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Identification of Key Agility Variables to Improve Poultry Supply Chain Sustainability: Indonesian Case

Identifikasi Variabel Kunci Kecepatan Berpindah untuk Meningkatkan Keberlanjutan Rantai Pasok Unggas: Studi Kasus di Indonesia

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Abstract

All industries face new challenges after COVID-19, including the Indonesian poultry industry. As an essential food supply sector, the poultry industry supply chain must respond and adapt to new post- COVID-19 conditions. This study aims to analyze the relationship between agility and sustainability in the supply chain of the Indonesian poultry industry for facing various challenges. The method used in this research was the Interpretive Structural Modeling-"Matriced Impacts Croisés Appliquée á un Classement" (ISM-MICMAC) method. The agility and sustainability variables were validated initially by involving industrial supply chain stakeholders in the Focus Group Discussion (FGD). The study successfully modeled the relationship between agility and sustainability in the integrated supply chain of the Indonesian poultry industry. The agility variable is the driver for the sustainability of the integrated national poultry industry supply chain, with customer sensitivity being an essential key factor in improving the sustainability of the Indonesian poultry supply chain.
Keywords: agility, COVID-19, ISM-MICMAC, sustainability

Abstract

Semua industri menghadapi tantangan baru pasca COVID-19, termasuk industri unggas nasional. Rantai pasok industri unggas sebagai sektor penting untuk pasokan makanan harus mampu merespon dan beradaptasi dengan kondisi baru pasca COVID-19. Penelitian ini bertujuan untuk menganalisis hubungan antara kecepatan berpindah dan keberlanjutan pada rantai pasok industri unggas nasional dalam menghadapi berbagai tantangan. Metode yang digunakan adalah metode Interpretive Structural Modeling-Matriced Impacts Croisés Appliquée á un Classement (ISM-MICMAC). *Validasi terhadap variabel kecepatan berpindah dan keberlanjutan dilakukan pada tahap awal dengan melibatkan aktor rantai pasok industri pada forum* Focus Group Discussion (FGD). *Hasil penelitian berupa model hubungan antara kecepatan berpindah dan keberlanjutan pada rantai pasok industri unggas nasional terintegrasi. Variabel kecepatan berpindah menjadi pendorong keberlangsungan rantai pasok industri unggas nasional yang terintegrasi dengan* customer sensitivity *menjadi faktor kunci yang penting untuk meningkatkan keberlanjutan rantai pasok industri unggas.*
Kata kunci: *COVID-19, ISM-MICMAC, keberlanjutan, kecepatan berpindah*

INTRODUCTION

The business world faces various health, economic, and social challenges due to the COVID-19 pandemic. The COVID-19 pandemic also affects all food system variables, from the main supply, processing, trade, and logistics systems nationally and internationally (Schmidhuber et al., 2020). The supply chain affects the Indonesian poultry industry, one of the critical sectors in the food supply. Feed industry disturbances significantly impact the poultry industry. Most feed ingredients for the national poultry industry are imported from China, such as amino acids and vitamins. The lockdown policy imposed some time ago in the country led to an increase in feed ingredient price volatility which increased production costs in the livestock sector. The purchasing feed cost dominates the total production cost in the livestock sector, which can exceed 66% (CBS, 2020b), with the volatility of feed ingredients' prices resulting in unstable retail prices of chicken meat. The increase in chicken meat retail price in June 2020 caused inflation of 0.18%, while the increase in chicken prices contributed 0.14% to national inflation (CBS, 2020a).

The COVID-19 pandemic also raises challenges for poultry industry sustainability, including supply chain disruptions, oversupply, animal welfare, and human welfare (de Olde et al., 2020; Yunita & Hasibuan, 2021). Large-scale Social Restrictions (LSSR) and lockdowns in several countries globally have affected international and national animal trade, including poultry (FAO, 2020). Widespread restaurants and food service outlets closures and reduced tourism and travel activities have decreased the demand for poultry meat. The availability of labor also receives essential attention in the poultry supply chain due to many transitions between regions. Although food logistics services are excluded from LSRR activities in Indonesia, the high number of COVID-19 cases causes a higher transportation cost. Every worker who works on the "front line" of the chicken meat supply chain, such as drivers, breeders, producers, distributors, and retail employees, carries considerable risk. Cases in the United States, as of April 2020, the number of meat processing facilities infected with COVID-19 was 4,913 out of 130,578 workers (Dyal et al., 2020). This condition worries how the industry and its supply chain can survive the impact of COVID-19.

Furthermore, industries and companies experienced severe economic losses during the COVID-19 pandemic in Indonesia (Caraka et al., 2020). The COVID-19 pandemic has increased volatility, uncertainty, complexity, and ambiguity (VUCA) situations that impact the business sector (Ali et al., 2021). VUCA was introduced in 1987 by the United States Army War College to explain the geopolitical conditions at the end of the Cold War (Horney et al., 2010; Murugan et al., 2020). VUCA is widely used to describe a chaotic, volatile, and rapidly changing business environment (Bennett & Lemoine, 2014; Horney et al., 2010).

The unexpected change led to the evolution of one of the newest concepts in a business strategy called the concept of agility (Ulrich & Yeung, 2019). Agility is needed, so the organizations have the adaptability to survive and thrive in a constantly changing and unpredictable business environment (Gagnon & Hadaya, 2018). Agility is a business challenges comprehensive response to take advantage of the rapid changes and fragmented global market for high-quality goods and services performance (Laanti et al., 2013). Service agility is dynamic, context-specific, embraces change aggressively, and growth-oriented. Agility is not about increasing efficiency, cutting costs, or weathering the daunting "storm" of competition. It is about success and winning, i.e., success in the emerging competitive arena and winning market share and customers in the storm of competition that many companies now "fear".

New normal conditions due to the COVID-19 pandemic require companies to increase agility in responding to the business environment’s rapid changes. Calvo et al. (2020) explain the difference between resilience and agility. Resilience is the supply chain’s ability to handle unexpected shocks or crises. In other words, resilience is related to the effectiveness of mitigation and actions or plans before and until the peak impact of the crisis occurs. In comparison, agility is needed after a crisis occurs and includes restoring normal activities with new environment adaptation to create a competitive advantage through accelerating results. According to Carvalho et al. (2012), the supply chain must anticipate dynamic market changes and adopt new strategies. The new strategies should improve the ability to respond the unexpected market changes quickly and cost-effectively. It also should increase the level of environmental turmoil volume and variety.

Every actor in the supply chain must be motivated by global issues to develop effective relationships and maintain their product presence in the market (Jermsittiparsert & Rungsrisawat, 2019). This situation will result in increased supply chain collaboration links to strategic sourcing and better response along the supply chain during the current pandemic. Agility is an organization's ability to meet the rapid changes in market demands promptly. Organizations have realized that agility in their supply chain is critical to business sustainability (Al-Zabidi et al., 2021). Sustainability is good for the environment and society. Environmental-friendly companies can help improve the environment by minimizing environmental pollution and supporting sustainable development. Companies must integrate agility with sustainability strategies in their supply chains to remain competitive and viable (Singh & Vinodh, 2017). Companies can meet customer needs by appropriately using resources in combining agility with sustainability. Supply chain sustainability agility modeling is an effective way to improve understanding of supply chain behavior. Several approaches related to agility and sustainability modeling during the COVID-19 period include mathematical modeling (Li et al., 2021), dynamic modeling (Ivanov, 2020b, 2020a), Partial Least Squares (PLS) (Tarigan et al., 2021), and fusion intelligent decision support systems (Hu et al., 2021). These studies focus on global supply chains that support decision-makers in developing strategic solutions to companies' problems. This study aims to analyze the relationship between agility and sustainability in the era of the COVID-19 pandemic, especially for the Indonesian poultry industry.

METHODS

The research used Interpretive Structural Modeling-"Matriced Impacts Croisés Appliquée á un Classement" (ISM-MICMAC) to understand the relationship between agility and sustainability in Indonesian poultry's supply chain industry.

Table 1. Agility and sustainability variable

Variable		Dimension	Description	References
Agility	Ability to adapt and respond to survive and grow in an ever-changing and unpredictable business environment (Gagnon & Hadaya, 2018).	Collaborative relationship (E1)	Supply chain ability to attract buyers or visitors to collaborate on product development and information systems.	(Allaoui et al., 2019; Dastyar et al., 2018; Ghobakhloo, 2020; Motadel, Toloie-Eshlaghy, & Halvachi-Zadeh, 2011; Rehman, Al-Zabidi, AlKahtani, Umer, & Usmani, 2020)
		Process integration (E2)	Integration of processes along the supply chain network to achieve certain goals.	(Allaoui et al., 2019; Dubey, Gunasekaran, & Childe, 2019; Motadel et al., 2011; Rehman et al., 2020; Yin, Zhang, & Dong, 2020)
		Information integration (E3)	Ability to use information technology and share data between buyers or consumers.	(Allaoui et al., 2019; Dastyar et al., 2018; Motadel et al., 2011; Rehman et al., 2020)
		Customer sensitivity (E4)	Ability to understand and respond to customer needs.	(Aisyah, Jaqin, & Purba, 2019; Dastyar et al., 2018; Dubey et al., 2019; Motadel et al., 2011; Rehman et al., 2020)
Sustainability	Sustainability refers to people, planets, and profits under which human beings and values exist in productive harmony with the current and next generations' social, environmental, and economic requirements (Jiang et al., 2019).	Economic resilience (E5)	A healthy and dynamic condition of economic stability and creating economic independence with high competitiveness.	(Allaoui et al., 2019; Ghobakhloo, 2020; Mangla et al., 2018; McCormick, 2009; A. K. Singh & Vinodh, 2017)
		Environmental integrity (E6)	Maintenance of life support systems that have an essential role in human survival by minimizing the environment's negative impacts and developing positive ones.	(Allaoui et al., 2019; Ghobakhloo, 2020; Hasanuzzaman & Bhar, 2019; McCormick, 2009; Mohanty, 2018)
		Social well-being (E7)	Satisfaction with basic human needs and the availability of rights and freedoms to be able to express aspirations for the achievement of a better life.	(Allaoui et al., 2019; Hasanuzzaman & Bhar, 2019; McCormick, 2009; Mohanty, 2018; A. K. Singh & Vinodh, 2017)
		Good governance (E8)	Fundamentals of sustainable development include sustainable and inclusive economic growth, social development, environmental protection, and eradicating poverty and hunger.	(Luthra & Mangla, 2018; Mangla et al., 2018)

A case study was conducted on an integrated chicken meat company, PT Charoen Pokpand, in Central Java. The description of agility and sustainability variables can be seen in Table 1. Agility variables were represented by four dimensions: collaborative relationship (E1), process integration (E2), information integration (E3), and customer sensitivity (E4). The sustainability variables were represented by four dimensions: economic resilience (E5), environmental integrity (E6), social well-being (E7), and good governance (E8). FGD was used to analyze the relationship between agility and sustainability variables. This study involved five expert respondents with more than five years of work experience. Three expert respondents are practitioners in the poultry supply chains, one expert respondent is a practitioner in the agility field, and one expert respondent is a researcher in the poultry supply chains.

The ISM-MICMAC's main objective is to analyze problem situations through graphical representations and structured models (Singh & Gupta, 2020). ISM-FuzzyMICMAC was used (Singh & Gupta, 2020) in modeling the framework for sustainable maintenance systems. Mangla (2018) used ISM and MICMAC to analyze the relationship between the sustainability of agri-food supply enablers. (Yadav & Singh, 2020) used FuzzyISM-FuzzyMICMAC to identify the driving factors for integrating blockchain technology into efficient supply chain management. The step-by-step to develop ISM is as follows (Attri, 2017):

1. Detailing the relevant problem or issue through a literature review to be used as a variable in the ISM method.
2. Determining contextual relations through expert opinion following the objectives of the modeling.

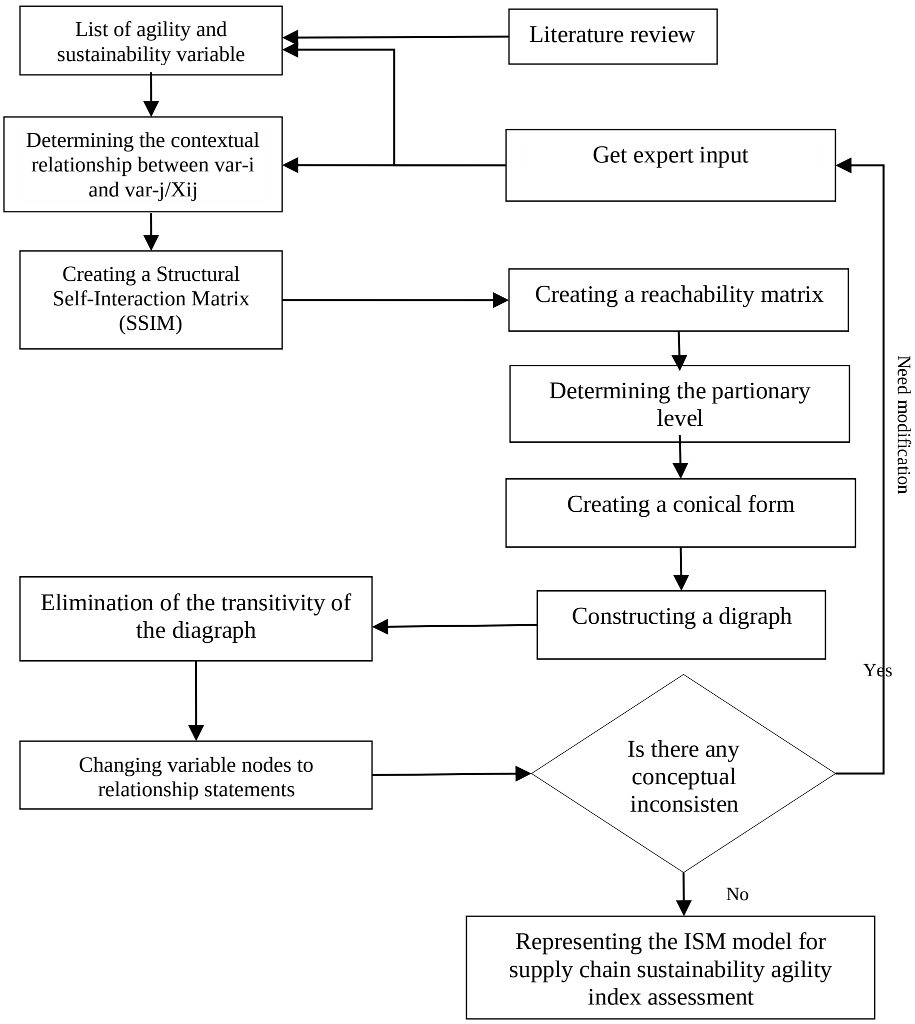

Figure 1. Research Flowchart

3. Creating a Structural Self-Interaction Matrix (SSIM).
4. Creating a Reach-ability Matrix (RM) and checking the Transitivity.
5. Determining the partition level, i.e., the variables are classified in different levels of the ISM structure to be formed.
6. Drawing a digraph with the transitivity relationship removed. Directly related variables are represented in a graph and hierarchical level.
7. Converting the digraph to ISM.
8. Presentation of the relation statement on the model.

The framework of this research can be seen in Figure 1.

RESULTS AND DISCUSSION

Results

Expert analysis results of contextual relationships in comparative "leads to" between agility and sustainability variables are represented in the Structural self-interaction matrix (SSIM) in Table 2. The following symbol denotes the relationship between the variables p and q (Poduval et al., 2015) :

1. "V" if variable "p" leads to variable "q".
2. "A" if variable "q" leads to variable "p".
3. "X" if variable "p" and "q" leads to each other.
4. "O" if variable "p" and "q" are not related to each other.

The relationship between variables in the SSIM is then converted into a reach-ability matrix (RM) using binary numbers "0" or "1". The value in the initial Reach-ability Matrix (RM) depends on the type of relationship in SSIM, which is summarized in the following relationship (Poduval et al., 2015):

1. V with entry row = 1 and entry column = 0
2. A with entry row = 0 and entry column = 1
3. X with entry row = 1 and entry column = 1
4. O with entry row = 0 and entry column = 0

The result of converting SSIM into a binary matrix from an initial RM is shown in Table 3.

The next stage was analyzing the final reach-ability matrix using Incorporating Transitivity. It is an essential feature of ISM. Transitivity is defined as if A has a relationship with B, and B has a relationship with C; thus, A has a relationship with C (Poduval et al., 2015). The final RM results can be seen in Table 4.

Table 2. Structural self-interaction matrix (SSIM)

	E8	E7	E6	E5	E4	E3	E2	E1
E1	V	V	V	V	A	X	V	
E2	V	V	V	V	A	X		
E3	V	V	V	V	A			
E4	V	V	V	V				
E5	X	X	X					
E6	X	X						
E7	X							
E8								

Table 3. Initial reach-ability matrix

	E1	E2	E3	E4	E5	E6	E7	E8
E1	1	1	1	0	1	1	1	1
E2	0	1	1	0	1	1	1	1
E3	1	1	1	0	1	1	1	1
E4	1	1	1	1	1	1	1	1
E5	0	0	0	0	1	1	1	1
E6	0	0	0	0	1	1	1	1
E7	0	0	0	0	1	1	1	1
E8	0	0	0	0	1	1	1	1

Table 4. Final reach-ability matrix

	E1	E2	E3	E4	E5	E6	E7	E8	DP
E1	1	1	1	0	1	1	1	1	7
E2	1*	1	1	0	1	1	1	1	7
E3	1	1	1	0	1	1	1	1	7
E4	1	1	1	1	1	1	1	1	8
E5	0	0	0	0	1	1	1	1	4
E6	0	0	0	0	1	1	1	1	4
E7	0	0	0	0	1	1	1	1	4
E8	0	0	0	0	1	1	1	1	4
D	4	4	4	1	8	8	8	8	

* transitivity relationship
D=Dependence; DP= Driving Power

The following step was developing level partitions. The final RM determines reach-ability and antecedent sets for each variable. The reach-ability set is a set that has a binary value of "1" (including itself) in the row in the final RM. The antecedent set is a set that has a binary value of "1" (including itself) in the column in the final RM. The variables with the same intersection between the reach-ability set and the antecedent set are Level-1 in the structure (Poduval et al., 2015). Table 5 shows the results of the overall level for each variable.

The formation of the conical matrix was the stage before forming the digraph. The conical matrix in this study can be seen in Table 6.

An initial digraph can be formed based on the conical matrix. A digraph is defined as a set of nodes (representing the variables in the conical matrix) related to each other according to the relationship in the matrix (V, A, X, O). These relationships are depicted by arrows from one node to another (Poduval et al., 2015). The initial digraph in this study is shown in Figure 2. A dotted line shows the transitivity relationship. The final digraph in this study is shown in Figure 3 after deleting the transitivity relationship line.

Table 5. Level variable from iteration result

Variable	Reach-ability Set	Antecedent Set	Intersection Set	Level
E1	E1, E2, E3, E5, E6, E7, E8	E1, E2, E3, E4	E1, E2, E3	II
E2	E1, E2, E3, E5, E6, E7, E8	E1, E2, E3, E4	E1, E2, E3	II
E3	E1, E2, E3, E5, E6, E7, E8	E1, E2, E3, E4	E1, E2, E3	II
E4	E1, E2, E3, E5, E6, E7, E8	E4	E4	III
E5	E5, E6, E7, E8	E1, E2, E3, E4, E5, E6, E7, E8	E5, E6, E7, E8	I
E6	E5, E6, E7, E8	E1, E2, E3, E4, E5, E6, E7, E8	E5, E6, E7, E8	I
E7	E5, E6, E7, E8	E1, E2, E3, E4, E5, E6, E7, E8	E5, E6, E7, E8	I
E8	E5, E6, E7, E8	E1, E2, E3, E4, E5, E6, E7, E8	E5, E6, E7, E8	I

Table 6. Conical matrix

	E5	E6	E7	E8	E1	E2	E3	E4
E5	1	1	1	1	0	0	0	0
E6	1	1	1	1	0	0	0	0
E7	1	1	1	1	0	0	0	0
E8	1	1	1	1	0	0	0	0
E1	1	1	1	1	1	1	1	0
E2	1	1	1	1	1*	1	1	0
E3	1	1	1	1	1	1	1	0
E4	1	1	1	1	1	1	1	1

* transitivity relationship

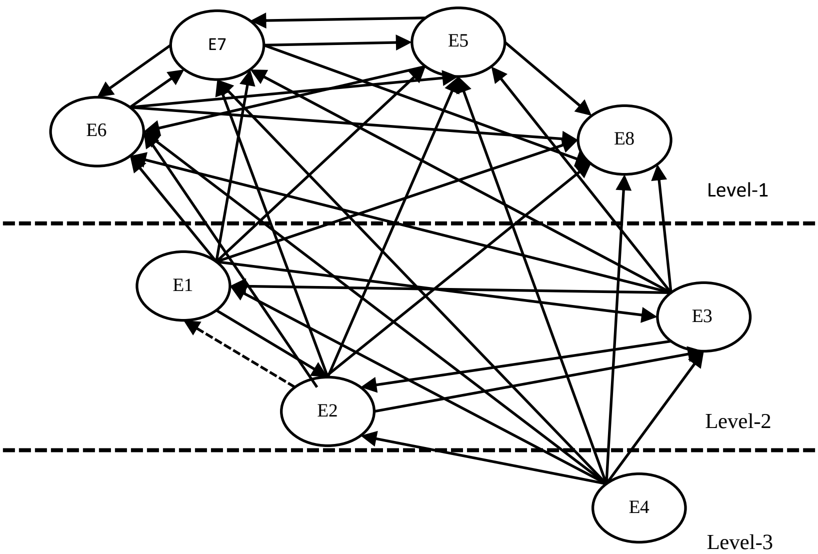

Figure 2. Initial Digraph

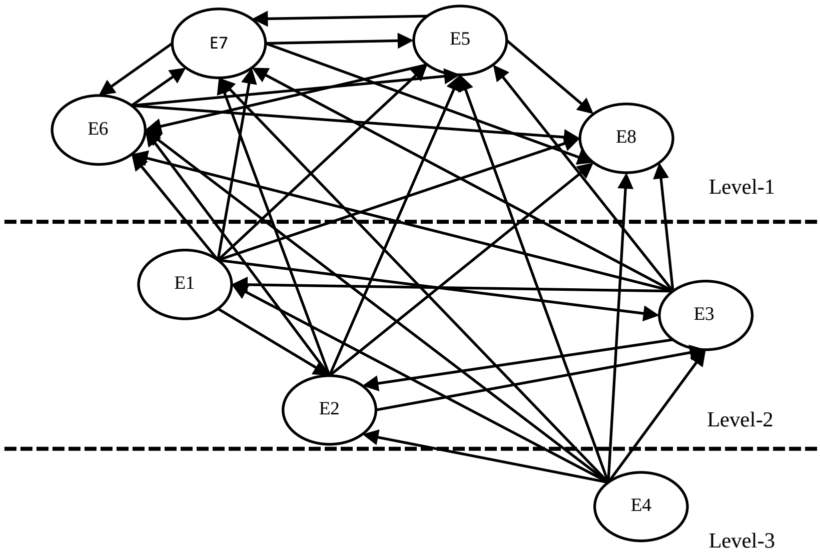

Figure 3. Final Digraph

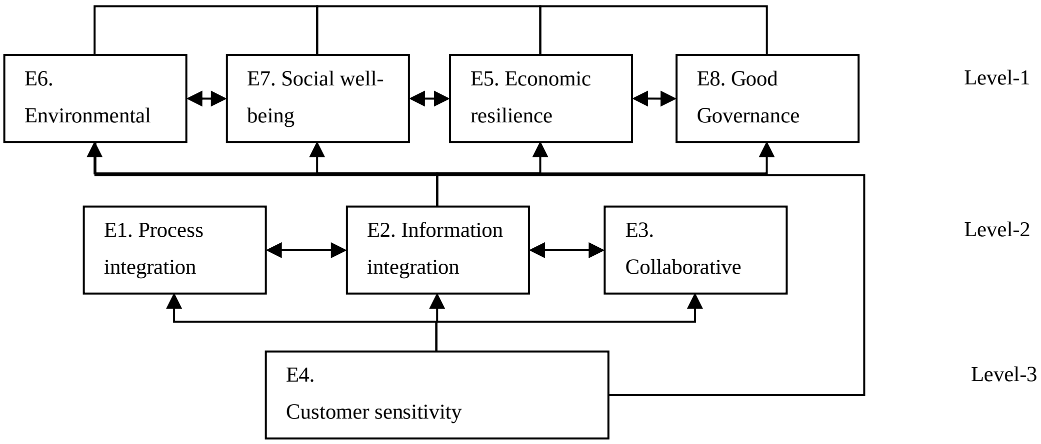

Figure 4. Interpretative Structural Model for Agility and Sustainability Variables of Poultry Supply Chain

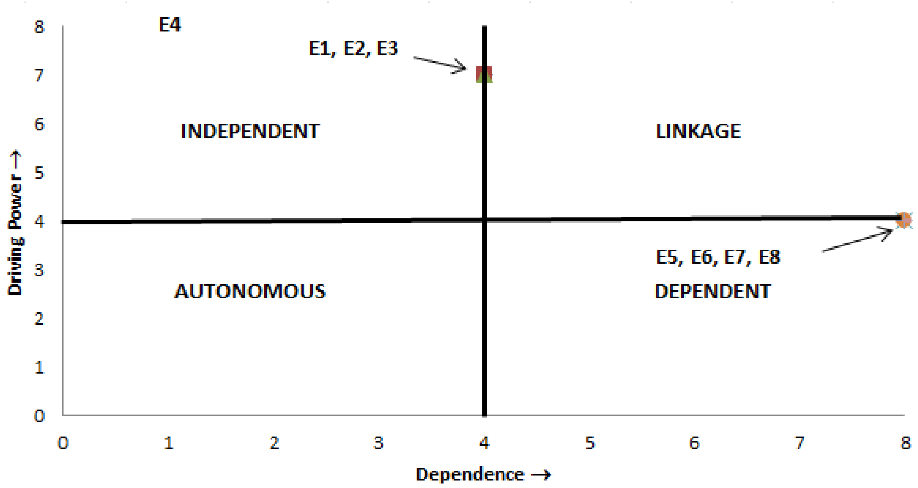

Figure 5. MICMAC Graph for Agility and Sustainability Variables of Poultry Supply Chain

The final step in the ISM process was developing an ISM-based framework. The final digraph was converted into a structural model by replacing the nodes with a description of each variable. The ISM in this study can be seen in Figure 4.

From the final RM in Table 4, each variable's Driving Power (DP) and Dependence (D) values are generated. The DP value shows how much the variable can cause other variables to occur and is obtained from the horizontal sum of each variable. The value of D shows how much the variable depends on other variables. The values D are obtained from the vertical sum of each variable. Based on the values of D and DP, the classification of variables is shown in Figure 5. In this study, four variables are in the Dependent sector (E5, E6, E7, E8), and the other four are in the Independent sector (E1, E2, E3, E4).

Discussion

This study demonstrated the relationship between agility and sustainability. It was concerned with identifying the position of agility on sustainability. The ISM approach utilized the dependencies and interactions between elements to analyze relationships. The results showed that the agility variable was the driver (Independent) for the sustainability (Dependent) of the integrated national poultry industry supply chain.

Variable customer sensitivity (E4) was at the third level (Figure 4) or the lowest level, indicating that the agility variable was the key variable in the model. The variables process integration (E1), collaborative relationship (E3), and information integration (E2) were in the second level. The first level of ISM structural model was the sustainability variables, which consist of economic resilience (E5), social well-being (E7), environmental integrity (E6), and good governance (E8). Based on previous research by Donthu & Gustafsson (2020), there has been a change in consumer behavior due to the COVID-19 pandemic in the tourism, retail, and education sectors. Measurement of supply chain agility at a dairy company in Saudi Arabia suggests that customer and market indicators are important indicators that management focuses on during the COVID-19 pandemic, in addition to cost and process indicators. (Rehman et al., 2020). Social distancing and work-from-home policies provided new market opportunities as long as the industry is observant in seeing opportunities by having customer sensitivity to create innovations. New market opportunities appeared suddenly, and businesses must respond immediately to support a circular economy (Nandi et al., 2021). Customer sensitivity was included in the strategy of marketing agility to show the existing market potential; thus, it will support a developing economy and more sustainable business (Osei et al., 2019). During the COVID-19 pandemic, consumer demand on social media platforms increased, including the demand for processed poultry products. The poultry supply chain's ability to respond the market demand trends was one of the solutions to the overproduction of fresh poultry meat in the market.

The integration in the production process can increase the company's competitiveness. According to Lukashenok & Solovyov (2020), an integrated process between units within the company resulting an increase in the production process and quality of the poultry industry's final product in Russia. Information integration in this study was associated with the use of agile technology. Information integration on the poultry supply chain was intended to integrate and increase transparency among stakeholders in the supply chain. It also minimizes the mediators' role in meeting market demand. The COVID-19 pandemic has made agile technology necessary, from managing and processing resources to becoming products to the delivery process. The information integration within a company using agile technology solved workers' vulnerability during the COVID-19 pandemic to the worker's safety and health (de Olde et al., 2020). It assisted decision-makers regarding the value proposition, helped companies strengthen ties with customers, and adopted more effective policies and practices (Kamble et al., 2019). The companies that used technology survived better during the COVID-19 pandemic than companies that did not use technology (Batra, 2020).

Variables with low driving power but high dependence value were categorized as Dependent. These variables were at the peak level of the ISM model. The variables in this group were variables in the concept of sustainability, consisting of "economic resilience", "social well-being", "environmental integrity", and "good governance". These variables represented the company's strategic goals and were sustainability pillars, as FAO (2020) stated. This study proved that these sustainability pillars were supported by the supply chain's ability to respond to consumer demands agilely.

The results showed that there were no variables classified as Autonomous and Linkage. Autonomous variables are variables that are not related to the system, while Linkage variables are very unstable and can affect the system (Poduval et al., 2015). Thus, all variables are relevant and important to the system, and there were no variables that disturbed the system's stability.

Variables with high driving power and low dependence were categorized into Independent groups. The variables in this sector were agility variables, consisting of “customer sensitivity”, “process integration”, “collaborative relationship”, and “information integration”. Company management should manage these variables more carefully because they help the company achieve sustainability at the highest level in the ISM structural model. These variables were the driving power for other dependent variables, so they must be prioritized.

CONCLUSIONS

The relationship between agility and sustainability variables in the poultry supply chain during the COVID-19 pandemic in Indonesia was successfully modeled. Four sustainability variables, namely “economic resilience”, “social well-being”, “environmental integrity”, and “good governance”, represented the company's strategic goals at the top level. The agility variable “customer sensitivity” acts as a key driver at the lowest level to support Indonesian poultry supply chain sustainability during the COVID-19 pandemic. On top of that are the remaining agility variables “process integration”, “collaborative relationship”, and “information integration”. None of the agility and sustainability variables are classified into Linkage and Autonomous groups. Four agility variables are categorized as Independent, whereas four sustainability variables are categorized as Dependent.

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