



Sustainable Strategy Development for Agro-Industrial SMIs Based on Process Performance Analysis: Integration of Value Stream Mapping, Eisenhower Matrix, and Interpretive Structural Modeling

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Abstract: This study aims to develop strategic recommendations for sustainable agro-industrial Small and Medium Industries (SMIs) in North Jakarta based on process performance analysis by integrating Value Stream Mapping (VSM), Eisenhower Matrix, and Interpretive Structural Modeling (ISM). A mixed-methods approach was employed, including field observations, in-depth interviews, literature review, and expert judgment to capture the actual conditions of agro-industrial SMIs comprehensively. Value Stream Mapping (VSM) analysis identifies the presence of non-value-added activities that contribute to production inefficiencies, indicating that the development of agro-industrial SMIs in North Jakarta remains at a basic level and highlighting the need to enhance the participation of SMI actors in development programs. The Eisenhower Matrix further classifies development factors into four strategic quadrants and generates seven alternative development strategies based on urgency and importance. Furthermore, ISM analysis reveals that strengthening the capacity of SMI facilitators is the key driving strategy that supports business feasibility and production standardization, digital and institutional ecosystem strengthening, and human resource development. These strategies subsequently enable technology integration and integrated environmental management of production, ultimately leading to the development of superior products based on innovation and market collaboration as the long-term strategic objective for sustainable SMI development in North Jakarta.

Keywords: Development strategies; Interpretive structural modeling; Small and medium industries; Strategic decision-making

Introduction

Small and Medium Industries (SMIs) play a dominant role in the national industrial structure, with more than 4.4 million business units accounting for approximately 99% of the total industries in Indonesia. In addition to their quantitative significance, SMIs contribute substantially to employment absorption by engaging around 10.5 million workers or 65% of the total industrial workforce. These figures indicate that SMIs are not only drivers of economic growth but also play a

strategic role in strengthening social resilience and regional development, including in the agricultural and agro-industrial sectors (Wahyudi et al., 2024). Furthermore, SMIs function as an economic safety net for low-income communities through productive activities (Asgar & Sofyan, 2023) and contribute significantly to Gross Domestic Product (GDP), thereby becoming an important pillar in inclusive and sustainable economic development (Afrini et al., 2024).

In the agro-industrial sector, SMIs play a strategic role in increasing the added value of agricultural

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commodities. Agro-industrial activities transform agricultural raw materials with low economic value into processed products with higher competitiveness and broader market opportunities. In addition, agro-industrial SMIs support the integration of upstream and downstream supply chains by connecting raw material suppliers, producers, distributors, and consumers. These industries also tend to be more flexible in adapting production processes and environmental management practices compared to large-scale industries (Sulistyowati et al., 2018). Recent studies further emphasize that sustainable agro-industrial development requires the integration of economic, social, and environmental dimensions to strengthen industrial competitiveness and resilience (Rahman et al., 2024; Parmawati et al., 2025).

Despite their important role, agro-industrial SMIs face various operational and managerial challenges. Agricultural raw materials are generally perishable, seasonal, and highly dependent on climate conditions, resulting in unstable supply and inconsistent quality (Silfia et al., 2021). In addition, SMI actors often encounter limitations in access to financing, low technological capability, weak innovation capacity, and limited digital adoption (Aeni et al., 2024). However, beyond these conventional constraints, many agro-industrial SMIs also experience inefficiencies in their production processes. Non-value-added activities such as waiting time, unnecessary transportation, excess inventory, inefficient workflow arrangements, and repeated manual handling frequently increase production costs and reduce productivity. These inefficiencies indicate that process performance remains a critical issue in agro-industrial SMI development and requires systematic evaluation to support sustainable industrial improvement and food safety (Roza et al., 2025).

The issue of process inefficiency is particularly relevant in North Jakarta, where agro-industrial SMIs continue to experience substantial business difficulties. Based on data from (BPS-Statistics DKI Jakarta Province, 2023), approximately 70.02% of SMIs in DKI Jakarta face operational constraints, with North Jakarta recording the highest proportion of problematic SMIs at 23.79%. The food industry sector, as part of agro-industry, represents one of the most affected sectors. The major challenges include limited capital, inconsistent raw material supply, restricted market access, and inefficient production management. Although development programs initiated by the SUDIN PPKUM have been implemented as policy interventions (Bay et al., 2025), field observations indicate that these programs have not been optimally prioritized and frequently overlap in implementation. Furthermore, most interventions focus primarily on economic and social dimensions, while

process efficiency improvement and environmental sustainability aspects remain insufficiently addressed (Diantoro et al., 2024). This condition creates a gap between sustainable development principles and their practical implementation in agro-industrial SMI development (Alhammadi & Alayed, 2022).

Considering the complexity of these problems and the limited institutional resources available for SMI assistance, an integrated strategic approach is required to determine improvement priorities and identify the most influential development factors. Value Stream Mapping (VSM) is considered relevant in this study because it enables the identification of waste and non-value-added activities within production processes, thereby supporting process efficiency improvement (Paramitha et al., 2025). Meanwhile, the Eisenhower Matrix is useful for classifying development priorities based on urgency and importance, allowing policymakers and stakeholders to allocate limited resources more effectively (Ap et al., 2021). Furthermore, Interpretive Structural Modeling (ISM) facilitates the identification of hierarchical relationships among development strategies and key driving factors, thereby reducing the risk of overlapping policy interventions and improving strategic coordination (L. Sari & Dewi, 2025).

Several previous studies on sustainable SMI development have integrated methods such as SWOT (R. Sari et al., 2023; Yanarita et al., 2025), Best Worst Method (BWM), entropy, and D-Numbers to support decision-making under uncertainty (Mendes et al., 2022; Cholil et al., 2024; Fatma et al., 2024). However, most existing studies remain limited to evaluating and prioritizing criteria without systematically analyzing production process inefficiencies or developing hierarchical relationships among strategic interventions. Therefore, the novelty of this study lies in the integration of Value Stream Mapping (VSM), the Eisenhower Matrix, and Interpretive Structural Modeling (ISM) to develop a sustainable agro-industrial SMI development strategy based on process performance analysis. This integrated approach provides a more systematic, applicable, and sustainability-oriented framework for improving agro-industrial SMI performance in North Jakarta.

Method

This study adopts an integrated methodological framework to formulate development strategies for agro-industrial SMIs through three main analytical approaches: Value Stream Mapping (VSM) for business process performance measurement, the Eisenhower Matrix for initial strategic classification, and Interpretive

Structural Modeling (ISM) for determining hierarchical relationships and priority strategies.

The respondents involved in this study consisted of 11 SMI owners from the otak-otak production center in Muara Angke, North Jakarta, 5 representatives from SUDIN PPKUKM, and 3 academic experts (Mendes et al., 2022). However, the Value Stream Mapping (VSM) analysis was conducted using a case study approach on one representative SMI selected based on the similarity of production characteristics, production capacity, and operational processes among the observed SMIs. Data from the remaining respondents were used to support validation, identify operational problems, and formulate strategic development factors.

Business Performance Measurement using Value Stream Mapping (VSM)

Business performance measurement is conducted using Value Stream Mapping (VSM), a lean-based analytical tool that enables the identification and visualization of material and information flows throughout the production process. VSM is employed to map each stage of the production system, starting from raw material procurement to finished product delivery, in order to evaluate process efficiency comprehensively. Through VSM, all activities are categorized into value-added (VA) and non-value-added (NVA) activities. This classification allows for the identification of inefficiencies such as waiting time, excessive inventory, unnecessary transportation, and process delays. Key performance indicators analyzed include cycle time, lead time, takt time, and value-added ratio (VAR). The results of VSM analysis provide empirical evidence of process bottlenecks and operational inefficiencies, which serve as the basis for identifying critical improvement areas and formulating strategic elements (Muñoz-villamizar et al., 2018).

Development of Strategic Alternatives using the Eisenhower Matrix

The identified strategic elements derived from VSM analysis and field findings are then structured into alternative development strategies using the Eisenhower Matrix. This matrix consists of four quadrants categorized based on two key dimensions: importance and urgency. The classification of each strategic element into the respective quadrant is determined through expert judgment, involving practitioners, policymakers, and academic experts (Rafke & Lestari, 2017). The four quadrants are defined as follows: Quadrant I (Important and Urgent): Strategies requiring immediate implementation; Quadrant II (Important but Not Urgent): Strategic priorities for long-term development; Quadrant III (Not

Important but Urgent): Supporting actions requiring short-term attention; Quadrant IV (Not Important and Not Urgent): Low-priority strategies.

This classification serves as an initial filtering and mapping mechanism to identify the most relevant and impactful strategic alternatives. The output of this stage is a set of structured strategies categorized based on their urgency and importance levels, which are then further analyzed using ISM.

Strategy Prioritization using Interpretive Structural Modeling (ISM)

To determine the interrelationships and hierarchical structure among the identified strategies, this study employs Interpretive Structural Modeling (ISM), a well-established methodology for analyzing complex systems and structuring relationships among elements (Sorooshian et al., 2023). The ISM process begins with the identification of relevant strategic variables, which are then evaluated pairwise using contextual relationships represented by four symbols:

Table 1. Interpretation of Symbols in the Variable Relationship Matrix

Symbol	Meaning
V	Variable i influences variable j
A	Variable j influences variable i
X	Variables i and j influence each other
O	No direct relationship between variables

These relationships are compiled into a Structural Self-Interaction Matrix (SSIM) based on expert input. The SSIM is subsequently converted into a Reachability Matrix (RM) by replacing symbolic relationships with binary values (0 and 1) (Timperio et al., 2020) and incorporating the principle of transitivity, which assumes that if variable i influences j, and j influences k, then i indirectly influences k. From the finalized RM, two key metrics are calculated for each element: Driver Power (DP): the total number of elements influenced by a variable; Dependence (D): the total number of elements influencing a variable.

Based on these values, the elements are classified into four sectors: Independent (high DP, low D), linkage (high DP, high D), autonomous (low DP, low D), dependent (low DP, high D). This classification is further visualized using MICMAC analysis, enabling the identification of key driving variables and dependent outcomes. Finally, a hierarchical structure model is developed to illustrate the levels of influence among strategies, allowing the identification of key driving strategies and long-term strategic objectives. This structured approach ensures that the resulting strategies are not only prioritized but also systemically interconnected, thereby enhancing their effectiveness in

supporting sustainable agro-industrial SMI development (Gurbaxani et al., 2025). Methodological framework showed in Figure 1.

Result and Discussion

Process Performance Analysis Using Value Stream Mapping (VSM)

The results of business performance analysis using Value Stream Mapping (VSM) reveal that the production flow of *otak-otak* consists of six main stages: grinding → mixing → storage (supermarket) → packaging → baking → finished product. The system operates with a production output of approximately 150 pieces per day, with a total cycle time of 214.48 seconds and an overall lead time of approximately 3 days. Shown in Figure 2.

The analysis reveals that the main inefficiency lies in non-value-added (NVA) activities, particularly at the supermarket (storage) stage, where semi-finished products are stored for approximately 3 days. This indicates excessive inventory and waiting time caused by a mismatch between upstream production and downstream demand. From a lean perspective, this reflects inventory and overproduction waste, suggesting that the system still operates under a push-based production approach (Lesmana, 2020).

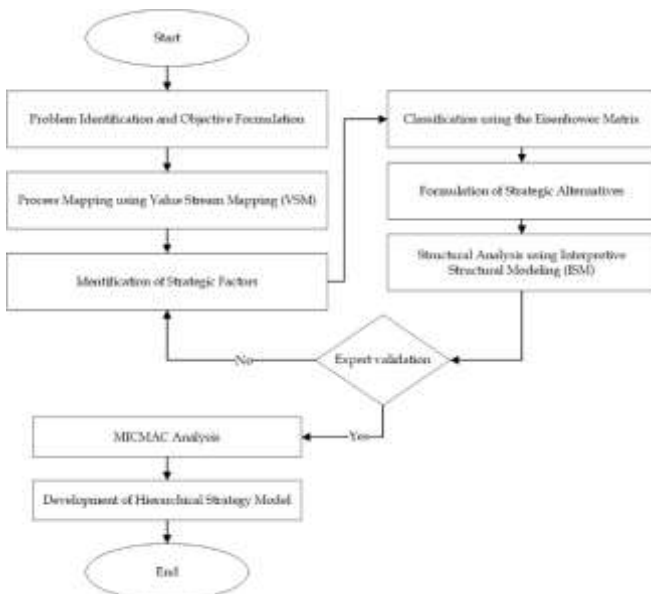


Figure 1. Methodological framework

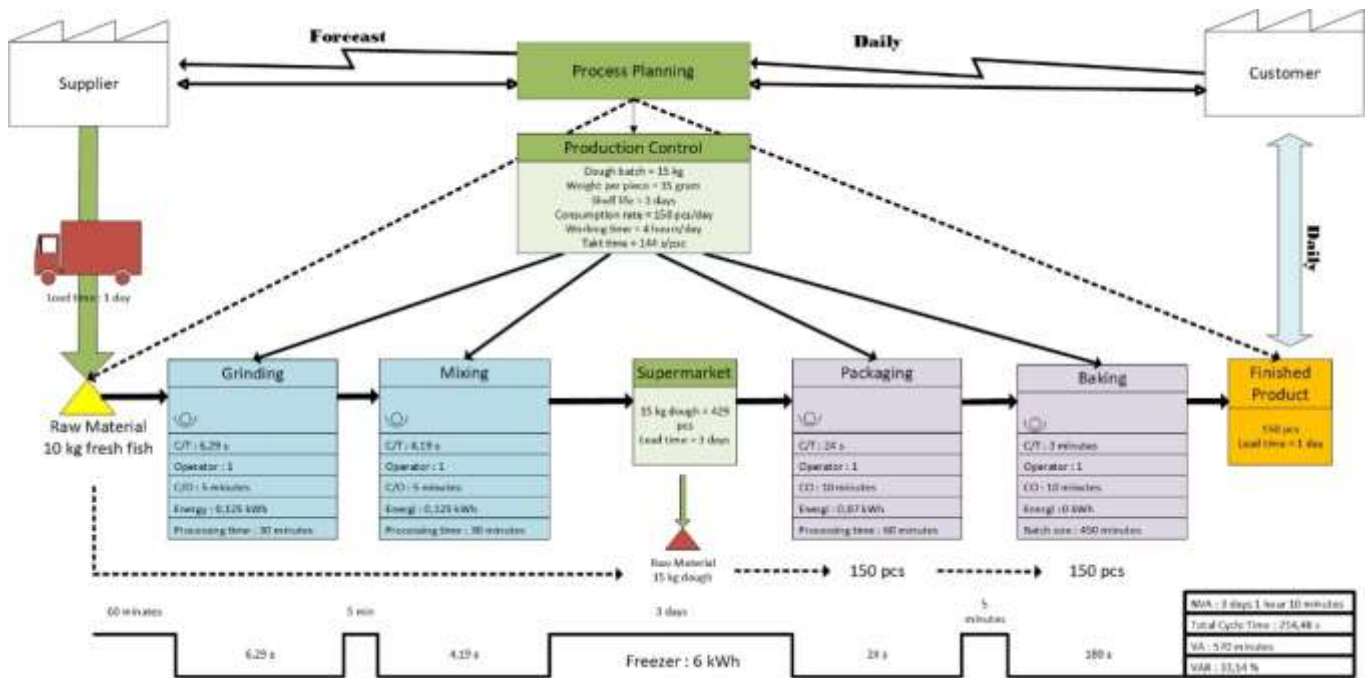


Figure 2. Value stream mapping of the production process

In addition, the highest energy consumption (± 6 kWh) is observed in the cooling/freezing process, indicating inefficiencies in both operational flow and resource utilization. These findings highlight that the main issues are related to poor inventory control, lack of process synchronization, and inefficient energy usage (Schmidt et al., 2018).

From a managerial perspective, these findings emphasize the need for improvements in inventory

management and production planning. First, the implementation of a pull-based inventory system (e.g., Kanban) is essential to control work-in-progress (WIP) and prevent overstocking at the supermarket stage. Second, production planning should be aligned with actual demand and takt time, enabling better coordination between processing stages and reducing waiting time. Third, reducing batch sizes and adopting more flexible scheduling can improve process flow and

minimize accumulation of semi-finished products (Purnomo & Purwandari, 2025).

Furthermore, integrating simple production planning tools, such as daily production scheduling and capacity balancing, can help ensure a smoother flow of materials across the system. By strengthening these managerial aspects, the enterprise can significantly reduce NVA activities, improve operational efficiency,

and enhance overall production responsiveness (Kurnia et al., 2023).

Eisenhower Matrix Results

The mapping results of the Eisenhower Matrix indicate that development factors are distributed across four quadrants with distinct priority characteristics, reflecting different levels of urgency and importance in the context of agro-industrial SMI development. Shown in Table 2.

Table 2. Eisenhower Matrix for Strategic Priority Assessment in SMI Development

Matrix Eisenhower	
Quadrant 2 (Important & Not Urgent) <ul style="list-style-type: none"> • Market access • Implementation of digital-based promotion and marketing systems • Collaboration with local government and SMI actors • Business innovation and product diversification • Business stability and legality • Implementation of GMP (Good Manufacturing Practices) and Halal standards • Proactive awareness of SMI actors 	Quadrant 1 (Important & Urgent) <ul style="list-style-type: none"> • Access to capital • Hygiene of production equipment • Suitability of product taste with consumer preferences
Quadrant 4 (Not Important & Not Urgent)	Quadrant 3 (Not Important & Urgent) <ul style="list-style-type: none"> • Product competitiveness • Implementation of 3R principles (Reduce, Reuse, Recycle) <ul style="list-style-type: none"> • Availability of waste treatment facilities <ul style="list-style-type: none"> • Wastewater disposal facilities • Provision of hygiene and sanitation equipment <ul style="list-style-type: none"> • Product innovation • Integration of technology in production processes <ul style="list-style-type: none"> • Business independence • Effectiveness of product distribution

Factors classified in Quadrant 1 (Important and Urgent)—such as access to capital, hygiene of production equipment, and product taste suitability—represent critical issues that require immediate managerial attention. These elements are directly linked to operational continuity and product acceptance in the market, thus forming the foundation for short-term corrective actions (Kemalasar, 2025).

Meanwhile, Quadrant 2 (Important but Not Urgent) contains strategic factors such as market access, digital marketing implementation, collaboration (Almauiza et al., 2024), innovation, business legality, and GMP and halal compliance. These factors are considered key drivers for long-term development, as they support business sustainability, competitiveness, and institutional strengthening. Therefore, this quadrant serves as the primary focus for strategic planning and resource allocation (Wahyudi et al., 2024; Ismail et al., 2025; Ririh et al., 2025). In contrast, factors in Quadrant 3 (Not Important but Urgent), including environmental management practices and technology integration, indicate supporting activities that require attention but

are not yet prioritized. These elements can be addressed gradually or integrated into broader development programs (Kannan & Gambetta, 2025).

Finally, Quadrant 4 (Not Important and Not Urgent) represents factors with relatively low priority, which may be considered for long-term improvement or monitored without immediate intervention. Overall, the Eisenhower Matrix provides a structured basis for filtering and prioritizing strategic elements, enabling the formulation of development strategies that are both responsive to urgent operational needs and aligned with long-term sustainability goals of agro-industrial SMIs.

Alternative Strategies for SMI Development

The results of the Eisenhower Matrix formulation presented in Table 2 serve as the primary basis for developing alternative strategies for SMI development. Based on this classification, seven strategic alternatives are identified, namely: A1 strengthening business feasibility and production quality standardization; A2 enhancing the capacity of SMI facilitators; A3 strengthening the digital and institutional ecosystem; A4

developing superior products based on innovation and collaboration; A5 improving human resource capacity; A6 implementing integrated environmental management of production; and A7 integrating technology within the SMI business ecosystem.

These strategic alternatives reflect a combination of short-term priorities and long-term development needs, as derived from the importance-urgency mapping.

Subsequently, the identified strategies are further analyzed to examine the interrelationships in terms of influence and dependency among elements. This analysis aims to determine the structural role of each strategy within the system. The results of the inter-element relationship assessment, based on driving power and dependence power, are presented in Figure 2.

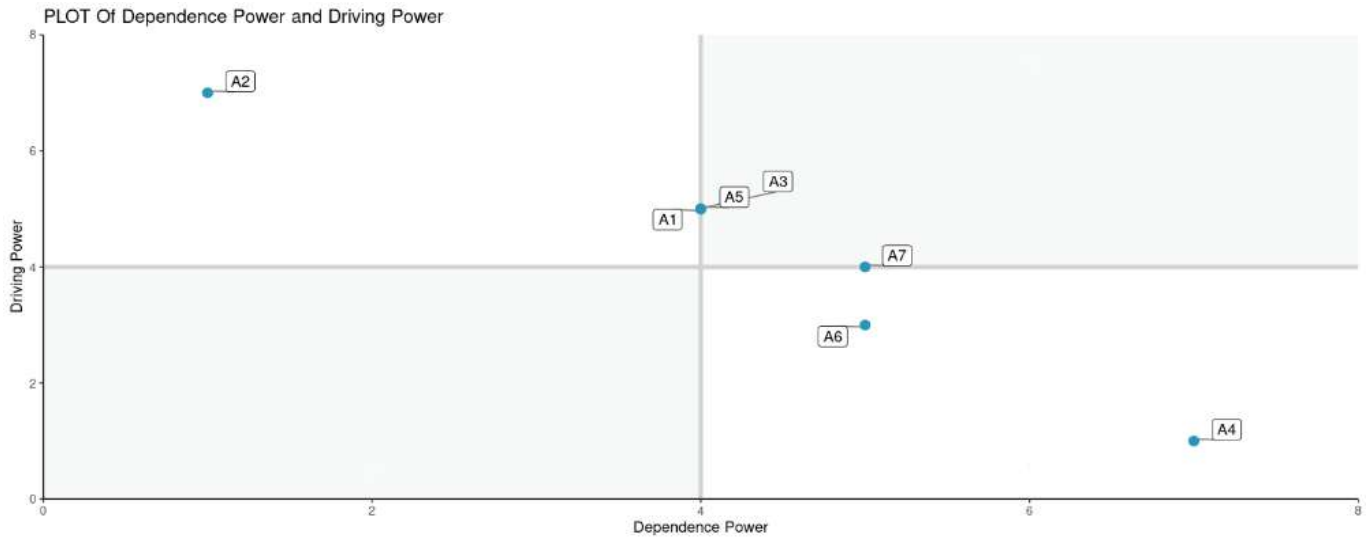


Figure 3. MICMAC Analysis of Alternative strategies for SMI development

Based on the MICMAC analysis, the distribution of strategic elements across the four quadrants reflects the structural role of each strategy in terms of driving power and dependence power, thereby providing a deeper understanding of the interrelationships among development strategies. The quadrant classification in this study follows the standard MICMAC framework proposed by Afif et al. (2025) consisting of Independent variables (Quadrant IV), Linkage variables (Quadrant II), Autonomous variables (Quadrant III), and Dependent variables (Quadrant I).

The results indicate that A2 (enhancing the capacity of SMI facilitators) is positioned in Quadrant IV (Independent Variables), characterized by high driving power and low dependence power. This finding demonstrates that A2 functions as the primary driving strategy within the system because it strongly influences other strategic variables while remaining relatively unaffected by them. In practical terms, strengthening the capacity of facilitators plays a foundational role in improving managerial assistance, production guidance, business mentoring, and coordination among stakeholders. Consequently, A2 becomes the key leverage factor that supports the implementation of other development strategies, including business feasibility improvement, institutional strengthening, and human resource development (Akhtar et al., 2022; Kholisoh et al., 2024). Therefore, A2 should be

prioritized during the early stages of strategy implementation.

Furthermore, A1 (strengthening business feasibility and production standardization), A3 (strengthening the digital and institutional ecosystem), and A5 (enhancing human resource capacity) are positioned in Quadrant II (Linkage Variables), indicating high driving power and high dependence power. Variables in this quadrant are considered highly strategic because they simultaneously influence and depend on other variables within the system. This condition implies that any change in these strategies may generate substantial effects throughout the system. However, due to their high dependence level, their implementation effectiveness strongly relies on support from the primary driving variable, namely A2. Thus, these linkage variables require continuous coordination and policy consistency to maintain system stability and sustainable development performance.

Meanwhile, A7 (technology integration) is located near the boundary between Quadrant II (Linkage) and Quadrant I (Dependent), indicating moderate driving power and relatively high dependence power. This position suggests that technology integration functions as an enabling strategy that connects organizational strengthening with operational improvement. The implementation of technology integration depends on the readiness of human resources, institutional systems, and facilitator support. At the same time, successful

technology adoption contributes to improving production efficiency, product quality consistency, and market competitiveness.

In contrast, A6 (integrated environmental management) and A4 (development of superior products based on innovation and market collaboration) are categorized in Quadrant I (Dependent Variables), characterized by low driving power and high dependence power. These variables represent strategic outcomes whose achievement largely depends on the successful implementation of other supporting strategies. In particular, A4 reflects the long-term objective of sustainable agro-industrial SMI development. The achievement of superior and competitive products can only occur after upstream supporting factors, such as facilitator capacity, institutional strengthening, human resource development, and technology integration, have been effectively implemented. Similarly, A6 depends on organizational readiness, technological capability, and stakeholder commitment to support sustainable production practices and environmental management systems (Abidin et al., 2024).

No variables are positioned in Quadrant III (Autonomous Variables), indicating that all identified strategic elements are interconnected and relevant within the system. This finding suggests that every strategy contributes either directly or indirectly to sustainable agro-industrial SMI development in North Jakarta.

Overall, the MICMAC analysis demonstrates that A2 acts as the core driving variable, followed by A1, A3, and A5 as critical linkage strategies. Meanwhile, A7 serves as an enabling strategy, whereas A6 and A4 function as dependent outcome variables. These findings indicate that strategic implementation should begin with strengthening the primary driving factors before progressing toward dependent outcomes. The result of a hierarchical model strategies showed in Figure 4.

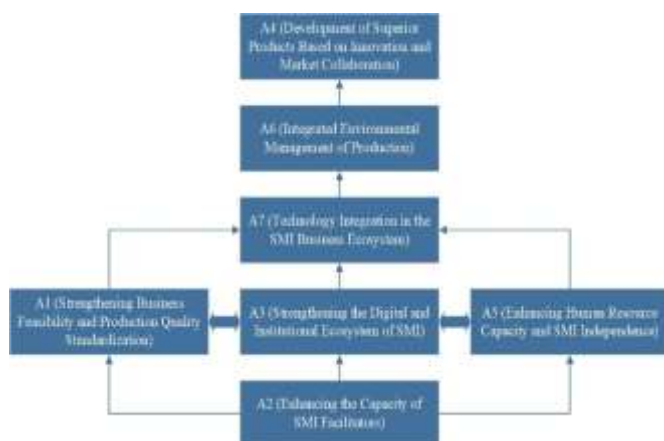


Figure 4. Hierarchical model strategies for SMI development

The hierarchical structure derived from the ISM analysis reveals a systematic and sequential relationship among the identified strategies, highlighting the flow of influence from foundational drivers to ultimate development outcomes. At the base level, A2 (enhancing the capacity of SMI facilitators) emerges as the key driving factor in the system. This indicates that the role of facilitators is fundamental in accelerating SMI development, as they act as intermediaries in transferring knowledge, technology, and policy support to business actors (Kholisoh et al., 2024). Strengthening A2 provides the necessary foundation for improving the overall readiness and capability of SMIs to adopt more advanced practices.

At the intermediate level, A1 (strengthening business feasibility and production quality standardization) (Sunarta et al., 2025), A3 (strengthening the digital and institutional ecosystem) (Adrian & Sarjana, 2023), and A5 (enhancing human resource capacity and SMI independence) (Popiela, 2025) are positioned as core supporting strategies. These elements function as critical pillars that translate facilitator capacity into tangible improvements in business performance (Murni, 2024). Specifically, A1 ensures operational feasibility and product quality consistency, A3 strengthens institutional networks and digital integration, and A5 enhances the adaptability and independence of human resources (Jannah et al., 2023). Collectively, these strategies form a strong operational and institutional foundation for further system transformation (Amelia et al., 2021).

These foundational improvements subsequently enable A7 (technology integration in the SMI business ecosystem), which acts as a central transformation mechanism (Yusuf et al., 2024). Technology integration plays a crucial role in bridging traditional practices with modern, efficient, and scalable business systems, thereby enhancing productivity, market access, and process efficiency (Ismanto et al., 2024).

Following this, A6 (integrated environmental management of production) is positioned at a higher level, indicating that sustainable environmental practices are achieved once technological and operational systems are adequately established. This reflects the notion that environmental sustainability in agro-industry is not a standalone effort but rather the result of well-integrated technological and managerial improvements (Elba Ridha et al., 2020).

At the top of the hierarchy, A4 (development of superior products based on innovation and market collaboration) represents the ultimate strategic objective. This indicates that the creation of competitive, innovative, and market-oriented products is the final outcome of a well-structured and integrated development process. The success of this strategy

depends on the effective implementation of all preceding elements, including capacity building, institutional strengthening, technological integration, and environmental management (Judijanto et al., 2023).

Overall, the ISM hierarchy demonstrates that sustainable SMI development requires a bottom-up approach, starting from strengthening facilitator capacity, followed by reinforcing operational and institutional capabilities, enabling technology adoption, and integrating environmental considerations, ultimately leading to the development of high-value, competitive products. This structured pathway ensures that strategy implementation is not only systematic but also aligned with long-term sustainability goals.

Conclusion

This study proposes an integrated framework for sustainable agro-industrial SMI development in North Jakarta by integrating Value Stream Mapping (VSM), the Eisenhower Matrix, and Interpretive Structural Modeling (ISM), including MICMAC analysis. The VSM results indicate the presence of significant inefficiencies caused by non-value-added activities, particularly excessive inventory and waiting time within the supermarket stage, highlighting the importance of improving inventory control and production planning systems. The Eisenhower Matrix classifies development factors based on urgency and importance, resulting in seven alternative development strategies. Furthermore, MICMAC analysis demonstrates that A2 (enhancing the capacity of SMI facilitators) functions as the primary driving factor within the system, while other strategies act as linkage and dependent variables. Strengthening facilitator capacity acts as the primary catalyst to address internal operational inefficiencies identified in the VSM analysis, particularly those related to production coordination, managerial capability, and operational assistance. The ISM hierarchy further confirms that facilitator capacity serves as the foundational strategy supporting improvements in business feasibility, institutional strengthening, human resource development, technology integration, and integrated environmental management. The proposed model suggests that the development of innovative and competitive products represents a high-level outcome that can be achieved through the structured and sequential implementation of interconnected development strategies. Therefore, sustainable agro-industrial SMI development requires an integrated approach that simultaneously addresses operational efficiency, institutional capacity, and sustainability-oriented business development. This study is limited to agro-industrial SMIs in North Jakarta and focuses primarily on strategic modeling based on expert

judgment. Future research is recommended to validate the proposed framework quantitatively, expand the study area to different agro-industrial sectors, and integrate sustainability performance indicators to evaluate the long-term effectiveness of the proposed strategies.

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Author Contributions

Conceptualization, D.N.; methodology, D.N.; software, D.N.; validation, D.N., A.I., and N.S.I.; formal analysis, D.N.; investigation, D.N.; resources, D.N.; data curation, D.N.; writing—original draft preparation, D.N.; writing—review and editing, D.N., A.I., and N.S.I.; visualization, D.N.; supervision, A.I. and N.S.I.; project administration, D.N.; funding acquisition, D.N. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

There is no conflict of interest in this research.

References

- Abidin, Z., Parananta, A. W., & Rini, H. P. (2024). Strategy of Sustainable Entrepreneurship Development as an Effort to Create a Tourism-Based Economy in Coastal Communities on Kera Nepa Beach, Sampang Regency. *Jurnal Penelitian Pendidikan IPA*, 10, 521–533. <https://doi.org/10.29303/jppipa.v10iSpecialIssue.8561>
- Adrian, A., & Sarjana, S. H. (2023). Peran Pemerintah dan Industri Jasa Keuangan dalam Mendukung Transformasi Digital UKM. *AKURASI: Jurnal Riset Akuntansi Dan Keuangan*, 5(1), 29–38. <https://doi.org/10.36407/akurasi.v5i1.795>
- Aeni, T. I., Rena, S., & Destiana, R. (2024). The Influence of the Use Financial Technology, Owner Financial Literacy, and Risk Tolerance on the Performance of MSMEs in Indonesia. *International Journal of Business, Law, and Education*, 5(1), 996–1006. <https://doi.org/10.56442/ijble.v5i1.494>
- Afif, E. L., & Ardi, R. (2025). Strategies to Reduce Food Loss and Waste in Emerging Economies: An Interpretive Structural Modelling Approach. *South African Journal of Industrial Engineering*, 36(4), 134–

147. <https://doi.org/10.7166/36-4-3170>
- Afrini, Alam, M. N., Christoporus, Nur, F. I., & Arfanika, I. (2024). Strategi Pengembangan Bisnis Produk Bawang Goreng Di Industri Kecil Menengah (Ikm) Raja Bawang Di Masa Pandemi Covid-19. *Jurnal Ilmiah Mahasiswa Fakultas Pertanian*, 4(1), 425–434. <https://doi.org/10.52045/jimfp.v4i1.711>
- Akhtar, N., Bokhari, S. A., Martin, M. A., Saqib, Z., Khan, M. I., Mahmud, A., Haq, M. Z., & Amir, S. (2022). Uncovering Barriers for Industrial Symbiosis : Assessing Prospects for Eco-Industrialization through Small and Medium-Sized Enterprises in Developing Regions. *Sustainability*, 14(6898), 1–21. <https://doi.org/10.3390/su14116898>
- Alhammadi, A. D., & Alayed, S. I. (2022). Impact of Triple Bottom Line Sustainability on Small Food Catering Business Success. *Journal of Southwest Jiaotong University*, 56(6), 444–452. <https://doi.org/10.35741/issn.0258-2724.57.6.41>
- Almauiza, M. I., Yulhendri, & Fahmi, Z. (2024). The Role of Driving Actors as Social Engineers in Improving the Community's Economy through Social Entrepreneurship in Marine Ecotourism. *Jurnal Penelitian Pendidikan IPA*, 10, 559–565. <https://doi.org/10.29303/jppipa.v10iSpecialIssue.8296>
- Amelia, D., Syukmayettil, L., & Zuripal. (2021). The Effect of Business Knowledge, Business Skill, Self Confidence and Innovation on Business Performance of Small and Medium Industry in the City of Bukittinggi. *IOP Conference Series: Earth and Environmental Science*, 747(1), 1–10. <https://doi.org/10.1088/1755-1315/747/1/012084>
- Ap, D., Sani, A., Yanti, Hindardjo, A., Adrial, Yuliza, M., Khristiana, Y., & T, H. (2021). Application of Eisenhower matrix and analytic hierarchy process for decision support system with the SAW method. *International Journal of Multidisciplinary Research and Growth Evaluation*, 2(3), 147–152. Retrieved from <https://www.allmultidisciplinaryjournal.com/uploads/archives/60AFA1F15488D1622122993.pdf>
- Asgar, H., & Sofyan, A. T. (2023). Application of BUMDES and MSME Technology through Collaborative Model Village Marketplace Design : Rasch Model Analysis of West Sumbawa Community Perceptions. *Jurnal Penelitian Pendidikan IPA*, 9, 211–218. <https://doi.org/10.29303/jppipa.v9iSpecialIssue.6434>
- Bay, E. S., Nasir, M. A., & Yusup, M. (2025). Peran Dinas Perindustrian Terhadap Industri Kecil Menengah di Nusa Tenggara Barat Perspektif Ekonomi Islam. *Mukaddimah: Jurnal Studi Islam*, 10(2), 409–433. Retrieved from <https://ejournal.uin-suka.ac.id/pusat/mukaddimah/article/view/4723/2371>
- BPS-Statistics DKI Jakarta Province. (2023). *Profil Industri Mikro dan Kecil Provinsi DKI Jakarta*.BPS.
- Cholil, S. R., Gernowo, R., & Widodo, C. E. (2024). A Novel BED: BWM-Entropy-D Numbers as Determinants of Sustainable Entrepreneurship in MSMEs. *IEEE Access*, 12(October), 167367–167387. <https://doi.org/10.1109/ACCESS.2024.3491838>
- Diantoro, E., Suheri, & Arianto, B. (2024). Studi fenomenologi konsep bisnis berkelanjutan dalam konteks pegiat UMKM. *Jurnal Manajemen Strategis*, 1(2), 127–144. <https://doi.org/10.30588/jmt.v1i02.2091>
- Elba Ridha, A., Matondang, N., & Haikal Sitepu, M. (2020). Pro-environmental behavior for small medium enterprise: A review. *IOP Conference Series: Materials Science and Engineering*, 801(1), 1–8. <https://doi.org/10.1088/1757-899X/801/1/012069>
- Fatma, F., Iskandarini, I., & Lubis, A. N. (2024). Strategy for Improving the Performance of Culinary SME Actors in Langsa City, Indonesia. *Internasional Journal of Advances in Social Sciences and Humanities*, 2(4), 256–275. <https://doi.org/10.56225/ijassh.v2i4.275>
- Gurbaxani, A., Mondal, S., & Raman, R. (2025). Investigating investment decisions of SMEs in information technology sector : an application of BWM-ISM approach. *Cogent Business & Management*, 13(1), 1–19. <https://doi.org/10.1080/23311975.2025.2598193>
- Ismail, Tarigan, A. A., Soemitra, A., & Nawawi, Z. M. (2025). Strengthening the global competitiveness of halal culinary SMEs in North Sumatra through a Maqasid of Shariah-based approach. *Journal of Islamic Economic Lariba*, 11(1), 383–406. <https://doi.org/10.20885/jielariba.vol11.iss1.art15>
- Ismanto, H., Nahar, A., Pebruary, S., Wibowo, P. A., & Firdaus, M. N. (2024). How do environmental awareness, IT use, and credit access shape the sustainability of Indonesian MSMEs? *Problems and Perspectives in Management*, 22(4), 512–522. [https://doi.org/10.21511/ppm.22\(4\).2024.38](https://doi.org/10.21511/ppm.22(4).2024.38)
- Jannah, A. A., Suryani, D., & Sukesi, T. W. (2023). Determinants of Food Safety Practices among Mothers of Toddlers in Gedongkiwo Village, Mantrijeron, Yogyakarta. *Jurnal Penelitian Pendidikan IPA*, 9, 324–331. <https://doi.org/10.29303/jppipa.v9iSpecialIssue.6161>
- Judijanto, L., Utami, E. Y., Apriliani, D., & Rijal, S. (2023). A Holistic Review of MSME Entrepreneurship in Indonesia: The Role of Innovation, Sustainability,

- and the Impact of Digital Transformation. *International Journal of Business, Law, and Education*, 5(1), 119-132. <https://doi.org/10.56442/ijble.v5i1.355>
- Kannan, S., & Gambetta, N. (2025). Technology-driven Sustainability in Small and Medium-sized Enterprises: A Systematic Literature Review. *Journal of Small Business Strategy*, 35(1), 129-157. <https://doi.org/10.53703/001c.126636>
- Kemalasari, Y. A. (2025). Penguatan Aspek Kebersihan dan Sanitasi dalam Proses Produksi Kelompok Usaha Rumah Tangga. *Qardhul Hasan: Media Pengabdian Kepada Masyarakat*, 11(3), 341-350. <https://doi.org/10.30997/qh.v11i3.21365>
- Kholisoh, H., Priyadi, B. P., & Purnaweni, H. (2024). Implementasi Program JAKPRENEUR dalam Pengembangan Usaha Mikro Kecil dan Menengah (UMKM) di Kota Administrasi Jakarta Pusat. *Journal of Management and Public Policy*, 13(2), 1-20. <https://doi.org/10.14710/jppmr.v13i2.43688>
- Kurnia, I. N. A., Hasanudin, M., & Putri, A. G. (2023). Influence Of The Triple Bottom Line Concept On Sustainability And Success Of Tofu Smes In Magelang. *Applied Accounting and Management Review (AAMAR)*, 2(2), 70-79. <https://doi.org/10.32497/aamar.v2i2.5095>
- Lesmana, S. A. (2020). Lean Manufacturing Implementation to Reduce Waste Using the Waste Assessment Model Method in the Production Process. *International Journal of Engineering Research and Advanced Technology*, 06(12), 07-16. <https://doi.org/10.31695/ijerat.2020.3672>
- Mendes, A. C. S., Ferreira, F. A. F., Kannan, D., Ferreira, N. C. M. Q. F., & Correia, R. J. C. (2022). A BWM approach to determinants of sustainable entrepreneurship in small and medium-sized enterprises. *Journal of Cleaner Production*, 371(July), 133300. <https://doi.org/10.1016/j.jclepro.2022.133300>
- Muñoz-villamizar, A., Santos, J., Garcia-sabater, J. J., Lleo, A., Grau, P., Muñoz-villamizar, A., Santos, J., & Grau, P. (2018). Green value stream mapping approach to improving productivity and environmental performance. *International Journal of Productivity and Performance Management*. <https://doi.org/10.1108/IJPPM-06-2018-0216>
- Murni, H. N. C. (2024). Educational Environment Management in the Perspective of Climate Change in Indonesia. *Jurnal Penelitian Pendidikan IPA*, 10(7), 3697-3705. <https://doi.org/10.29303/jppipa.v10i7.7305>
- Paramitha, M. P., Diansari, B. N., & Agusti, F. (2025). Identifikasi Waste pada Produksi Kaca Grafir dengan Metode Value Stream Mapping (VSM) di ABC overproduction, waiting, transportation, excess processing, inventory, motion, dan defect sistem produksi yang masing berlangsung secara konvensional tanp. *MANUFAKTUR*, 3(3), 66-78. <https://doi.org/10.61132/manufaktur.v3i3.1047>
- Parmawati, R., Soemarno, Widagdo, S., & Putra, I. P. (2025). Circular Economy and Integrated Pest Management in Rice Farming: A Model for Sustainable Agricultural Education. *Jurnal Penelitian Pendidikan IPA*, 11(5), 993-1005. <https://doi.org/10.29303/jppipa.v11i5.11128>
- Popiela, J. P. (2025). Sustainability in human resource management practices used by small and medium-sized enterprises: a systematic review. *Central European Management Journal*, 33(1), 87-106. <https://doi.org/10.1108/CEMJ-03-2024-0097>
- Purnomo, S., & Purwandari, S. (2025). A Comprehensive Micro, Small, and Medium Enterprise Empowerment Model for Developing Sustainable Tourism Villages in Rural Communities: A Perspective. *Sustainability*, 17(1368), 1-40. <https://doi.org/10.3390/su17041368>
- Rafke, H. D., & Lestari, Y. D. (2017). Simulating Fleet Procurement in an Indonesian Logistics Company. *The Asian Journal of Shipping and Logistics*, 33(1), 1-10. <https://doi.org/10.1016/j.ajsl.2017.03.001>
- Rahman, H., Oktavia, S., Shetye, N., & Sedjiro, W. L. A. (2024). Enhancing Operations for Sustainability in Indonesian SMEs through Climate Change Awareness and Business Orientation. *Industrial and Manufacturing Engineering*, 23(1), 109-119. <https://doi.org/10.25077/josi.v23.n1.p109-119.2024>
- Ririh, K. R., Machfud, M., Anggraeni, E., & Rochman, N. T. (2025). The way of human resource development and resource / infrastructure management affect the agroindustrial innovation process in a merged public research institution. *Intangible Capital*, 21(1), 45-61. <https://doi.org/10.3926/ic.2923>
- Roza, M., Sari, M., Meria, A., Herman, M., & Meriko, L. (2025). Food Safety and Community Behavior Toward Traditional Foods in West Sumatra Tourist Destinations: A Chemical, Biological, and Science Education Perspective. *Jurnal Penelitian Pendidikan IPA*, 11(11), 165-174. <https://doi.org/10.29303/jppipa.v11i11.12383>
- Sari, L., & Dewi, Y. A. (2025). Strategi Pengembangan Koperasi Syariah Berbasis Teknologi Finansial Dengan Pendekatan Interpretatif Structural Modelling (Studi Kasus: Kkspn, Kota Bukittinggi). *Journal of Society and Bussiness*, 2(1), 85-94. Retrieved from <https://languar.net/index.php/NETIZEN/article/view/516>
- Sari, R., Munthe, M. A., & Daulay, A. P. (2023). Sustainable Strategy in the Development of

- Mangrove Ecotourism in Pasar Rawa Village, Langkat Regency. *Jurnal Penelitian Pendidikan IPA*, 9(12), 11261–11267. <https://doi.org/10.29303/jppipa.v9i12.5664>
- Schmidt, F. C., Zanini, R. R., & Junior, R. S. (2018). Evaluation of Sustainability Practices in Small and Medium-Sized Manufacturing Enterprises in Southern Brazil. *Sustainability*, 10(2460). <https://doi.org/10.3390/su10072460>
- Silfia, Helmi, Noer, M., & Henmaidi. (2021). Developing the competitiveness and sustainability of agricultural cluster areas based on micro, small and medium enterprise by means of community entrepreneurship. *IOP Conference Series: Earth and Environmental Science*, 757(1), 1–11. <https://doi.org/10.1088/1755-1315/757/1/012011>
- Sorooshian, S., Tavana, M., & Ribeiro-navarrete, S. (2023). From classical interpretive structural modeling to total interpretive structural modeling and beyond : A half-century of business research. *Journal of Business Research*, 157(113642). <https://doi.org/10.1016/j.jbusres.2022.113642>
- Sulistiyowati, L., Pardian, P., Syamsyiah, N., & Deliana, Y. (2018). Development of small and medium business (SMES) of mango dodol processing to increase the added value (a case study in Ujungjaya Village, Indramayu District, West Java). *IOP Conference Series: Earth and Environmental Science*, 142(1), 1–8. <https://doi.org/10.1088/1755-1315/142/1/012042>
- Sunarta, Fdhilah, A. S. H., & Wibowo, B. P. (2025). The impact of product innovation and service quality on survival recovery of MSMES: the mediating role of financial performance. *Salud, Ciencia y Tecnología - Serie de Conferencias*, 4(1314), 1–13. <https://doi.org/10.56294/sctconf20251314>
- Timperio, G., Tiwari, S., Gaspar Sánchez, J. M., García Martín, R. A., & de Souza, R. (2020). Integrated decision support framework for distribution network design. *International Journal of Production Research*, 58(8), 2490–2509. <https://doi.org/10.1080/00207543.2019.1680894>
- Wahyudi, A. S., Yulivan, I., & Rahman, A. (2024). The Role of Micro, Small, and Medium Enterprises (MSMEs) in Supporting Indonesia's Economic Resilience. *Jurnal Pertahanan*, 10(2), 297–307. Retrieved from <https://jurnal.idu.ac.id/index.php/defensejournal> <http://dx.doi.org/10.33172/jp.v10i2.19519>
- Yanarita, Afentian, Indrayanti, L., Tanduh, Y., Madiyawati, M., Pidjath, C., Putir, E., & Siska, G. (2025). Analysis of Potential and Value Chains as a Strategy for Developing Non-Timber Forest Products in Central Kalimantan Forests. *Jurnal Penelitian Pendidikan IPA*, 11(9), 973–981. <https://doi.org/10.29303/jppipa.v11i9.12664>
- Yusuf, Y., Resdati, Sidiq, R. S. S., Hidir, A., & Bahagiana, B. (2024). The Use of E-Commerce by State-Owned Enterprises (SOEs) in the Meranti Islands as Sociopreneurs for the Optimization of Sago Potential Utilization. *Jurnal Pene*, 10(8), 6277–6282. <https://doi.org/10.29303/jppipa.v10i8.7255>