as a primary development instrument, became a source of disagreement and reflected a communication gap in policy implementation that has not yet been bridged.

Within the technological dimension, three out of four factors reached consensus, with readiness for technology adoption, sustainable technological innovation, and the safety and reliability of production technology being agreed upon as crucial aspects. Only digital technology accessibility failed to reach consensus, reflecting that business actors still do not prioritize digitalization within their business processes, whereas government representatives and academics view digitalization as a gateway to broader market access. These findings are consistent with the Delphi study by Ammann et al. (2022), which found that one of the barriers to digital technology adoption is the lack of knowledge, expertise, and training.

Within the inclusivity dimension, the factor of labor equality and inclusion once again failed to reach consensus, with the level of agreement actually declining. Most key informants adopted a neutral position, indicating that labor inclusivity issues are still considered relevant but have not yet been explicitly prioritized. These findings are consistent with the study by Mangubhai et al. (2022), which identified three fundamental differences between fisheries

practitioners and development practitioners regarding gender inclusion. Fisheries organizations tend to perceive equality as an instrument for achieving production goals, whereas development organizations regard it as a core value. This demonstrates a difference in orientation that leads to disagreement, even though all parties acknowledge its relevance.

Based on the results of the second round, seven factors failed to reach consensus, namely 1.5, 2.2, 2.3, 3.4, 4.5, 5.2, and 6.1. A total of 20 relevant factors were identified through the combination of factors from the first and second Delphi rounds that had achieved consensus and were considered stable. These factors include: 1.1, 1.2, 1.3, 1.4, 1.6, 1.7, 1.8, 2.1, 2.4, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 4.4, 5.1, 5.3, 5.4, and 6.2. These 20 factors will serve as the basis for the development of the SSIM questionnaire.

b. Mapping the Structural Relationships Among Factors

The ISM analysis produced a hierarchical model consisting of four levels. The results of the prospective analysis, as shown in Figure 3, indicate that each level belongs to a different category. Levels 1 and 2 fall into the dependent category, characterized by low driving power and high dependence power. These levels consist of groups of factors that tend to be influenced by factors located beneath them. Level 3 is categorized as linkage, possessing both high driving power and high dependence power. At Level 4, the group of factors is categorized as independent because it has high driving power and low dependence power. This level contains the factors with the strongest driving influence on the development of fish-processing MSMEs in Tegal.

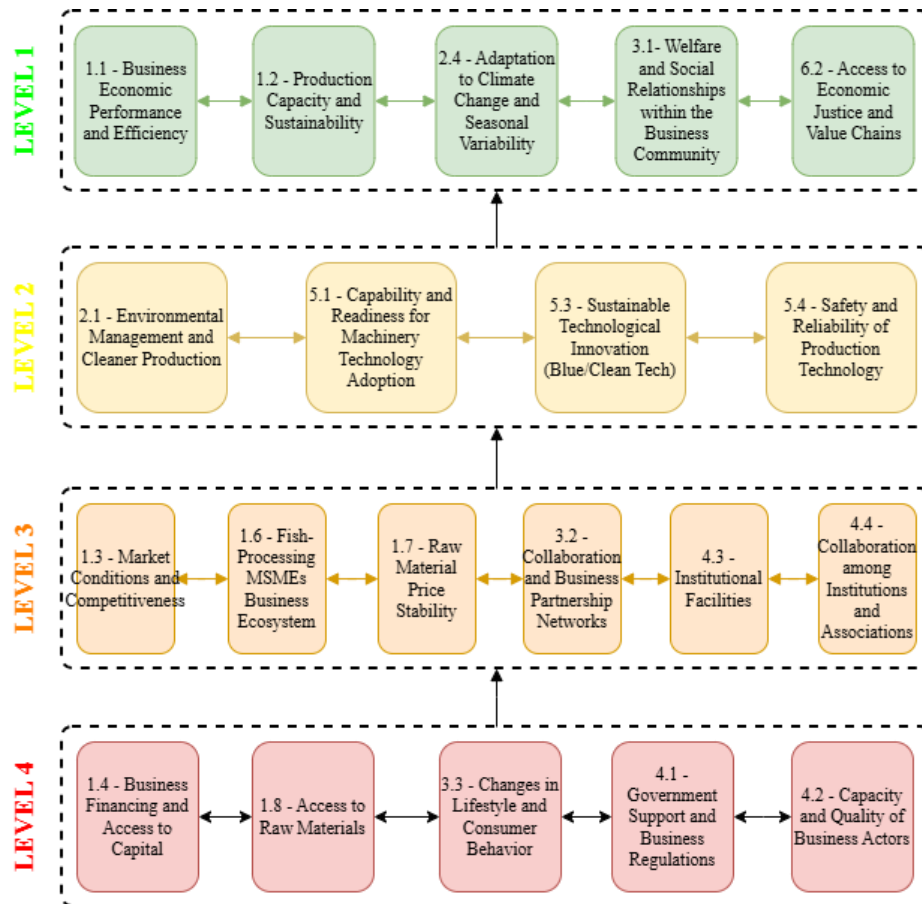


Figure 2. Final ISM Diagram

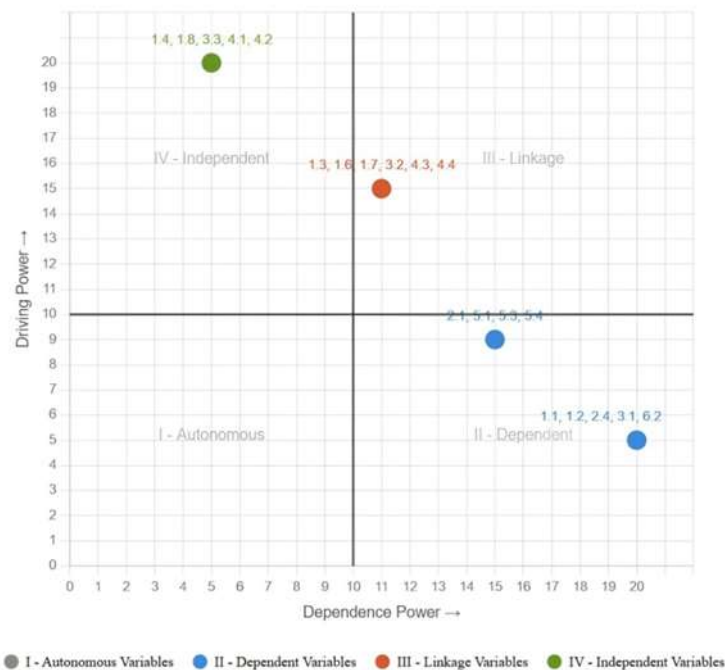


Figure 3. Prospective Analysis Quadrant

At Level 4, the factor of Business Financing and Acces to Capital (1.4) plays a crucial role in the development of fish-processing

enterprises in Tegal City. Access to business financing directly influences the Level 3 factor of Market Conditions and Business

Competitiveness (1.3). Businesses with healthy capital conditions are better able to intensify and diversify their products, thereby strengthening their market competitiveness. According to government representatives, fish gel product businesses in Tegal City generally produce a wide variety of products such as empuk-empuk, keong mas, fish nuggets, fish meatballs, fish tofu, fish crackers, fish dimsum, and kaki naga. However, businesses with limited capital tend to produce only three to four types of products, whereas larger-scale businesses are capable of carrying out broader product diversification. This finding is consistent with Hamzah et al. (2026), who studied fish-processing MSMEs in Paciran District, Lamongan Regency, and found that business capital together with product innovation simultaneously influences the competitiveness of fish-processing MSMEs. Nevertheless, there is a difference in findings, as that study concluded that business capital partially had no significant effect on competitiveness, whereas the ISM results of the present study position access to and financing for businesses as a key factor directly driving competitiveness. This indicates that the local context of Tegal City makes access to capital a determining factor. In addition, the factor of Business Economic Performance and Efficiency (1.4) directly influences another factor at the same level, namely Access to Raw Materials (1.8). Adequate access to financing enhances the ability of businesses to secure sufficient raw materials for production. According to MSME representatives, fish-processing enterprises are able to purchase larger quantities of raw materials when they have adequate access to capital. In reality, many businesses lack sufficient capital and do not apply for bank loans because almost all banks in Tegal City require additional collateral, which is considered burdensome for business actors, as stipulated in the Regulation of the Coordinating Ministry for Economic Affairs Number 1 of 2023 concerning Guidelines for the Implementation of People's Business

Credit (KUR), Article 14 paragraph (3), which states that additional collateral is not required for KUR loans up to IDR 100,000,000.00. (Coordinating Minister for Economic Affairs of the Republic of Indonesia, 2023)

The factor of Access to Raw Materials (1.8) also plays a crucial role because it belongs to Level 4 and is simultaneously categorized as an independent factor. This factor directly influences the factor of Raw Material Price Stability (1.7) at Level 3 (linkage), which serves as a driving factor for Levels 1 and 2. According to government representatives, raw material prices tend to remain stable when raw materials are easily available. In the salted fish business sector, the presence of fishing vessels targeting ikan layang, selar, and banyar is highly expected by business actors. In 2026, many fishing vessels were converted into squid-catching vessels due to increased demand from frozen squid export companies, causing salted fish MSMEs to struggle in obtaining raw materials and forcing them to source supplies from Juwana Port in Pati Regency at higher prices. This condition is consistent with the findings of Ernawati et al. (2020) in the fisheries processing industry in South Konawe Regency, which found that although raw materials originate from local resources, their availability is highly fluctuating, and raw material constraints are particularly experienced by fish fermentation, smoking, and drying industries, most of which depend on small-scale traditional fishers. The difference is that, in the context of Tegal City, the shift in fishing fleet functions toward squid commodities due to export market pressure became the main structural and more specific causal factor. The instability of raw material prices subsequently affects the Fish-Processing MSMEs Business Ecosystem (1.6), where price fluctuations hinder production activities and disrupt relationships among business actors, particularly within freezing businesses that postpone raw material purchases when fish

prices increase. As a result, productivity within the value chain declines, and businesses face difficulties in consistently fulfilling demand.

In addition, the business ecosystem directly influences Collaboration and Business Partnership Networks (3.2) and Collaboration among Institutions and Associations (4.4). According to academic and government representatives, business activities within the ecosystem involve various interdependent actors. One example is the Fish Processing and Marketing Group (Kelompok Pengolah dan Pemasar Ikan / Poklahsar), which reflects the fish-processing ecosystem in Tegal. Membership in Poklahsar facilitates communication among fish processors, institutions, and government agencies, while also providing access to licensing facilitation and halal certification that are generally inaccessible to fish processors operating outside the group. This finding is consistent with Tampa & Mattalitti (2025), who concluded that strengthening social networks, access to entrepreneurship training, and institutional support are key factors in the successful development of community-based microenterprises, and they recommended collaboration among government, NGOs, and the private sector to create inclusive and sustainable business ecosystems. However, their study focused on rural communities in general with an emphasis on digitalization and technological literacy, whereas the ISM results of the present study specifically indicate that membership in fisheries institutional ecosystems such as Poklahsar determines access to multi-stakeholder collaboration within the urban fish-processing industry. Thus, participation in the ecosystem makes collaboration among stakeholders easier and more structured.

Collaboration with stakeholders is closely related to the factors of Environmental Management and Cleaner Production (2.1), Capability and Readiness for Technology Adoption (5.1), Sustainable Technological Innovation (Blue/Clean Tech) (5.3), and the Safety and Reliability of Production

Technology (5.4). These four factors are Level 2 factors categorized as dependent. Academics stated that MSMEs often face difficulties in purchasing modern machinery because of high costs and limited understanding of its operation. Therefore, through partnerships with government institutions, universities, or associations, MSMEs can obtain machinery assistance, operational training, and access to information on the latest technologies. This finding is consistent with the results of a community service project involving the Lomek fish-processing MSME in Pambang Baru Village, Bengkalis (Santoso et al., 2025), which showed that the implementation of grinding machines, energy-efficient stoves, and hygienic packaging technology through intensive assistance increased daily production capacity from 5 kg to 10 kg of processed products, with a 143% increase in daily gross income, while 90% of cooperative members successfully operated and maintained the equipment after receiving technical and managerial training. The difference is that the context of that study focused on the transfer of appropriate technology through direct community service programs, whereas the ISM results of the present study position technology adoption as a dependent factor whose improvement strongly depends on the establishment of robust multi-stakeholder collaboration within the business ecosystem. Furthermore, these four factors influence Level 1 factors, namely Business Economic Performance and Efficiency (1.1), Adaptation to Climate Change and Seasonal Variability (2.4), and Production Capacity and Sustainability (1.2). The application of cooling technologies (cold storage) and freezers helps maintain raw material quality during extreme weather conditions, cleaner production supports the efficient use of water, energy, and raw materials, and technological innovation enables product diversification when certain fish species become difficult to obtain due to seasonal changes. Therefore, the factor of Access to

Raw Materials (1.8) indirectly influences all factors across various levels through this chain of influence.

Another crucial factor is Changes in Lifestyle and Consumer Behavior (3.3), which directly affect three Level 3 factors: Market Conditions and Competitiveness (1.3), Fish-Processing MSMEs Business Ecosystem (1.6), and Raw Material Price Stability (1.7). According to MSME representatives, fish consumption declines prior to Eid al-Fitr due to shifts in public consumption toward beef, demonstrating that consumers play a role in changing market conditions. Conversely, fish gel-processing MSMEs experience increased demand during GEMARI (Gerakan Memasyarakatkan Makan Ikan / Fish Consumption Promotion Movement) activities, which contributes to rising demand and month-to-month inflation of 0.67% in the food, beverage, and tobacco group (BPS, 2025a). This finding is consistent with Sinaga & Kusumanti (2021), who analyzed changes in consumer behavior toward processed fish products during the COVID-19 pandemic using SWOT analysis and found that consumer preferences for processed fish products fell within Quadrant I, indicating the need for aggressive marketing strategies in response to demand dynamics. However, whereas their study focused on the external pressures of the pandemic that encouraged a surge in independent processed fish production, the ISM results of the present study indicate that shifts in consumer behavior are more structural in nature, encompassing seasonal changes, government program stimuli, and migration of shopping activities to online marketplaces, all of which simultaneously affect market conditions, the business ecosystem, and price stability. This shift toward online shopping has encouraged business actors to adapt, as evidenced by increasing demand for digital marketing training through the subdistrict-level Musrenbang (development planning deliberation forum). Consequently, the value chain of fish-processing enterprises

has become increasingly complex while simultaneously transforming the structure of the business ecosystem itself.

Furthermore, the factor of Government Support and Business Regulations (4.1) is also categorized as an independent factor that influences all Level 3 factors, including Market Conditions and Competitiveness, the Fish-Processing MSMEs Business Ecosystem, Raw Material Price Stability, Collaboration and Business Partnership Networks, Institutional Facilities, as well as Collaboration among Institutions And Associations. All key informants stated that policies such as product standardization, halal certification, and licensing facilitation determine the competitiveness of fish-processing MSMEs in both local and national markets. The government acts as the architect of the ecosystem through the development of Poklaha, the improvement of infrastructure at Jongor Fish Auction Place (Tempat Pelelangan Ikan / TPI), Fish Processing Industry Centers, and cold storage facilities, while also serving as the holder of policy instruments that influence raw material price stability through catch quota regulations, seafood distribution arrangements, and import policies. This finding is consistent with Harianja et al. (2026), who evaluated government-subsidized business incubation programs for fish-processing and fish-marketing MSMEs in Indonesia using importance-performance analysis (IPA) involving 47 MSMEs. Their study found that the program performed well in aspects such as technical fish-processing training, GMP/SSOP implementation, laboratory testing, packaging design, and promotional material development, but still required significant improvement in market expansion aspects. However, the difference lies in the fact that the study revealed a gap between the importance and performance of licensing and certification facilitation programs, which were actually considered low priorities from the beneficiaries' perspective, whereas the ISM results of the present study position regulatory and

licensing support as an essential component of government roles that directly determine competitiveness and the MSME ecosystem. The government also acts as an active facilitator in the formation of partnership networks through nucleus-plasma partnership programs, industrial clusters, and policies requiring large enterprises to partner with MSMEs.

The final crucial factor is the Capacity and Quality of Business Actors (4.2), which has strong relationships with Market Conditions and Competitiveness (1.3), the Fish-Processing MSMEs Business Ecosystem (1.6), Collaboration and Business Partnership Networks (3.2), and Collaboration among Institutions and Associations (4.4). The capacity of business actors determines the ability of MSMEs to produce competitive products, as demonstrated by the MSME Imoet Foods, which implemented clean production SOPs in order to penetrate modern retail networks in Tegal. This finding is consistent with Uliyah et al. (2026), who studied 60 MSMEs in the Greater Magelang area using PLS 3.0 and found that the quality of human resources has a positive and significant effect on MSME competitiveness, while emphasizing the importance of investment in human resource development so that MSMEs can better position themselves in both local and global markets. The difference is that their study examined MSMEs in general across multiple sectors

within tourism areas, whereas the ISM results of the present study found that the capacity of business actors in the fish-processing sector not only affects competitiveness but also directly shapes the ability to collaborate among stakeholders. This is evidenced by the MSME Ulam Sari, which successfully qualified as a P2MKP (Pusat Pelatihan Mandiri Kelautan dan Perikanan / Independent Marine and Fisheries Training Center) due to the owner’s knowledge capacity and experience. Business actors with stronger managerial, innovation, communication, and adaptive capabilities tend to be more capable of developing business networks and partnerships with institutions, associations, and government agencies. Therefore, the quality of human resources ultimately determines the overall effectiveness of the fish-processing ecosystem in Tegal.

c. Formulation of Development Strategies

The researchers formulated development strategies based on the final ISM diagram and the results of the prospective analysis. The alternative strategies that were developed are presented in Table 4. Subsequently, the researchers conducted a Focus Group Discussion (FGD) to determine the priority scale and implementation time horizon for the proposed strategies.

Table 4. Alternative Strategies for the Development of Fish Processing MSMEs in Tegal City

	Alternative Strategies
1	Facilitation of MSMEs KUR without additional collateral
2	Simplification of licensing for fish processing MSMEs
3	Improvement of Managerial Capacity
4	Strengthening of Fish Processing Groups
5	Raw Material Price Information System
6	Assurance of Access to Fish Raw Materials
7	Development of Fish Processing Centers in Tegal City
8	Acceleration of Food Safety and Certification Improvement
9	Subsidy for SNI-Compliant Processing Machines
10	Branding and Digital Marketing of Fish Products
11	Weather and Seasonal Information Dissemination
12	Assistance in Waste Management and Clean Production
13	Fair Profit-Sharing Scheme
14	Economic and Social Monitoring of the Fish Processing Ecosystem

1. Short-Term Strategies

Short-term strategies are focused on addressing the independent factors at Level 4, which serve as the root driving forces of the system, particularly the factor of Business Financing and Access to Capital (1.4). Collateral requirements represent one of the most fundamental obstacles for MSMEs in accessing formal financing, and these limitations directly hinder the ability of business actors to increase productivity and expand market reach (Lestari, 2025). Facilitating KUR for MSMEs without additional collateral is considered a solution for business actors who perceive current credit services as burdensome, in accordance with the Regulation of the coordinating minister for Economic Affairs of the Republic of Indonesia Number 1 of 2023 concerning Guidelines for the Implementation of KUR, Article 14 paragraph (3), which states:

“Additional collateral as referred to in paragraph (1) letter b shall not apply to KUR loans with a ceiling of up to IDR 100,000,000.00 (one hundred million rupiah).”

In practice, however, banking institutions have not fully enforced this regulation and still impose additional collateral requirements for loan ceilings below IDR 100,000,000.00. In fact, specific sanctions exist for banks that require collateral for KUR loans below this threshold. Article 14 paragraph (5) stipulates that KUR distributors requesting additional collateral for loans up to IDR 100 million will receive disincentives in the form of withheld interest or KUR margin subsidies sourced from the state budget (APBN). The study by Saleh et al. (2025) similarly identified collateral requirements and banking regulations as key barriers limiting MSME access to credit, but recommended regulatory simplification and improved financial literacy as the primary solutions. In contrast, the present study emphasizes regulatory enforcement as a strategy that must be immediately implemented, given

that the KUR regulatory framework already exists. Accordingly, business actors should only be required to pledge the financed business itself as primary collateral, as stated in Article 14 paragraph (2):

“Primary collateral as referred to in paragraph (1) letter a shall consist of the business or object financed by KUR.”

By facilitating KUR schemes in accordance with existing regulations, where additional collateral is not imposed, the capital barriers that have long constrained business development can be addressed more effectively. This strategy involves multiple stakeholders, including Financial Services Authority (OJK), banking institutions, and the government of Tegal.

The Simplification of licensing for fish processing MSMEs is also considered a high-priority strategy because Government Support and Business Regulations (4.1) constitute an independent Level 4 factor with major influence over other factors. In practice, the Business Identification Number (Nomor Induk Berusaha / NIB) system and the National Industrial Information System (Sistem Informasi Industri Nasional / SIINas) have not yet been fully integrated, forcing business actors to repeatedly submit the same documents. As a result, many businesses continue operating informally and face difficulties accessing government assistance and formal financing. This condition is consistent with the findings of Sihombing (2025), which emphasized that fragmented regulations and lengthy bureaucratic processes hinder MSME growth, particularly in terms of business licensing and access to financing. The study also found that approximately 40% of MSMEs experienced difficulties in understanding and accessing relevant government policy information. However, that study did not specifically explain the effects on the MSME ecosystem. In contrast, the present strategy is more specifically directed toward the fish-processing business ecosystem in Tegal and is more implementation-oriented by

recommending the full integration of the NIB and SIINas platforms through a Single Sign-On (SSO) mechanism. Under this system, business actors would only need to register and submit documents once, without waiting for broader legal reforms. With a simpler licensing system, fish-processing MSMEs in Tegal City would have greater opportunities to strengthen business legitimacy and expand access to business development opportunities.

Improvement of Managerial Capacity represents a direct response to the factor of Capacity and Quality of Business Actors (4.2), implemented through training in business management, financial management, production recording, digital marketing, branding, supply chain management, and partnership networking, supported by continuous mentoring to ensure that the acquired knowledge is directly applied in business operations. This is consistent with the findings of Bamfo (2024), which emphasized that managerial weaknesses, including strategic planning, financial management, and market research, constitute major causes of MSME failure, making training and capacity-building programs key interventions for improving business sustainability and competitiveness. The study also explained that MSME failure rates remain high despite managerial training because such training cannot stand alone without being combined with improved access to financing, regulatory simplification, and macroeconomic stability. This further strengthens the relevance of the present strategy for developing fish-processing enterprises in Tegal, where managerial capacity enhancement must be implemented synergistically with other short-term strategies, particularly KUR facilitation and licensing simplification, in order to make fish-processing MSMEs in Tegal City more competitive and sustainable.

Strengthening of Fish Processing Groups / Poklahsar is another important strategy related to the factors of Capacity and Quality of Business Actors (4.2) and the

Fish-Processing MSMEs Business Ecosystem (1.6). Revitalization efforts are focused on groups that have already been established but remain inactive or only function when government assistance is available. This strategy is implemented through the restructuring of organizational visions in accordance with the current conditions of members, along with the formulation of operational and measurable missions, such as increasing active membership, expanding marketing cooperation, and strengthening production capacity. The study by Gunawan et al. (2023) on Poklahsar Kamilah found that the group demonstrated a high level of group dynamics (score 74.4), determined by indicators such as group objectives, organizational structure, coaching, cohesiveness, and effectiveness. These findings confirm that such internal aspects constitute the primary foundation of a well-functioning and active Poklahsar. However, that study only examined Poklahsar Kamilah as an already active and dynamic group without offering strategic recommendations, whereas the present study focuses on stagnant Poklahsar groups and explores ways to address these challenges. This condition highlights that revitalization through measurable vision and mission restructuring is essential for improving group functions and responsibilities, ensuring that Poklahsar no longer depends solely on external assistance stimuli. This strategy requires strong collaboration between the Department of Marine Affairs, Fisheries, Agriculture, and Food (Dinas Kelautan dan Perikanan, Pertanian dan Pangan / DKP3) and Poklahsar groups in Tegal.

The establishment of a raw material price information system is categorized as a supporting short-term priority because its impact will be more optimal after financing foundations and human resource capacities have first been strengthened. Technically, this system is designed as a simple digital platform providing information on fish price developments, raw material availability,

fishing seasons, and major distribution locations through coordination among the Department of Manpower and Industry (Disnakerin), the Department of Investment and One-Stop Integrated Service (DPMPTSP), fishing ports, fish collectors, and fishermen. This is consistent with the findings of Azis et al. (2026), which emphasized that the absence of an integrated information system connecting stakeholders within the supply chain leads to data fragmentation and limited transparency, resulting in inefficiencies from production to distribution. Therefore, digital information systems are necessary to strengthen visibility and support decision-making. The difference is that the study developed a national-scale system for the rice supply chain in West Java (the BERASKU model) involving broad multi-stakeholder coverage, whereas the present strategy is local and sector-specific, focusing on fish price information for fish-processing MSMEs in Tegal, making it easier to implement gradually and contextually according to regional capacity.

2. Medium-Term Strategies

Medium-term strategies are designed to stabilize the linkage factors at Level 3, particularly the Fish-Processing MSMEs Business Ecosystem (1.6), Raw Material Price Stability (1.7), and Market Conditions and Competitiveness (1.3). The Assurance of Access to Fish Raw Materials is considered a high priority because, in 2026, many fishing vessels were converted into squid-catching vessels due to surging export demand, resulting in severely limited supplies of scad (ikan layang), trevally (selar), and Indian mackerel (banyar), as well as significant price increases. This strategy includes three regulatory instruments: regulating the composition of fishing fleets, limiting seafood purchases by large companies to prevent market domination that disadvantages MSMEs, and providing government-owned cold storage facilities as buffer stocks that purchase fish during periods of abundant harvests (low

prices) and sell them at standardized prices during shortages, similar to the mechanism implemented by BULOG in stabilizing rice prices. This is consistent with the findings of Fidaus et al. (2024), who examined the management of a 1,000-ton cold storage facility in Muara Baru built by the Ministry of Marine Affairs and Fisheries (KKP) within the framework of the National Fish Logistics System (Sistem Logistik Ikan Nasional / SLIN). Their study found that the facility had not functioned optimally as a buffer stock due to weaknesses in property rights, governance mechanisms, incentive alignment, and risk management, and therefore recommended establishing a more authoritative management body, adjusting business models to user needs, and developing a Warehouse Management System. The difference is that the previous study evaluated the implementation of an already-operational national-scale cold storage system, whereas the ISM-based strategy in the present study recommends initiating cold storage facilities as a price stabilization instrument at the local level in Tegal, requiring synergy between DKP3 and the Ministry of Marine Affairs and Fisheries. Therefore, lessons learned from the institutional challenges of the Muara Baru cold storage facility provide an important reference for ensuring more effective implementation in Tegal City from the outset.

The Development of Fish Processing Centers in Tegal City is also considered a high-priority strategy because a structured ecosystem, as reflected in the role of Poklahsar, has proven effective in facilitating collaboration among business actors, institutions, and government agencies, while simultaneously strengthening the Fish-Processing MSMEs Business Ecosystem (1.6) and encouraging the formation of Collaboration and Business Partnership Networks (3.2) and Institutional Facilities (4.3) at Level 3. Fish-processing centers in Tegal have not yet demonstrated optimal performance, resulting in the majority of fish processors not receiving

tangible benefits. Therefore, this strategy should begin with identifying operational, infrastructural, and accessibility barriers by directly involving input from Poklaksar groups. This is in line with the findings of Maulana et al. (2021), who examined MSME development through multi-sector collaboration in Malang Regency and concluded that cross-sector collaboration involving the Ministry of Cooperatives and SMEs, the Ministry of Industry, National Development Planning Agency (Bappenas), state-owned enterprises, and financial institutions accelerated MSME development more effectively than fragmented efforts by individual actors. The study also emphasized that strong cooperation between government and MSMEs in the empowerment process is essential to prevent programs from becoming one-sided. However, that study analyzed multi-sector collaboration at the regency level across various business sectors, whereas the present study specifically recommends synergy among technical agencies (DKP3, the Department of Manpower and Industry, the Department of Cooperatives, MSMEs, and Trade, as well as universities) within the context of optimizing fish-processing centers as a fisheries-based production ecosystem in Tegal. Consequently, the collaboration proposed in this study is more sector-focused and concentrated within a single industrial ecosystem.

The Acceleration of Food Safety and Certification Improvement and Subsidy for SNI-Compliant Processing Machines constitutes another high-priority strategy because it is directly related to the ability of MSMEs to penetrate modern markets. The case of Imoet Foods demonstrates that BPOM and Halal certifications essentially encourage business actors to implement clean and well-documented production SOPs. In addition to Halal and BPOM certifications, there is also the Fish Processing Feasibility Certificate (Sertifikat Kelayakan Pengolahan / SKP), which is specifically intended for fish-processing businesses as an indicator of their ability to

implement Good Manufacturing Practices (GMP). The findings of Rangkuti & Chahaya (2025) stated that the implementation of GMP in five smoked-fish home food industries (Industri Rumah Tangga Pangan / IRTP), assessed using 37 BPOM parameters, remained at Level IV, with dominant serious and critical non-conformities related to hygiene, sanitation, record-keeping, and labeling. The study concluded that intensive guidance, improved business actors' understanding, and institutional support are necessary to ensure product quality and safety. However, that study merely described the existing GMP conditions without proposing strategic interventions, whereas the present study explicitly recommends accelerating certification through structured mentoring combined with subsidies for SNI-standard machinery as instruments for increasing production quantity. Consequently, both quality aspects (certification) and production capacity (machinery) are addressed simultaneously through the synergy between the factors of Environmental Management and Cleaner Production (2.1) and the Capability and Readiness for Machinery Technology Adoption (5.1).

Branding and Digital Marketing of Fish Products, along with Weather and Seasonal Information Dissemination, are categorized as lower-priority medium-term strategies because they are more adaptive in nature. These strategies support the factors of Market Conditions and Competitiveness (1.3) and Raw Material Price Stability (1.7), whose impacts become significant only after production capacity and the business ecosystem have become more stable. Fish-processing MSME products in Tegal, such as fish cakes (otak-otak), boiled fish (pindang), salted fish, and pressure-cooked fish products (presto), have generally been marketed without strong branding identities, limiting their market reach primarily to local and regional scales and preventing penetration into national markets. Harahap & Harahap (2024), in their study on fish-

cracker MSMEs, found that low awareness of branding and digital marketing resulted in limited visibility and market reach. After participating in branding and digital marketing training, MSMEs were able to establish a stronger online presence and promote their products to broader audiences, thereby contributing to business growth and sustainability. However, that study directly intervened through training without considering production capacity readiness as a prerequisite, whereas the present study positions digital marketing as a secondary priority that becomes effective only after the stability of the business ecosystem has first been established.

Weather and fishing season socialization is included as a medium-term priority because the raw material supply of fish-processing MSMEs in Tegal is highly dependent on stock availability at fishing ports. Understanding seasonal patterns helps business actors plan inventories, arrange production schedules, and adjust product strategies, such as increasing the production of dried or preserved fish products during periods of abundant supply to minimize waste. This is consistent with the findings of Sudiansyah et al. (2026) on dried-fish MSMEs in Bengkulu, which emphasized that adaptation strategies play a key role in improving MSME performance, particularly through production efficiency, product innovation, and marketing adjustments. However, the study also highlighted an important distinction: business scale and competitive advantage were proven to have positive and significant effects on MSME performance, both directly and indirectly through adaptation strategies. This indicates that seasonal socialization alone is insufficient unless accompanied simultaneously by strengthening business capacity and product competitiveness.

3. Long-Term Strategies

Long-term strategies target the dependent factors at Levels 1 and 2, which represent

the final outcomes of the overall system, namely Business Economic Performance and Efficiency (1.1), Production Capacity and Sustainability (1.2), and Adaptation to Climate Change and Seasonal Variability (2.4). Assistance in Waste Management and Clean Production are directly related to the factor of environmental management and cleaner production (2.1) at Level 2, where implementation requires a long-term process involving behavioral change, continuous training, and partnerships with universities and research institutions. This strategy is consistent with the findings of Frisilla et al. (2024), who analyzed the implementation of cleaner production in small-scale household fish-based pempek industries in Pontianak and found that cleaner production approaches applied comprehensively throughout the production cycle, ranging from solid waste minimization to wastewater treatment, have the potential to improve profitability and business efficiency while simultaneously maintaining environmental sustainability.

A Fair Profit-Sharing Scheme within the value chain is another strategy that responds to the factor of access to Access to Economic Justice and Value Chains (6.2) at Level 1. Inequitable value distribution within supply chains often becomes a structural barrier that weakens MSME motivation and sustainability; however, addressing this issue requires comprehensive ecosystem transformation, making it more appropriate as a long-term strategy. This is consistent with the findings of Marisa et al. (2021), who revealed that value added in fish processing is distributed unevenly among actors within the value chain, where fish farmers with direct access to processing industries achieve stronger financial positions compared to those selling through intermediary traders. The study further found that collecting traders obtained the highest profits within the value chain, amounting to IDR 25,507,513 per ton.

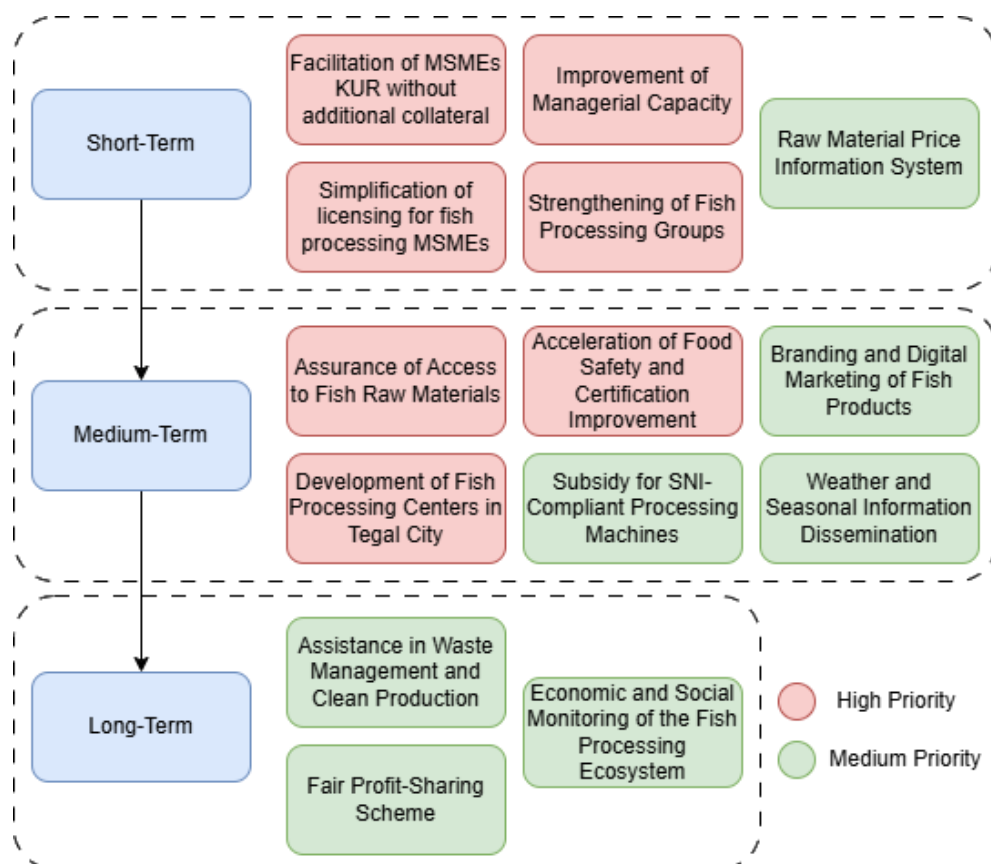


Figure 4. Alternative Strategies for the Development of Fish Processing MSMEs in Tegal City Based on Priority Scale and Time Horizon

CONCLUSION

This study successfully identified 20 relevant factors influencing the development of fish-processing MSMEs in Tegal City through a two-round Delphi method, spanning six sustainability dimensions: economic, environmental, social, institutional, technological, and inclusivity. The consensus-building process demonstrated that factors directly related to operational realities such as business financing, access to raw materials, raw material price stability, government support, and the capacity of business actors were more consistently recognized across stakeholder groups compared to factors perceived as secondary or abstract, such as cultural preservation, labor gender inclusion, and digital marketing accessibility.

The ISM and prospective analyses revealed a four-level hierarchical structure in which Business Financing and Access to Capital (1.4), Access to Raw Materials (1.8),

Government Support and Business Regulations (4.1), Changes in Lifestyle and Consumer Behavior (3.3), and the Capacity and Quality of Business Actors (4.2) occupy Level 4 as independent variables — serving as the foundational drivers of the entire system. Level 3 linkage variables, including Raw Material Price Stability (1.7), Market Conditions and Competitiveness (1.3), and the Fish-Processing MSMEs Business Ecosystem (1.6), function as the system's transmission mechanisms that amplify or dampen the influence of root factors. Levels 1 and 2 represent dependent outcome variables, including Business Economic Performance and Efficiency, Production Capacity and Sustainability, and Adaptation to Climate Change, which are ultimately shaped by upstream factors.

Based on the ISM hierarchical model and the prospective analysis quadrant, 14 alternative development strategies were formulated and subsequently validated through a Focus Group Discussion

involving 12 multi-stakeholder experts. These strategies were organized into three time horizons. In the short term, priority is given to facilitating KUR access without additional collateral, simplifying business licensing, improving managerial capacity, strengthening Poklhasar groups, and establishing a raw material price information system. In the medium term, efforts focus on securing raw material access, developing fish-processing centers, accelerating food safety certification, providing subsidies for SNI-standard machinery, and promoting branding and digital marketing. In the long term, strategies address waste management assistance, clean production practices, a fair profit-sharing scheme within the value chain, and ecosystem monitoring. These findings contribute to the broader achievement of SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure) by providing a structured, evidence-based, and multidimensionally sustainable framework for MSME development. The combined Delphi–ISM–Prospective Analysis approach demonstrates its effectiveness in uncovering systemic relationships among complex development factors, offering a replicable methodology for similar fisheries-based MSME studies in other regions. Future research is recommended to conduct empirical validation of the relationships among variables structured in the ISM model using quantitative approaches, such as multiple linear regression or Partial Least Squares Structural Equation Modeling (PLS-SEM), in order to test the statistical significance, strength, and direction of relationships among factors, as well as to strengthen the findings of the resulting structural model.

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