Available online at : http://josi.ft.unand.ac.id/

Jurnal Optimasi Sistem Industri

| ISSN (Print) 2088-4842 | ISSN (Online) 2442-8795 |

Research Article

Interrelationship Performance Indicators Model of Agile Supply Chain Management in Palm Oil Industry

Rangga Primadasa, Bellachintya Reira Christata

Department of Industrial Engineering, Faculty of Engineering, Universitas Muria Kudus, Kudus 59327, Central Java, Indonesia

ARTICLE INFORMATION

Received : January 11, 2023
Revised : May 5, 2023
Available online : May 31, 2023

KEYWORDS

Agile Supply Chain Management, Palm Oil Industry, ISM, MICMAC

CORRESPONDENCE

Phone : +6281391299055
E-mail : rangga.primadasa@umk.ac.id

A B S T R A C T

This paper tries to model agile supply chain management performance indicators in the palm oil industry. The interpretative Structural Modeling (ISM) method is used to find the relationship between these indicators. The ISM stages begin with identifying indicators, compiling contextual relationships, compiling reachability matrices, compiling level partitions, compiling digraphs, and compiling ISM models. Then MICMAC analysis is used to group each of these indicators into four categories based on their driving power and dependence power. In this study, 16 hands of agile supply chain management in the palm oil industry were obtained, of which the four-level ISM model could be constructed. Two indicators are at level 4, six hands are at level 3, three indicators are at level 2, and five indicators are at level 1. Meanwhile, through MICMAC analysis, five indicators are found in the independent indicators category, six hands are in the linkage indicator category, four indicators are included in the dependent indicator category, and one indicator is in the autonomous indicator category. This research can be used by managers in the palm oil industry who want to increase agility in their supply chain. In general, indicators at level 4 can affect indicators at level 3, and so on. So that management can start fixing the indicators at level 4 first. In addition, indicators that have a driving power value in MICMAC analysis can be prioritized to improve their performance.

INTRODUCTION

The palm oil industry is an important commodity industry for Indonesia. CPO production in 2021 will reach 46.88 million tons, 0.31 percent lower than 2020 production reached 47,034 million tons. Then the export value of palm oil in 2021 reached 34.2 million tons, which includes Crude Palm Oil (CPO), Palm Kernel Oil (PKO), and oleochemicals. This export value rose 0.6 percent from 2020 that reached 34.0 million tons. Meanwhile, domestic palm oil consumption in 2021 reached 18.422 million tons, up six percent from 2020 which reached 17,349 million tons. The increase in local consumption is around 6 percent for food, 25 percent for oleochemicals, and 2 percent for biodiesel [1].

The palm oil industry and its derivatives face the challenges of price and demand fluctuations. For example, cooking oil which is the main food product made from CPO has increased significantly since the end of 2021, when bulk cooking oil in December 2021 touched the price of Rp18,400/kg for consumers, then increased again in January 2022 to reach Rp18,550/kg [2]. One of the causes of the increase in cooking oil prices is the rising CPO price, which in January 2022 reached Rp13,244/kg, an increase of 77 percent from January 2021 prices [3]. The increase in cooking oil prices has caused the government to have a moratorium on the export of CPO and its derivatives since 28 April 2022, which was finally revoked on 21 May 2022 [4]. The fluctuations in demand and prices, coupled with changing government policies, have forced the palm oil industry and its entire supply chain to be agile.

Agility is defined as an effective response to a changing, unpredictable environment [5]. Agile supply chain management itself is a practice of integrating agility in managing the supply chain, the main thing is to apply the strategy of "quick response" and "time compression" in the delivery of products and services to consumers at reasonable prices, meaning that the entire supply chain must also have the capacity to apply the right technology and strategic management to support the company's goals [6]. Implementing agile strategies has the advantage of being quick and efficient in responding to changes in market demand [7].

Research on agile supply chain management has been carried out, among others [8] which examines the opportunities and constraints of agile supply chain management in multinational corporations. Then research from [6] who designed the 11 steps on an agile supply chain for the footwear industry. Other research [5] focuses on identifying the impact of an agile supply chain on profitability. Many studies on agile supply chain management

DOI: 10.25077/josi.v22.n1.p1-8.2023

have been carried out, but none have focused on developing agile supply chain management models in the palm oil industry.

The ISM method and MIMCAC analysis were used in this study. Interpretative structural modeling is used to develop a more structured model [9]. The ISM method can be used to develop an effective multi-hierarchy model of multivariate problems [10]. Meanwhile, MICMAC analysis is an analytical technique to determine driving power and dependence factors [11].

This study has the objectives of (1) identifying performance indicators for agile supply chain management in the palm oil industry, (2) developing interpretative structural modeling (ISM) between agile supply chain management indicators in the oil palm industry, (3) classifying and analyzing each agile supply chain performance indicator of palm oil industry using MICMAC analysis.

This paper consists of five parts. After the introduction, it will be followed by the method. Then the third part is the results and discussion. The fourth part is the conclusion, and the last fifth is the managerial implications.

METHOD

In general, this research is divided into three sub-stages, the first sub-stage is to identify agile supply chain management (ASCM) performance indicators for the palm oil industry, the second sub-stage is the preparation of an interpretative structural modeling (ISM) ASCM model between performance indicators. The second sub-stage itself is quite long, including the creation of contextual relationships between indicators, the creation of a structural-self interaction matrix, the creation of the reachability matrix, the creation of level partitions, the creation of digraphs, the replacement of variable nodes with indicator statements [12]. The third sub-step performs the MICMAC analysis.

Step 1: Determines Agile Supply Chain Management Performance Indicators

At this stage, a literature review is conducted to identify agile supply chain performance indicators for the palm oil industry. Previously, Primadasa et al. [12] used this literature review method to identify green supply chain performance indicators for the palm oil industry from journal papers related to GSCM. Meanwhile, for this research, all journal papers related to agile supply chain management will be reviewed, plus the development of indicators through a field study process.

Step 2: Create Contextual Relationship Between Agile Supply Chain Indicator with Structural Self Interaction Matrix (SSIM)

The relationship between factors or indicators was identified by involving a group of experts [14]. The relationship between these indicators is shown in the form of a structural self-interaction matrix (SSIM) [15]. The code letters V, A, X, and O are used to compare indicators, V is used if indicator i affect indicator j, A is used if indicator j affects indicator i, X is used if indicators affect each other, and O is used if indicators do not affect each other [16].

Step 3: Create Reachability Matrix

The reachability matrix is the conversion of the SSIM matrix into a binary matrix by replacing V, A, X, and O with 0 and 1 [17]. The matrix is called the initial reachability matrix with the following conversion rules:

If the SSIM is written V, then the reachability matrix is written 1 for entries (i,j) and 0 for entries (j,i)

If the SSIM is written A, then the reachability matrix is written 0 for entries (i,j) and 1 is written for entries (j,i)

If the SSIM is written X, then the reachability matrix is written 1 on entry (i,j) and entry (j,i)

If the SSIM is written O, then the reachability matrix is written 0 on the entry (i,j) and entry (j,i)

Furthermore, the transitivity check is carried out with the rules where if indicator I is related to indicator II, and indicator II is related to indicator III, then indicator I is related to indicator III [18]. The final results of the transitivity check are shown in the final reachability matrix table.

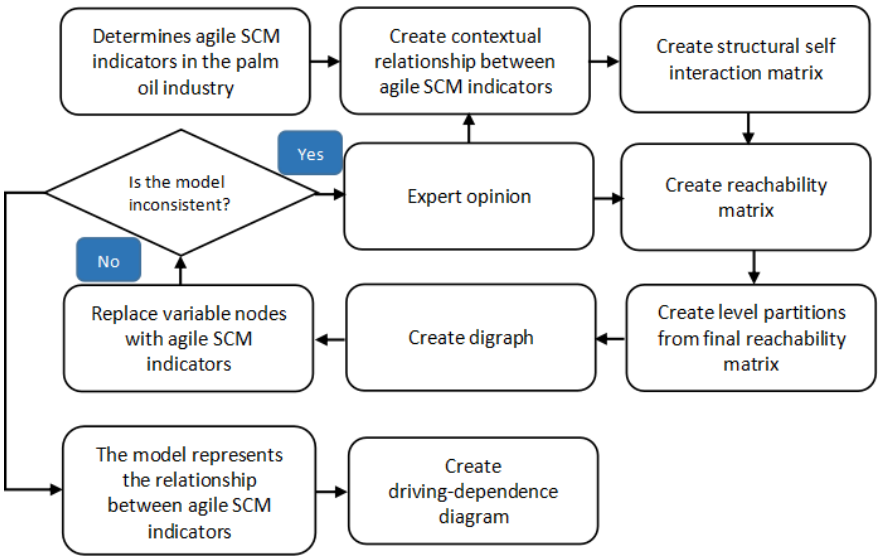

Figure 1. Flowchart of Research Stages

 DOI: 10.25077/josi.v22.n1.p1-8.2023

Step 4: Create Level Partitions

At this stage, the partition level for each indicator is determined, derived from the intersection set which is the intersection between the antecedent set and the reachability set [19]. If the antecedent set or reachability set can be "eliminated" for the first time in the first iteration, it enters level 1.

Step 5: Create Digraph

The digraph describes the relationship between factors and the level of each factor is displayed in the form of number nodes [20]. Transitivity has been omitted in the digraph [20].

Step 6: Create ISM Model

The arranged digraph is converted into an ISM model by replacing nodes with identified indicators [21].

Step 7: MICMAC Analysis

At this stage, the partition level for each indicator is determined, MICMAC analysis is done by grouping each indicator into a driving power-dependence diagram consisting of four types of indicators, namely autonomous indicators (bottom-left), dependent indicators (bottom-right), independent indicators (top-left), and linkage indicators (top-right) [22]. The position of each indicator in the diagram is determined by adding up the horizontal values in the final reachability matrix for driving power and adding up the vertical values for dependence power.

RESULTS AND DISCUSSION

Agile Supply Chain Performance Indicators for Palm Oil Industries

In this study, 16 agile supply chain performances were obtained for the palm oil industries as shown in Table 1. While in another study [23], seven supply chain agility criteria were obtained. However, in general, seven indicators obtained in previous studies [23] have been directly or indirectly obtained in this study, for example, the firm ability to accommodate a change in orders is in indicator A5 in this study, then indicators of ease of sharing information between suppliers and customer by the A2 indicator in this study.

Sustainable Supply Chain Indicators Matrix (SSIM) and Reachability Matrix

The relationship between agile supply chain indicators in the palm oil industry is shown in the structural self-interaction matrix (SSIM) shown in Table 2. Then the SSIM display with codes V, A, X, and O is changed in the reachability matrix shown in Table 3 with binary codes 1 and 0. After checking the transitivity, it is displayed in the form of the final reachability matrix in Table 4.

Level Partitions and Digraph

The level of each agile supply chain indicator for the palm oil industry appears after going through four iterations and is shown in Table 5, namely the final level partitions. Each level is then visualized through graphs as shown in Figure 2. As shown in the digraph, it can be seen that five indicators are at level 1, 3 indicators are at level 2, six indicators are at level 3, and two indicators are at level 4.

Interpretative Structural Modeling (ISM) Agile Supply Chain Performance Indicators for Palm Oil Industries

In previous studies [13], both objects were the palm oil industry and also used the ISM method, but to find the ISM Green Supply Chain Performance Indicators model, a model with three levels was obtained, while this study obtained four levels. Level 4 of this research consists of indicator A11, namely

Table 1. Agile Supply Chain Performance Indicators for Palm Oil Industries

Code	Agile SCM Performance Indicators	Ref.
A1	Quality relationship with suppliers	[24]
A2	Connectivity between companies in the supply chain	[24]
A3	Quality of the relationship between plantations, transportation and palm oil mill	Development
A4	Opportunity seeking	[25]
A5	Anticipating and responding to change	[25]
A6	Service level improvement	[5]
A7	Collaborative planning	[5]
A8	Managerial decisiveness	[23]
A9	Data processing models capabilities	[23]
A10	Advance technology and organization adoption	[26]
A11	Customer/marketing sensitivity	[27]
A12	Delivery reliability	[28]
A13	Dynamic production scheduling	[29]
A14	Loading ramp capacity (to accommodate FFB)	Development
A15	Storage tank capacity (to accommodate CPO)	Development
A16	CPO quality (FFA content, water content, impurities)	Development

Table 2. Structural Self Interaction Matrix (SSIM) Agile Supply Chain Management Performance Indicators for Palm Oil Industry

Code	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2
A1	O	O	O	O	O	O	A	O	A	A	O	V	O	X	A
A2	O	O	O	O	A	X	O	O	O	X	O	V	V	A	
A3	V	O	O	V	A	V	A	O	O	V	O	V	V		
A4	O	O	O	A	A	A	A	A	A	A	A	A			
A5	O	A	A	A	A	A	A	A	A	A	O				
A6	O	A	O	A	A	A	O	O	O	O					
A7	O	O	O	V	O	V	O	O	O						
A8	O	O	O	V	V	V	V	V							
A9	O	O	O	O	O	O	A								
A10	O	O	O	O	O	V									
A11	O	O	O	A	A										
A12	O	O	O	O											
A13	O	A	A												
A14	O	O													
A15	O														

Table 3. Initial Reachability Matrix Agile Supply Chain Management Performance Indicators for Palm Oil Industry

Code	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
A1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
A2	0	0	0	0	0	1	0	0	0	1	0	1	1	0	1	1
A3	1	0	0	1	0	1	0	0	0	1	0	1	1	1	1	1
A4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
A5	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
A6	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
A7	0	0	0	1	0	1	0	0	0	1	0	1	1	1	1	1
A8	0	0	0	1	1	1	1	1	1	0	0	1	1	0	0	1
A9	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0
A10	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	1
A11	0	0	0	0	0	1	0	0	0	0	1	1	1	0	1	0
A12	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	0
A13	0	0	0	1	0	1	0	0	0	0	1	1	1	0	0	0
A14	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0
A15	0	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0
A16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

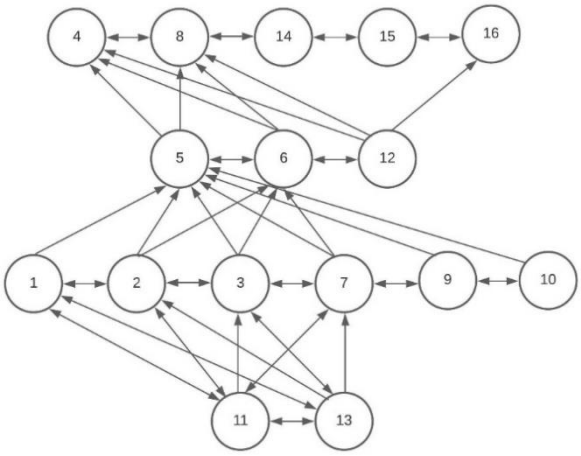

Figure 2. Digraph Agile SCM Performance Indicators of Palm Oil Industri

Table 4. Final Reachability Matrix Agile Supply Chain Management Performance Indicators for Palm Oil Industry

Code	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	Driving Power
A1	1	0	0	1	0	1	0	0	0	1	0	1	1	1	1	1	**9**
A2	1	0	0	1	0	1	0	0	0	1	1	1	1	1	1	1	**10**
A3	1	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	**9**
A4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**
A5	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	**2**
A6	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	**2**
A7	1	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	**9**
A8	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	**14**
A9	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	**3**
A10	1	0	0	1	0	1	1	1	0	1	1	1	1	1	1	1	**12**
A11	1	0	0	1	0	1	0	0	0	1	1	1	1	1	1	1	**10**
A12	1	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1	**13**
A13	1	0	0	1	0	1	0	0	0	1	1	1	1	1	1	1	**10**
A14	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1	1	**11**
A15	1	1	0	1	0	1	0	0	0	1	1	1	1	1	1	1	**11**
A16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Depend-ence	**12**	**1**	**1**	**10**	**2**	**10**	**3**	**4**	**1**	**11**	**11**	**13**	**15**	**11**	**11**	**11**	

 DOI: 10.25077/josi.v22.n1.p1-8.2023

Tabel 5. Final Level Partitions

Code	Reachability Set	Antecedent Set	Intersec-tion Set	Level
A1	1,2,3,4,5,7,11,13,16	1,2,3,7,8,10,11, 12,13,14,15	1,2,3,7,11, 13	3
A2	1,2,3,4,5,6,7,11,13, 16	1,2,3,7,8,10,11, 12,13,14,15	1,2,3,7,11, 13	3
A3	1,2,3,4,5,6,7,13,16	1,2,3,7,8,10,11, 12,13,14,15	1,2,3,7,13	3
A4	4	1,2,3,4,5,6,7,8,9, 10,11,12,13,14,15	4	1
A5	4,5	1,2,3,5,7,8,9,10, 11,12,13,14,15	5	2
A6	4,6	2,3,6,7,8,10,11, 12,13,14,15	6	2
A7	1,2,3,4,5,6,7,11,1	1,2,3,7,8,10,11, 12,13,14,15	1,2,3,7,11	3
A8	1,2,3,4,5,6,7,8,9, 10,11,12,13,16	8	8	1
A9	4,5,9	8,9,10,12	9	3
A10	1,2,3,4,5,6,7,9,10, 11	8,10,12	10	3
A11	1,2,3,4,5,6,7,11,13, 16	1,2,7,8,10,11,12, 13,14,15	1,2,11,13	4
A12	1,2,3,4,5,6,7,9,10, 11,12,13,16	8,12	12	2
A13	1,2,3,4,5,6,7,11,13, 16	1,2,3,8,10,11,12, 13,14,15	1,2,3,11,1 3	4
A14	1,2,3,4,5,6,7,11,13, 14,16	14	14	1
A15	1,2,3,4,5,6,7,11,13, 15,16	15	15	1
A16	16	1,2,3,7,8,10,11,12, 13,14,15,16	16	1

Customer/marketing sensitivity, and indicator A13, namely Dynamic production scheduling. Level 3 previous research [13] has one indicator, namely BOD (Biological Oxygen Demand) while this study consists of six indicators including quality relationships with suppliers, connectivity between companies in the supply chain, quality of the relationship between plantations, transportation, and palm oil mills, collaborative planning, data processing models capabilities, advanced technology, and organization adoption. Level 2 previous research [13] consists of four indicators including water generated before recycled, acidification potential, COD, and % waste reused. While level 2 of this research, only three indicators were found, including anticipating and responding to change, service level improvement, and delivery reliability. The previous level 1 research [13] obtained six indicators while this study found five indicators including opportunity seeking, managerial decisiveness, loading ramp capacity, storage tank capacity, and CPO quality. In general, agile supply chain indicators at level 4 affect hands at level 3, and so on. Details of the ISM model of agile performance indicators obtained can be seen in Figure 3.

The results of this study expand the development of research on agile supply chain where the agile supply chain indicators are modeled by the relationship between the indicators, while in previous studies [23] tends to be more on grouping based on the level of influence of the indicator. In studies related to the supply chain of palm oil, this research provides a new body that emphasizes the relationship of agility indicators while previous studies [30] emphasizing on agility based on network design in its palm oil supply chain.

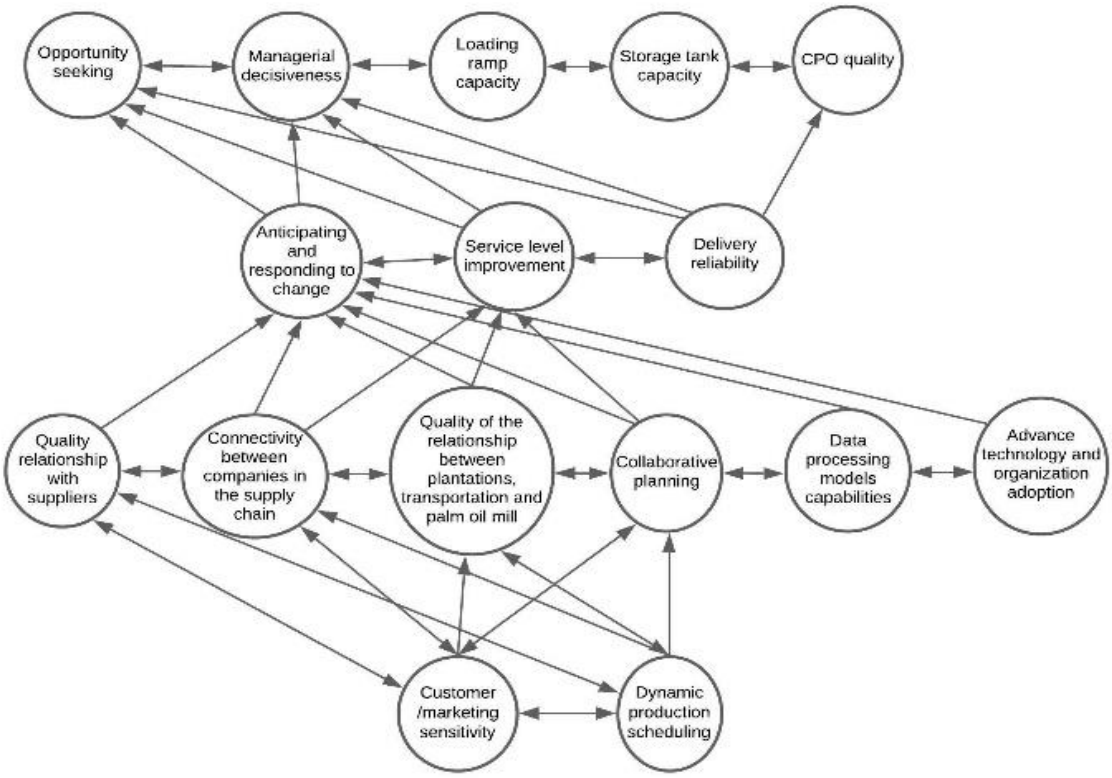

Figure 3. Agile SCM Performance Indicators Model of Palm Oil Industry

MICMAC Analysis

In this study, there is only one indicator that is included in autonomous indicators, namely the A9 indicator, data processing models capabilities. While in the previous study [13], five indicators were categorized as autonomous indicators. Indicators that fall into the autonomous category have less drive power and less power, as well as a disconnect from other indicators [31].

This study found four indicators that fall into the category of dependent indicators, namely opportunity seeking (A4), anticipating and responding to change (A5), service level improvement (A6), and CPO quality (A16). While in previous research [13] there is only one indicator that falls into this category, namely global warming potential. Indicators that fall into this category are generally dependent on other indicators [32].

Linkage indicators in this study obtained six indicators, namely the quality relationship with suppliers (A1), connectivity between companies in the supply chain (A2), quality of the relationship between plantations, transportation, and palm oil mill (A3), collaborative planning (A7), customer/marketing sensitivity (A11), and dynamic production scheduling (A13). Meanwhile, in the previous study [13] there were no indicators that were categorized as linkage indicators. Indicators that fall into the linkage category are indicators that have a greater impact on other indicators [33] category, namely global warming potential. Indicators that fall into this category are generally dependent on other indicators. Independent indicators in this study include managerial decisiveness (A8), advanced technology and organization adoption (A10), delivery reliability (A12), loading ramp capacity (A14), storage tank capacity (A15). While in previous research [13], there was not a single indicator that was categorized as the independent indicator. Indicators that fall into this category have a strong driving power and have a strong influence on other indicators (Figure 4) [34].

CONCLUSION

Performance indicators for agile supply chain management of the palm oil industry obtained a number of 16 indicators including the quality relationship with suppliers, connectivity between companies in the supply chain, quality of the relationship between plantations, transportation, and palm oil mill, opportunity seeking, anticipating and responding to change, service level improvement, collaborative planning, managerial decisiveness, data processing models capabilities, advance technology and organization adoption, customer/marketing sensitivity, delivery reliability, dynamic production scheduling, loading ramp capacity, storage tank capacity, and CPO quality. Interpretative Structural Modeling (ISM) Agile Supply Chain Performance Indicators for palm oil industries consist of four levels, where there are two indicators at level 4, namely: customer/marketing sensitivity and dynamic production scheduling. Level 3 has six indicators, namely quality relationship with suppliers, connectivity between companies in the supply chain, quality of the relationship between plantations, transportation, and palm oil mill, collaborative planning, data processing models capabilities, advance technology and organization adoption. Then level 3 consists of three indicators including anticipating and responding to change, service level improvement, and delivery reliability. Finally, level 1 consists of five indicators, namely opportunity seeking, managerial decisiveness, loading ramp capacity, storage tank capacity, and CPO quality. The results of MICMAC Analysis put five indicators into the category of independent indicators including managerial decisiveness, advance technology and organization adoption, delivery reliability, loading ramp capacity, and storage tank capacity. Then six indicators are categorized as linkage indicators, namely quality relationship with suppliers, connectivity between companies in the supply chain, quality of the relationship between plantations, transportation, and palm oil mill, collaborative planning, customer/marketing sensitivity,

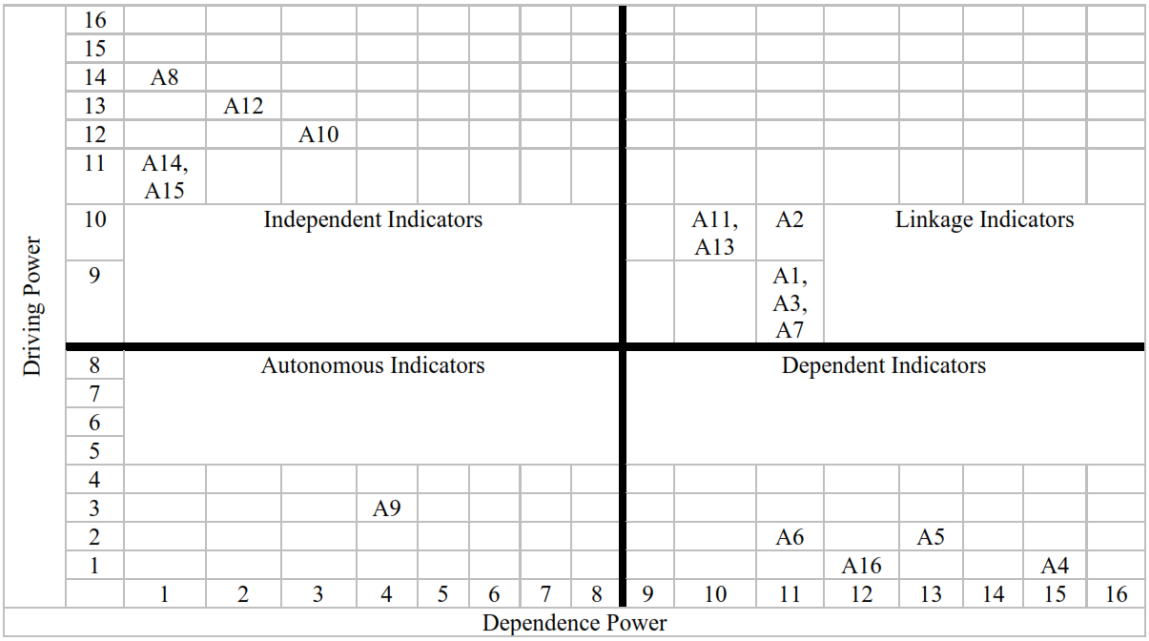

Figure 4. Driving Power-Dependence Diagram

 DOI: 10.25077/josi.v22.n1.p1-8.2023

dynamic production scheduling. Meanwhile, four indicators are categorized as dependent indicators including opportunity seeking, anticipating and responding to change, service level improvement, and CPO quality. Finally, there is only one indicator that is included in autonomous indicators, namely data processing models capabilities.

Managerial Implications

The results of this study can be used by managerial parties in the palm oil industry if they want to make their supply chain more agile then priority can be given to those at level-4, followed by level-3, level-2, and level-1 indicators. Because in the ISM agile SCM model in Figure 3, which is formed in general, if the level-4 level such as customer/marketing sensitivity and dynamic production scheduling can be improved, it will affect the improvement of level-3, and so on. However, the results of the MICMAC analysis also need to be considered, for example, indicators that are in the category of independent indicators that have a higher driving power value than other categories can be prioritized.

REFERENCES

[1] GAPKI, "Kinerja Industri Sawit 2021 & Kinerja 2022," 2022. [Online]. Available: https://gapki.id/news/20519/kinerja-industri-sawit-2021-prospek-2022

[2] CNBC Indonesia, "Bunda Jangan Ngamuk, Ini 3 Penyebab Harga Minyak Goreng Mahal," 2022. https://www.cnbcindonesia.com/news/20220106062500-4-304982/bunda-jangan-ngamuk-ini-3-penyebab-harga-minyak-goreng-mahal

[3] Katadata, "https://katadata.co.id/agung/berita/6233ff14d5695/kenapa-minyak-goreng-mahal-ini-tiga-alasannya," 2022. https://katadata.co.id/agung/berita/6233ff14d5695/kenapa-minyak-goreng-mahal-ini-tiga-alasannya

[4] P. P. B. K. DPR RI, "Dampak Kebijakan Larangan Mudik," 2022. [Online]. Available: https://berkas.dpr.go.id/puslit/files/info_singkat/Info Singkat-XIV-10-II-P3DI-Mei-2022-230.pdf

[5] R. Abdoli Bidhandi and C. Valmohammadi, "Effects of supply chain agility on profitability," Bus. Process Manag. J., vol. 23, no. 5, pp. 1064–1082, 2017, doi: 10.1108/BPMJ-05-2016-0089.

[6] U. Abdul Kadar, S. R. Devadasan, and K. Balakrishnan, "Design of agile supply chain model for footwear industry," Int. J. Bus. Excell., vol. 17, no. 2, pp. 230–244, 2019, doi: 10.1504/IJBEX.2019.097545.

[7] D. M. Gligor, C. L. Esmark, and M. C. Holcomb, "Performance outcomes of supply chain agility: When should you be agile?," J. Oper. Manag., vol. 33–34, pp. 71–82, 2015, doi: 10.1016/j.jom.2014.10.008.

[8] P. V. Zhukov, A. A. Silvanskiy, K. Y. Mukhin, and O. L. Domnina, "Agile supply chain management in multinational corporations: Opportunities and barriers," Int. J. Supply Chain Manag., vol. 8, no. 3, pp. 416–425, 2019.

[9] J. R. Jadhav, S. S. Mantha, and S. B. Rane, "Development of framework for sustainable Lean implementation : an ISM approach," J Ind Eng Int, 2014, doi: 10.1007/s40092-014-0072-8.

[10] Y. Han, R. Zhou, Z. Geng, J. Bai, B. Ma, and J. Fan, "A novel data envelopment analysis cross-model integrating interpretative structural model and analytic hierarchy process for energy efficiency evaluation and optimization modeling: Application to ethylene industries," J. Clean. Prod., vol. 246, 2020, doi: 10.1016/j.jclepro.2019.118965.

[11] S. Mithun, A. Hossen, Z. Mahtab, G. Kabir, S. Kumar, and H. Adnan, "Barriers to lean six sigma implementation in the supply chain : An ISM model," Comput. Ind. Eng., vol. 149, no. January 2019, p. 106843, 2020, doi: 10.1016/j.cie.2020.106843.

[12] R. Primadasa and D. Tauhida, "Hubungan antar Hambatan Green Supply Chain Management (GSCM) pada Industri Kelapa Sawit di Indonesia," J. Optimasi Sist. Ind., vol. 19, no. 1, p. 40, 2020, doi: 10.25077/josi.v19.n1.p40-49.2020.

[13] R. Primadasa, A. Sokhibi, and D. Tauhida, "Interrelationship of Green Supply Chain Management (GSCM) Performance Indicators for Palm Oil Industry in Indonesia," 2019, doi: 10.1088/1757-899X/598/1/012034.

[14] Z. Yang and Y. Lin, "The effects of supply chain collaboration on green innovation performance:An interpretive structural modeling analysis," Sustain. Prod. Consum., vol. 23, pp. 1–10, 2020, doi: 10.1016/j.spc.2020.03.010.

[15] S. Dhir and S. Dhir, "Modeling of strategic thinking enablers: a modified total interpretive structural modeling (TISM) and MICMAC approach," Int. J. Syst. Assur. Eng. Manag., vol. 11, no. 1, pp. 175–188, 2020, doi: 10.1007/s13198-019-00937-z.

[16] X. Gan, R. Chang, J. Zuo, T. Wen, and G. Zillante, "Barriers to the transition towards off-site construction in China: An Interpretive structural modeling approach," J. Clean. Prod., vol. 197, pp. 8–18, 2018, doi: 10.1016/j.jclepro.2018.06.184.

[17] A. Verma, N. Seth, and N. Singhal, "Application of Interpretive Structural Modelling to establish Interrelationships among the Enablers of Supply Chain Competitiveness," Mater. Today Proc., vol. 5, no. 2, pp. 4818–4823, 2018, doi: 10.1016/j.matpr.2017.12.056.

[18] C. Singh, D. Singh, and J. S. Khamba, "Developing a conceptual model to implement green lean practices in Indian manufacturing industries using ISM-MICMAC approach," J. Sci. Technol. Policy Manag., vol. 12, no. 4, pp. 587–608, 2020, doi: 10.1108/JSTPM-08-2019-0080.

[19] N. Lamba and P. Thareja, "Modelling of barriers pertaining to implementation of green supply chain management using ISM approach," Mater. Today Proc., no. xxxx, 2020, doi: 10.1016/j.matpr.2020.09.488.

[20] M. N. Patel, A. A. Pujara, R. Kant, and R. K. Malviya, "Assessment of circular economy enablers: Hybrid ISM and fuzzy MICMAC approach," J. Clean. Prod., vol. 317, no. July, p. 128387, 2021, doi: 10.1016/j.jclepro.2021.128387.

[21] M. Movahedipur, J. Zeng, M. Yang, and X. Wu, "An ISM approach for the barrier analysis in implementing sustainable supply chain management: An empirical study," Manag. Decis., vol. 55, no. 8, pp. 1824–1850, 2017, doi: 10.1108/MD-12-2016-0898.

[22] A. H. Azadnia, G. Onofrei, and P. Ghadimi, "Electric vehicles lithium-ion batteries reverse logistics implementation barriers analysis: A TISM-MICMAC

approach," Resour. Conserv. Recycl., vol. 174, no. May, p. 105751, 2021, doi: 10.1016/j.resconrec.2021.105751.

[23] A. Jindal, S. K. Sharma, K. S. Sangwan, and G. Gupta, "Modelling Supply Chain Agility Antecedents Using Fuzzy DEMATEL," Procedia CIRP, vol. 98, pp. 436–441, 2021, doi: 10.1016/j.procir.2021.01.130.

[24] D. M. Gligor and M. C. Holcomb, "Understanding the role of logistics capabilities in achieving supply chain agility: A systematic literature review," Supply Chain Manag., vol. 17, no. 4, pp. 438–453, 2012, doi: 10.1108/13598541211246594.

[25] S. Fayezi, A. Zutshi, and A. O'Loughlin, "Understanding and Development of Supply Chain Agility and Flexibility: A Structured Literature Review," Int. J. Manag. Rev., vol. 19, no. 4, pp. 379–407, 2017, doi: 10.1111/ijmr.12096.

[26] M. Balaji, V. Velmurugan, and C. Subashree, "TADS: An assessment methodology for agile supply chains," J. Appl. Res. Technol., vol. 13, no. 5, pp. 504–509, 2015, doi: 10.1016/j.jart.2015.10.002.

[27] V. Jain, L. Benyoucef, and S. G. Deshmukh, "A new approach for evaluating agility in supply chains using Fuzzy Association Rules Mining," Eng. Appl. Artif. Intell., vol. 21, no. 3, pp. 367–385, 2008, doi: 10.1016/j.engappai.2007.07.004.

[28] B. Talukder, G. P. Agnusdei, K. W. Hipel, and L. Dubé, "Multi-indicator supply chain management framework for food convergent innovation in the dairy business," Sustain. Futur., vol. 3, no. April 2020, p. 100045, 2021, doi: 10.1016/j.sftr.2021.100045.

[29] F. E. Minguillon and G. Lanza, "Coupling of centralized and decentralized scheduling for robust production in agile production systems," Procedia CIRP, vol. 79, no. i, pp. 385–390, 2019, doi: 10.1016/j.procir.2019.02.099.

[30] A. P. Chaidir, "Flexible Supply Chain Network Design For CPO Derivatives," J. Basic Sci. Technol., vol. 9, no. 3, pp. 86–93, 2020, [Online]. Available: www.iocscience.org/ejournal/index.php/JBST

[31] S. Phogat and A. K. Gupta, "Development of framework for just-in-time implementation in maintenance: An ISM-MICMAC approach," J. Qual. Maint. Eng., vol. 24, no. 4, pp. 488–510, 2018, doi: 10.1108/JQME-08-2017-0052.

[32] M. Ahmad, X. Tang, J. Qiu, and F. Ahmad, "Applied Sciences Interpretive Structural Modeling and MICMAC Analysis for Identifying and Benchmarking Significant Factors of Seismic Soil Liquefaction," no. 1964, doi: 10.3390/app9020233.

[33] B. Ruben R, V. S., and A. P., "ISM and Fuzzy MICMAC application for analysis of Lean Six Sigma barriers with environmental considerations," Int. J. Lean Six Sigma, vol. 9, no. 1, pp. 64–90, 2018, doi: 10.1108/IJLSS-11-2016-0071.

[34] W. Wang, X. Liu, Y. Qin, J. Huang, and Y. Liu, "Assessing contributory factors in potential systemic accidents using AcciMap and integrated fuzzy ISM - MICMAC approach," Int. J. Ind. Ergon., vol. 68, no. July, pp. 311–326, 2018, doi: 10.1016/j.ergon.2018.08.011.

AUTHOR(S) BIOGRAPHY

Rangga Primadasa, S.T., M.T.
Studying in Industrial Engineering, University of Muhammadiyah Malang 2007-2012. After graduating, worked as an Assistant Processing Palm Oil Mill in East Kotawaringin, Central Kalimantan for 2 years (2012-2014). Then 2015-2017 Studying a Master's Degree in Industrial Engineering at the Islamic University of Indonesia. Then In 2018-now work as a lecturer in Industrial Engineering Study Program at Muria Kudus University.

Bellachintya Reira Christata, S.T., M.T.
Studied Industrial Engineering at Atma Jaya University Yogyakarta 2015-2019. Continuing a master's study in Industrial Engineering in 2019-2021. After graduating, she worked as a PPIC at PT. Pura Barutama. 2022-present as a lecturer in Industrial Engineering Study Program at Muria Kudus University.

 DOI: 10.25077/josi.v22.n1.p1-8.2023