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Institutionalization of Tempe Production System Using Interpretative Structural Modeling (ISM) Approach in the Development of Parerejo Tempe Village

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ABSTRACT

This study aims to identify key actors in the development of Tempe SMEs through the institutionalization of soybean processed product production systems. The method used is the Interpretative Structural Modeling (ISM) approach using alternative policy formulations in the future, with development stages including (a) conducting a hierarchy; (b) classifying sub-element analysis with a sub-element classification matrix; (c) determining the state of a factor; (d) developing possible scenarios that may occur. The results of the study indicate that the development of Tempe SMEs through the form of centers that can be used as the development of Tempe Villages, specifically dedicated to the protection of SMEs, natural and cultural resources that can be linked through the following legal steps: 1) Increasing public awareness of the importance of supporting business centers; 2) Increasing community capacity, so that they can participate in every stage of integrated management; and 3) Increasing community income with sustainable and environmentally friendly utilization, related to this, fundamental improvements are needed in the planning and management of natural resource development.

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1. Introduction

Tempe is one of Indonesia's most important traditional fermented soybean products and has become an inseparable part of the national food system. Besides serving as an affordable source of plant-based protein, tempe contributes significantly to the development of micro, small, and medium enterprises (MSMEs) through employment generation, household income, and regional economic growth. The increasing demand for healthy and sustainable food has further strengthened the strategic role of tempe-based industries in supporting local economic resilience. Nevertheless, the sustainability of tempe production systems remains highly dependent on the availability of raw materials, production efficiency, institutional support, and collaboration among stakeholders. Recent studies emphasize that improving production systems is essential to enhance competitiveness and ensure the long-term sustainability of agro-based MSMEs (Suryaningrat et al., 2015; Fu, 2018; Herminingrum, 2019).

Despite its economic importance, many tempe MSMEs continue to experience structural constraints that hinder business development. These constraints include fluctuating soybean prices, unstable raw material availability, limited production facilities, inadequate waste management, low technological adoption, weak institutional capacity, and insufficient stakeholder collaboration. Such problems not only reduce production efficiency but also limit the ability of MSMEs to respond to market dynamics and environmental challenges. Previous studies have shown that strengthening institutional arrangements and improving production management are key determinants for enhancing the competitiveness and sustainability of small-scale food industries (Hermansyah, 2021).

Parerejo Village, located in Pasuruan Regency, East Java, is recognized as one of the traditional centers of tempe production with a long-established entrepreneurial culture. The majority of households are involved directly or indirectly in tempe processing activities, making the village an important economic cluster for local communities. Although Parerejo possesses substantial production potential, the development of its tempe industry has not yet been supported by an integrated institutional system capable of coordinating production activities, strengthening stakeholder participation, and promoting sustainable business development. The existing production system remains fragmented, causing inefficiencies in production planning, resource utilization, environmental management, and market development. Consequently, there is a need for a systematic approach capable of identifying the key driving factors and institutional priorities required to support the development of the Tempe Village concept.

Several previous studies have investigated production systems, supply chain management, and institutional development in agro-industrial sectors. However, most of these studies focus primarily on technical production improvements, production planning, or supply chain optimization. Only a limited number of studies have comprehensively analyzed the hierarchical relationships among institutional actors, development objectives, constraints, and strategic activities using Interpretative Structural Modeling (ISM). Furthermore, studies specifically addressing the institutionalization of tempe production systems within rural MSME clusters remain scarce, particularly in the context of integrated village-based industrial development. This research gap indicates the necessity of developing an institutional framework capable of integrating multiple stakeholders into a coordinated production system.

Interpretative Structural Modeling (ISM) is a decision-support methodology designed to analyze complex systems by identifying contextual relationships among system elements and arranging them into hierarchical structures based on driving power and dependence. Unlike conventional descriptive approaches, ISM enables decision makers to determine strategic priorities, identify key driving factors, and formulate policy interventions systematically. The integration of ISM with Matrix Impact Cross-reference Multiplication Applied to Classification (MICMAC) analysis further strengthens strategic decision-making by classifying variables according to their influence and dependency levels, thereby facilitating more effective institutional planning.

The object of this research is the institutional development of the tempe production system in Parerejo Tempe Village, Pasuruan Regency, Indonesia. The study focuses on identifying the key actors, institutional barriers, development objectives, and strategic activities required to establish an integrated production system that supports sustainable MSME development. Data were obtained through expert judgments involving representatives from academia, government institutions, business actors, financial institutions, community organizations, and practitioners directly involved in tempe industry development. This study is important because the sustainability of rural MSMEs increasingly depends on institutional collaboration rather than solely on production capability. Identifying strategic institutional priorities is expected to support policy formulation for local governments, improve stakeholder coordination, increase production efficiency, strengthen environmental management, and enhance community welfare. The resulting institutional model may also serve as a practical reference for developing similar agro-industrial clusters in other regions of Indonesia.

The novelty of this research lies in the development of an institutional model for tempe production systems using an integrated Interpretative Structural Modeling (ISM) approach that simultaneously analyzes institutional actors, development objectives, constraints, and strategic activities within a single hierarchical framework. Unlike previous studies that examine these aspects separately, this study constructs a comprehensive institutional structure capable of identifying key driving elements and supporting evidence-based policy formulation for village-based tempe industry development.

Based on these considerations, this study aims to identify the strategic institutional elements that influence the development of the tempe production system, determine the hierarchical relationships among these elements using Interpretative Structural Modeling (ISM), classify their driving and dependence powers through MICMAC analysis, and formulate institutional development strategies to support the sustainable development of Parerejo Tempe Village..

2. Literature Review

2.1 Production System in Small and Medium Enterprises

A production system is an integrated framework consisting of inputs, transformation processes, outputs, and feedback mechanisms designed to achieve organizational objectives efficiently. In manufacturing-based Micro, Small, and Medium Enterprises (MSMEs), production systems encompass raw material procurement, production planning, quality control, inventory management, distribution, and continuous improvement. An effective production system enables enterprises to minimize operational costs, improve product quality, optimize resource utilization, and enhance customer satisfaction (Slack et al., 2022). Recent studies indicate that production systems in MSMEs are increasingly influenced not only by operational efficiency but also by sustainability, digitalization, institutional support, and collaborative governance. Sustainable production systems integrate economic, environmental, and social dimensions to improve long-term competitiveness while minimizing environmental impacts (Bressanelli et al., 2021). Likewise, digital transformation has become an important driver for increasing flexibility, productivity, and organizational resilience in manufacturing SMEs (Sony & Naik, 2020).

Within agro-based MSMEs such as the tempe industry, production systems are characterized by dependence on agricultural raw materials, seasonal supply fluctuations, traditional processing technologies, and limited managerial capabilities. Therefore, production performance should not only be evaluated from technical efficiency but also from institutional coordination among producers, suppliers, government agencies, financial institutions, universities, and local communities (Hermansyah, 2021).

2.2 Institutional Development of MSMEs

Institutional development refers to the process of establishing governance structures, organizational arrangements, regulations, stakeholder relationships, and collaborative mechanisms that support organizational sustainability. Institutional capacity determines how effectively MSMEs gain access to innovation, financing, technology, markets, and government support (North, 1990).

Recent literature demonstrates that institutional quality significantly affects innovation capability, environmental sustainability, competitiveness, and organizational resilience among SMEs (Anwar et al., 2023). Institutional collaboration also facilitates knowledge sharing, resource mobilization, and collective learning, which are critical for rural industrial development (OECD, 2023). For village-based industries, institutional strengthening extends beyond administrative functions by integrating multiple stakeholders into collaborative governance systems. Such collaboration enhances production planning, environmental management, conflict resolution, and business expansion. Consequently, institutional development has become one of the most important determinants of sustainable MSME growth (United Nations Industrial Development Organization [UNIDO], 2022).

2.3 Interpretative Structural Modeling (ISM)

Interpretative Structural Modeling (ISM) is a systems analysis methodology developed to identify contextual relationships among elements and transform complex systems into hierarchical structures. ISM enables researchers to convert expert knowledge into structured models that facilitate strategic decision-making under conditions of limited quantitative information (Eriyatno, 2003).

The ISM procedure consists of identifying relevant elements, establishing contextual relationships through expert judgment, constructing the Structural Self-Interaction Matrix (SSIM), converting it into the Reachability Matrix (RM), applying transitivity rules, partitioning hierarchical levels, constructing the digraph, and interpreting the final structural model (Attri et al., 2013).

Compared with conventional statistical approaches, ISM offers several advantages. First, it accommodates qualitative expert knowledge when empirical data are limited. Second, it visualizes causal relationships among variables. Third, it identifies strategic driving factors that become priorities for policy intervention (Sharma et al., 2022).

Recent developments have expanded ISM through integration with Fuzzy Logic, Decision-Making Trial and Evaluation Laboratory (DEMATEL), and MICMAC Analysis, allowing researchers to analyze increasingly complex manufacturing and sustainability systems (Kumar et al., 2024).

2.4 Matrix Impact Cross-reference Multiplication Applied to Classification (MICMAC)

Matrix Impact Cross-reference Multiplication Applied to Classification (MICMAC) complements ISM by evaluating the driving power and dependence power of each system element (Godet, 2006). MICMAC classifies variables into four categories:

a. Autonomous variables
b. Dependent variables
c. Linkage variables
d. Independent variables

Independent variables possess high driving power with low dependence and therefore become strategic priorities for managerial intervention. Conversely, dependent variables are largely influenced by other variables and require indirect improvement through interventions on the independent variables (Sharma et al., 2022). The integration of ISM and MICMAC provides a comprehensive framework for identifying causal structures while simultaneously prioritizing strategic actions. This approach has been widely applied in manufacturing systems, supply chain management, green production, Industry 4.0, and organizational development (Kamble et al., 2020).

2.5 State of the Art and Research Gap

During the last decade, research on MSMEs has shifted from operational efficiency toward sustainable production, collaborative governance, and institutional resilience. Studies have confirmed that organizational performance depends not only on production capability but also on stakeholder collaboration, institutional support, technological innovation, and environmental sustainability (Bressanelli et al., 2021; OECD, 2023). Several researchers have implemented ISM to analyze manufacturing systems, supply chain management, sustainable production, and Industry 4.0 implementation (Kamble et al., 2020; Kumar et al., 2024). However, most previous studies focus on technological adoption, operational barriers, or supply chain performance, while relatively few investigate institutional development within traditional agro-industrial clusters. Specifically, studies addressing tempe-based MSMEs remain limited and generally emphasize production efficiency, product quality, or marketing performance without simultaneously analyzing institutional actors, development objectives, production constraints, and strategic activities in an integrated hierarchical framework (Hermansyah, 2021).

Therefore, this study contributes to the existing body of knowledge by integrating Interpretative Structural Modeling (ISM) and MICMAC Analysis to develop a comprehensive institutional framework for the Parerejo Tempe Village. Unlike previous studies, this research simultaneously examines development actors, institutional barriers, strategic activities, and development objectives to formulate evidence-based institutional strategies for sustainable rural industrial development.

To summarize the theoretical foundations, recent research developments, and identified research gaps, Table 1 presents a synthesis of the relevant literature that forms the basis of this study.

Table 1. Summary of Literature Review and Research Gap

No	Research Aspect	Main Concept	Findings from Previous Studies	Research Gap	References (APA Style)
1	Production System	Production systems integrate input, process, output, and feedback to improve operational efficiency and competitiveness.	Efficient production systems improve productivity, quality, cost efficiency, and customer satisfaction. Sustainable production increasingly incorporates environmental and social dimensions.	Most studies emphasize operational efficiency but pay less attention to institutional collaboration in traditional MSMEs.	Slack et al. (2022); Bressanelli et al. (2021) (Monash University)
2	MSME Institutional Development	Institutional development strengthens governance, stakeholder collaboration, and organizational sustainability.	Institutional quality significantly affects innovation, financing access, competitiveness, and MSME resilience.	Few studies integrate institutional actors into a structured decision-making model for rural industrial clusters.	North (1990); OECD (2023).
3	Collaborative Governance	Sustainable MSME development requires collaboration among government, academia, business, financial institutions, and communities.	Multi-stakeholder collaboration increases innovation capability, technology transfer, and business sustainability.	Institutional collaboration in village-based tempe industries has rarely been modeled systematically.	UNIDO (2022); Hermansyah (2021).
4	Interpretative Structural Modeling (ISM)	ISM is a systems methodology for identifying contextual relationships and arranging variables into hierarchical structures.	ISM effectively identifies key driving factors and supports strategic decision-making in complex systems.	Limited application of ISM for institutional development of traditional agro-industrial clusters.	Attri et al. (2013); Mahmood (2025). (MDPI)
5	MICMAC Analysis	MICMAC classifies variables according to driving power and dependence power.	MICMAC assists policymakers in identifying strategic priority variables and validating ISM models.	Previous studies mainly use MICMAC in manufacturing and supply chain contexts rather than institutional development of MSMEs.	Godet (2006); Sharma et al. (2022).
6	ISM–MICMAC Integration	Integration of ISM and MICMAC enables comprehensive hierarchical modeling and strategic prioritization.	Hybrid ISM–MICMAC frameworks have been successfully applied in Industry 4.0, sustainability, supply chain management, and organizational analysis.	Few studies combine ISM and MICMAC to simultaneously analyze actors, objectives, constraints, and institutional strategies within village-based MSME development.	Nirmal et al. (2025); Mahmood (2025). (Monash University)
7	Tempe MSMEs	Tempe MSMEs contribute significantly to local economies through employment and food security.	Existing studies mainly focus on production efficiency, product quality, marketing, and community empowerment.	Comprehensive institutional models for Tempe Village development remain limited.	Hermansyah (2021).
8	Research Novelty	Institutional development integrates production systems, stakeholder collaboration, and strategic governance.	Existing literature generally analyzes actors, barriers, or objectives separately.	This study integrates institutional actors, development objectives, production constraints, and strategic activities into a single hierarchical framework using ISM–MICMAC to formulate sustainable development strategies for Parerejo Tempe Village.	Developed by the authors based on literature synthesis.

Source**:** Literature synthesis by the authors based on previous studies.

Furthermore, a comparison between previous studies and the present research is presented in Table 2 to highlight the methodological differences, research limitations, and the novelty offered by this study.

Table 2. Comparison between Previous Studies and the Present Study

Authors	Research Object	Method	Main Findings	Research Limitations	Contribution of This Study
Hermansyah (2021)	Gaplek SMEs	PRA–PLS	Community empowerment improves MSME performance	Does not analyze institutional hierarchy	Develops institutional hierarchy using ISM–MICMAC
Kamble et al. (2020)	Industry 4.0	ISM–MICMAC	Identified critical success factors for Industry 4.0 implementation	Manufacturing industries only	Applies ISM–MICMAC to traditional agro-based MSMEs
Bressanelli et al. (2021)	Sustainable Manufacturing	Systematic Review	Sustainability improves manufacturing competitiveness	No institutional modeling	Focuses on institutional governance for sustainability
Nirmal et al. (2025)	Sustainable Supply Chain	ISM–MICMAC	Developed hierarchical framework for Industry 4.0-enabled sustainable supply chains	Focused on supply chain practices	Develops institutional framework for Tempe Village development. (Monash University)
This Research	Parerejo Tempe Village	ISM–MICMAC	Develops an integrated institutional hierarchy consisting of actors, barriers, objectives, and strategic activities to support sustainable MSME development	–	Provides a comprehensive institutional decision-support model for village-based tempe industry development

Source: Literature synthesis by the authors based on previous studies.

3. Methodology

3.1 Sampling

This study employed a qualitative decision-support approach using Interpretive Structural Modeling (ISM) to formulate an institutional development model for the Tempe Production System in Parerejo Tempe Village, Pasuruan Regency, Indonesia. ISM was selected because it is capable of identifying complex relationships among multiple institutional factors and arranging them into a hierarchical structure that supports strategic decision-making. Compared with conventional statistical methods, ISM is particularly suitable for problems involving interdependent variables and expert knowledge in policy formulation.

The unit of analysis comprised institutional factors influencing the development of Tempe Small and Medium Enterprises (SMEs), including stakeholders, development objectives, constraints, and supporting activities. The research context focused on Parerejo Village, a well-established center of tempe production that possesses significant socio-economic and cultural potential but continues to face institutional and managerial challenges.

Sampling was conducted using purposive sampling, as recommended for ISM studies that require expert judgment rather than large representative samples. Respondents were intentionally selected based on their knowledge, experience, and involvement in SME development and institutional management. The selection criteria included: (1) willingness to participate in the study, (2) recognized expertise and credibility in institutional or SME development, and (3) at least two years of professional experience in relevant organizations.

A total of seven experts participated in this study, representing government agencies, academia, business practitioners, SME associations, community organizations, non-governmental organizations

(NGOs), and other institutions directly involved in the development of Tempe SMEs. The diversity of respondents ensured that the resulting institutional model reflected multiple stakeholder perspectives and enhanced the credibility of the findings.

3.2 Measurement and Data Collection

Data were collected through multiple methods to ensure the credibility and completeness of information. Primary data consisted of field observations, semi-structured interviews, expert questionnaires, and focus discussions with selected stakeholders. Secondary data were obtained from government reports, institutional documents, previous studies, and other relevant publications concerning SME development and production systems. The questionnaire was specifically designed to identify contextual relationships among institutional factors affecting the development of Tempe SMEs. Prior to implementation, the identified factors were compiled through an extensive literature review and subsequently verified through expert discussions to ensure their relevance to the research context. The questionnaire asked experts to evaluate pairwise relationships among factors using the standard ISM contextual relationship symbols: **V** (factor *i* influences factor *j*), **A** (factor *j* influences factor *i*), **X** (both factors influence each other), and **O** (no relationship).

The ISM analysis followed the procedure proposed by Eriyatno (2003). First, a Structural Self-Interaction Matrix (SSIM) was developed based on expert judgments. The SSIM was then transformed into a Reachability Matrix (RM) by converting symbolic relationships into binary values (1 and 0). The reachability matrix was subsequently refined using the transitivity rule to produce the final matrix.

Following the construction of the final reachability matrix, hierarchical partitioning was performed to determine the relative position of each institutional factor within the system. A Conical Matrix was then developed to arrange factors according to their hierarchical levels, followed by the construction of the ISM digraph representing the structural relationships among factors.

Finally, MICMAC (Matrice d'Impacts Croisés Multiplication Appliquée à un Classement) analysis was conducted to classify each factor according to its Driving Power (DP) and Dependence (D) values. Based on these two dimensions, factors were categorized into four groups: Autonomous, Dependent, Linkage, and Independent. This classification facilitated the identification of key driving factors that should be prioritized in the institutional development strategy for Tempe SMEs.

To enhance the reliability of the findings, the ISM matrices and hierarchical structures were repeatedly reviewed and validated through iterative consultations with the participating experts until consensus was achieved. The combination of multiple data collection techniques, expert validation, and systematic ISM procedures improves the trustworthiness, consistency, and reproducibility of the research process, allowing future researchers to replicate the study under similar institutional settings.

4. Results and Discussion

4.1 Structural Self-Interaction Matrix (SSIM)

Implementation of the analysis of the factors inhibiting the implementation of the Production System (PS) through the institutionalization of Tempeh SMEs by observing the results of the study of 15 barrier factors based on collected literature studies, combined results of brainstorming with experts, there are 3 inhibiting factors based on the literature study, resulting in verification factors and additional factors from experts, then there are 15 factors that hinder the realization of the production system as shown in table 1. The use of solutions through ISM begins with SSIM calculations obtained from the distribution of questionnaire results and brainstorming to respondents to obtain the relationship between factors, namely relationships that influence each other. The results of identifying the contextual relationship between SSIM factors.

Table 1. PS Barrier Factors After Verification

Item	Roadblock Factor	Sources
1	Low awareness and demands from the community to support SMEs to implement green production.	Study of literature
2	Lack of fostering green production from stakeholders to SMEs.	Expert contribution
3	Lack of green production socialization program for Gaplek SMEs.	Expert contribution
4	The low skill of Gaplek SMEs in managing the composition of chemical use in cassava.	Expert contribution
5	Lack of trained personnel on green production in Gaplek SMEs.	Expert contribution
6	Lack of the establishment of cassava clusters to facilitate green production in Gaplek SMEs.	Expert contribution
7	Low understanding of SMEs on the dangers and risks of using chemicals.	Expert contribution
8	There is no conversion of the gaplek bleaching process in Gaplek SMEs.	Expert contribution
9	The unavailability of the main sewer system in Gaplek SMEs.	Expert contribution
10	Limited area for producing and processing cassava waste in Gaplek SMEs.	Expert contribution
11	The low awareness of SMEs towards the economic and environmental benefits of implementing green production.	Study of literature
12	The low responsibility of Gaplek SMEs for environmental impacts caused.	Expert contribution
13	The low awareness of the Gaplek SMEs in maintaining and controlling environmental impacts.	Expert contribution
14	Lack of comparative studies of similar SMEs that have successfully implemented green production.	Expert contribution
15	Waste treatment requires high costs.	Study of literature

Experts from industry and academia must be familiar with the problem being considered. to be analyzed for factors, contextual relationships that influence or are influenced. This contextual relationship between the factors identified was developed. SSIM is then arranged based on the results of gathering expert opinions in the form of symbols to show the direction of the relationship between the 2 factors i and j. These symbols are V, A, X, or O, with the following information:

V = factor i influences factor j X = factor i and factor j influence each other
A = factor i is influenced by factor j O = factors i and j do not affect each other

4.2 Reachability Matrix

SSIM is converted to a reachability matrix by substituting four symbols (V, A, X, or O) from SSIM to 1 or 0 on the reachability matrix. The rules in substitution are as follows:

a. If the symbol on SSIM is V, then entry (i, j) is 1 and entry (j, i) is 0 on the reachability matrix.
b. If the symbol on SSIM is A, then entry (i, j) is 0 and entry (j, i) is 1 on the reachability matrix.
c. If the symbol on SSIM is X, then entry (i, j) is 1 and entry (j, i) is 1 on the reachability matrix.
d. If the symbol on SSIM is O, then entry (i, j) is 0 and entry (j, i) is 0 on the reachability matrix.

Using the concept of transitivity, the initial reachability matrix is changed to the final reachability matrix. The transitivity concept means that if A is related to B, B is related to C, then A is related to C. In the final reachability matrix table there is driving power and dependence power, then it will used for the next stage of analysis, namely MICMAC analysis.

4.3 Partisi Level

Reachability set, antecedent set, and intersection set of each factor are formed. Factors that have the same intersection set and reachability set are level 1 in the ISM hierarchy. After level 1 is identified, the factor is eliminated then the next iteration is continued.

In the first iteration it is obtained that waste treatment requires high costs (15) to be level 1 then the factor is eliminated in the second iteration. In the second iteration, the limited area for producing and processing soya bean waste in Tempeh SMEs (10) becomes level 2, then the factor is eliminated in the third iteration. As such, furthermore, the low understanding of SMEs on the dangers and risks of using chemicals (7) and the low awareness of SMEs towards the economic and environmental benefits of implementing green production (11) are level 11 in the last iteration. In total there are 11 iterations in this calculation.

4.4 Conical Matrix

The Conical Matrix is made from the reachability matrix by arranging the order of factors based on their level. The top level factor is placed at the top of the ISM model, the second level factor is placed in the second position of the ISM model, and so on until the lowest level factor is at the lowest position on the ISM model.

4.5 Making the ISM Model

Digraph or directed graph is a structural model that is formed from a conical matrix. The model is created using vertices and lines that connect between vertices. Digraph is transformed into an ISM model by replacing vertices with factors in sentence form with arrow directions that show the relationship of each factor in the form of lines and vertices. The top level is placed at the top of the ISM model factor, the second level is placed at the second position of the ISM model factor, and so on until the lowest level factor is located at the lowest position on the ISM model.
Data processing using the ISM approach found the most influential factors in preventing the realization of green production. Influential factors are factors which are located at the bottom of the ISM hierarchy. These factors are the low understanding of SMEs on the dangers and risks of using chemicals (7) and low awareness of SMEs towards the economic and environmental benefits of implementing green production (11).

4.6 Classification of MICMAC Analysis

MICMAC analysis was conducted to evaluate the driving power and dependence of the identified barrier factors. In addition, MICMAC serves as a validation tool for the ISM model by classifying the factors according to their levels of driving power and dependence. Based on the MICMAC analysis, the identified barrier factors were classified into four categories as follows:

(i) **Autonomous factors (Sector 1):** Barrier factors in this sector have weak driving power and weak dependence. These factors have little influence on the overall system and are relatively disconnected from other factors. In this study, no barrier factors were classified in the Autonomous category.

(ii) **Dependent factors (Sector 2):** Barrier factors in this sector have weak driving power but high dependence on other factors. The identified factors include: lack of the establishment of soybean clusters to facilitate green production in Tempe SMEs (6); the absence of conversion in the tempe bleaching process (8); the unavailability of a main wastewater drainage system in Tempe SMEs (9); limited space for producing and processing cassava waste (10); low responsibility of Tempe SMEs for the environmental impacts they generate (12); low awareness of Tempe SMEs in maintaining and controlling environmental impacts (13); and the high cost of waste treatment (15).

(iii) **Linkage factors (Sector 3):** Factors in this sector possess both high driving power and high dependence, indicating unstable relationships in which changes to one factor may significantly influence other factors within the system. The identified linkage factor is the low skill of Tempe SMEs in managing the composition of chemicals used in the production process (4).

(iv) **Independent factors (Sector 4):** Independent factors have strong driving power but low dependence, indicating that they are the key driving factors influencing the entire system. These factors include: low public awareness and limited community support for SMEs to implement green production (1); lack of stakeholder assistance in promoting green production among SMEs (2); insufficient green production socialization programs for Tempe SMEs (3); lack of trained personnel capable of implementing green production practices (5); limited understanding among SMEs regarding the dangers and risks associated with chemical use (7); low awareness of the economic and environmental benefits of green production (11); and the lack of benchmarking studies on similar SMEs that have successfully implemented green production (14).

Institutionalization of Tempeh SMEs after determining alternative values based on the value of each criterion shows that the priority alternative values to be supplied are in Pasuruan Regency. This determination is needed to align the potential of the hierarchy more directed from the decomposition, determination of influence, arrangement, manufacture, testing and classification of sub elements appropriately. The steps in the ISM technique are as follows (Eriyatno, 2003): Decomposition of each element into sub elements; Determination of the influence between sub elements on each element; Value of 1 mean that there is an influence between the i-th element and the j-th element, while eij = 0 means that there is no influence between the i-th element and the j-th element; Preparation of SSIM (Structural Self Interaction matrix); Making RM (Reachability Matrix) for each element; Testing RM with transitivity rules; Classification of sub elements.

The results of expert assessment of contextual relationships between sub-elements produce an SSIM (Self Structural Interpretative Matrix) matrix and the results of the assessment are converted into an initial reachability (RM) matrix. The reachability matrix that does not meet the transitivity rules, is then converted to the reachability matrix that meets the transitivity rules, so a final reachability matrix is obtained. Then a final SSIM is formed that meets the transitivity rules. The final SSIM that meets the transitivity rules is interpreted in the institution, then presented in a diagram of the hierarchical structure model of the SME Center development system elements. Structuring the sub-elements of the Tempe UKM Center Development System, among others :

a. Elements of System Development Actors

Structuring the actor element, which consists of 10 sub-elements, using the ISM technique and through V, A, X, and O assessments will produce a reachability matrix, a hierarchical model structure, and sub-element classification are symbolized as follows: (1) Tempe SME Group (L1). (2) Entrepreneur (L2). (3) Community leaders (L3). (4) Local government (L4). (5) Central government (L5). (6) Financial institutions and banks (L6).

The elements of the SME area development system at level I are the central government and tertiary institutions, level II is community leaders, level III is Tempe SME group, level IV is entrepreneurs and financial institutions and banks, and level V is local government and Tempe SME Sentra investors. Tempe SME Center is an area that in management and utilization requires integration, related to the diversity of ecosystems and the uses that are carried out. These conditions make management in the form of developing the Tempe SME Center an activity that elaborates a number of interests. In relation to resource management, management can be understood as the right to regulate internal use patterns and change resources by making improvements. This management activity can be displayed by one stakeholder or jointly by a group or as a result of collaboration between various groups. Collaborative management, or co-management, has been defined as the division of power and responsibilities of resource users between government and local authorities (Plummer, 2009).

Co-management is defined as a term given to systems that combine governance as control with local, decentralized decision making and accountability, ideally by combining strengths and reducing each other's weaknesses (Singleton, 2003). Referring to this, in planning Tempe SME Centers, as a form of decentralization of responsibilities and authority in resource management, it requires the involvement of all relevant stakeholders from the local government, investors of tapioca entrepreneurs SME centers, financial institutions and banks, Tempe SME groups, community leaders, and college. Stakeholders in their capacity as users (users) will try to use resources while still paying attention to the rules and obeying all rules that have been set together in the planning process, while overseeing the occurrence of adverse forms of utilization. Furthermore, the implementation of co-management is not only related to the division of management responsibilities, but also requires cooperation, participation, improvement of local knowledge and scientific knowledge (Carlsson & Berkes, 2005; Masud et al., 2022; Puley & Charles, 2022).

b. Element of Purpose of Development Program

Structure of the objective element consisting of 12 sub-elements, using the ISM technique and through the V, A, X, and O assessments will produce a reachability matrix, a hierarchical model structure, and sub-element classification. The goal sub-elements are symbolized as follows: (i) Realizing the development of the Tempe SME Center (T1). (ii) Increase the productivity of Tempe SMEs (T2). (iii) Improving the quality of life of the Tempe SME community (T3). (iv) Improving environmental services for Tempe SME (T4). (v) Increase the income of the Tempe SME community (T5). (vi) Achieve sustainable use of resources (T6). (vii) Expanding employment opportunities (T7). (viii) Increase the diversification of cassava processed products (T8). (ix) Increase regional economic activities in the Tempe SME Center (T9). (x) Increasing investor interest in Tempe SME Centers (T10). (xi) Conduct technology development (T11). (xii) Increase regional income (T12).

The aim element of the Tempe SME development system program at level I is to realize the development of Tempe SME, level II is to increase the productivity of Tempe production, improve the quality of life of Tempe SME, improve the environmental services of Tempe SME and develop technology, level III is to increase the diversification of Tempe processed products and increase investor interest in Tempe SME Centers, level IV is to realize sustainable use of elementary schools, level V is to increase the income of Tempe SME people, level VI is to expand employment, level VII is to increase regional economic activities in Tempe SME Centers, while level VIII, increase regional income.

Based on the above hierarchy shows that the purpose of a program in realizing the development of Tempe SMEs plays an important role. Tempe SME development through the form of centers is an area program that can be used as a conservation area, especially dedicated to the protection of SME communities, natural and cultural resources that can be associated, or managed through change efforts with development patterns that are only oriented towards economic growth, need to be replaced with sustainable development.

5. Conclusion

The results of research using ISM can show the condition and function of management in the Tempeh production system very well through the implementation of Co-management at the Tempe SME center will be able to provide changes towards a better direction through: 1) Increasing public awareness of the importance of business centers in supporting life; 2) Increasing the capacity of the community, so that they can participate in every stage of management in a clean and integrated manner; and 3) Increasing community income with forms of use that are sustainable and sustainable and environmentally sound, in connection with this there needs to be a fundamental improvement in the planning and management of natural resource development. The approach and practice of village area development management that has been carried out sectorally and is disaggregated, needs to be improved through an integrated and sustainable management approach.

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