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Institutional Development in the Supply Chain System of Oil Palm Agroindustry in South Kalimantan

Hesty Heryani[1*], Agung Cahyo Legowo[1], Noor Ridha Yanti[2], Marimin[3], Sapta Raharja[3], Machfud[3], Taufik Djatna[3], Sri Martini[3], Taufik Baidawi[3], Irawan Afrianto[3]

[1]*Department of Agro-industrial Technology, Faculty of Agriculture, University of Lambung Mangkurat, Banjarbaru 70714, Indonesia*
[2]*Department of Public Health, Faculty of Science and Technology, University of Cahaya Bangsa, Banjar, 70122, Indonesia*
[3]*Department of Agro-industrial Technology, Faculty of Agricultural Technology, Bogor Agricultural University, Bogor 16680, Indonesia*

Abstract. Developing oil palm agroindustry in South Kalimantan involves internal and external factors for its sustainability. The long distance of each stakeholder requires a digitally connected system. The research aimed at identifying criteria, sub-criteria, and alternatives in the developed network model, determine the sensitivity to determine the relevance of actor's role, determine the effectiveness and efficiency before and after implementation of the system, and analyse the level of certainty and importance of assumptions developed. The methods used were surveys, focus group discussions, and questionnaires. Experts in the Analytical Network Process (ANP) method were from academia, business, society and government. Supply Chain Operation Reference (SCOR) method to analyse supply chain performance involved 178 respondents. The level of certainty and importance of assumptions was with Strategic Assumption Surfacing and Testing (SAST). The results of the analysis show there was an interdependence between the sub-criteria on the specified criteria and alternatives applied to achieve the goals. Pairwise comparisons showed the highest sub-criteria cluster was the replanting program with a weight of 0.662, for alternative cluster the highest priority weight in the system involving all actors playing a role was 0.391, with relevant sensitivity test results. The results of the analysis of effectiveness and efficiency before and after implementation of the system showed an increase in SCOR value for all actors. The results of SAST analysis were in Quadrant I with the highest level of importance and certainty of 7.6 meaning very important and certain. The implications of the research results can be seen in fostering the use of technology in realizing transparency, especially regarding the price, quality, and traceability of fresh fruit bunches, the realization of a monitoring system for policymakers and capital assistance for independent oil palm smallholders.

Keywords: Analytical Network Process (ANP); Effectiveness; Efficiency; Strategic Assumption Surfacing and Testing (SAST); Supply Chain Operation Reference (SCOR)

1. Introduction

The agricultural sector, especially the oil palm plantation sub-sector, is experiencing rapid growth and involves the community, especially independent oil palm smallholders,

*Corresponding author's email: hheryani@ulm.ac.id, Tel.: +65-11-4772254, Fax.: +65-11-4772254
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on a large scale. On the other hand, the development of the CPO processing industry and its derivatives is in line with the growth in plantation areas and palm oil production as a source of raw materials for the cooking oil industry, industrial oil (cocoa butter substitute, margarine/shortening, oleo chemical, and soap) and fuel (biodiesel) (Lee et al., 2014; Hasibuan et al., 2018; Hidayati et al., 2018; Syahza & Asmit, 2019).

Based on data from the Central Statistics Agency (BPS) in 2019, 7.94 million hectares (54.42%) of oil palm land were controlled by private plantations, 6.04 million hectares (41.35%) by smallholders, and 0.62 million hectares (4.23%) by large state plantations. Palm oil production in 2019 was 30.06 million tons of Crude Palm Oil (CPO) (62.08%) from private plantations, 16.22 million tons (33.51%) from smallholder plantations and 2.13 million tonnes (4.41%) from large state plantations. The area of oil palm plantations in South Kalimantan reaches 497,261 ha, with Tanah Bumbu Regency reaching 73,865 ha, then Tanah Laut Regency reaching 73,121 ha (BPS, 2020).

Generally, Oil Palm Mills (PKS) obtain fresh fruit bunches (FFB) from plasma plantations, secondary cooperatives, independent oil palm farmers, and FFB traders. Independent smallholders are responsible for producing FFB for sale to mills (Matondang et al., 2020), however, independent smallholders are less informed than plasma smallholders (Alwarritzi et al., 2015; Marimin et al., 2020). For this reason, it is necessary to develop a system and strengthen institutions. Institutional development and supply chain systems strengthen organization's partnerships which work together during a business process in managing operations contributing to improved performance in individual supply chains for national and global economic development (Peters et al., 2011; Kauppi, 2013).

Currently, the traceability system supports supply chain sustainability management in two ways. First, production areas connected to the supply chain and second, identification of key actors operating in a given supply chain including producers, traders, shippers and consumers who are able to produce more cost-effective and coordinated interventions (Godar et al., 2016).

The various supply chain management (SCM) concepts have attracted the attention of several researchers conducting a supply chain assessment known as Leagile Supply Chain (LASC), information sharing (IS) and supply chain performance dimensions (Abdulameer et al., 2020) and market orientation, supply chain management of an industry (Ashari et al., 2018). Integrated supply chain collaboration for business performance based on a working model for strategic planning and operational multi-criteria analysis can use the Analytic Network Process method in comprehensive decision making (Dano et al., 2019; Aritonang et al., 2020; Heryani & Yanti, 2020). Jeon et al. (2017) and Rahmanda et al. (2017) use ANP as a supply chain collaboration for e-business performance-based framework to bring organizations to achieve competitive advantage.

This study aimed at identifying criteria, sub-criteria, and alternatives in the network model developed according to the goals set and to analyse the relevance of the roles of the actors by conducting a sensitivity test. The next stage was analyzing the supply chain performance of independent smallholders to determine the effectiveness and efficiency before and after implementation as well as analyzing the level of certainty and importance of the assumptions developed in the institutional network model of the palm oil supply chain system of independent smallholders in South Kalimantan.

2. Methods

2.1. Existing Conditions of Institutions in the Supply Chain

South Kalimantan currently did not have an information system involving actors intensively. Institutional strengthening in an effort to control sustainability for the independence of oil palm farmers was also covered in the system developed with Tanah Bumbu and Tanah Laut Regencies as research samples.

2.2 Identification of Criteria, Sub-criteria and Alternatives in the Network Model

The network model for institutional development in the supply chain system of the oil palm agroindustry in South Kalimantan was shown in Figure 1. The sample of respondents was determined by purposive sampling method where respondents made conclusive results in decision making (Etikan et al., 2016), and Network modeling using Super Decisions software version 2.10.0.

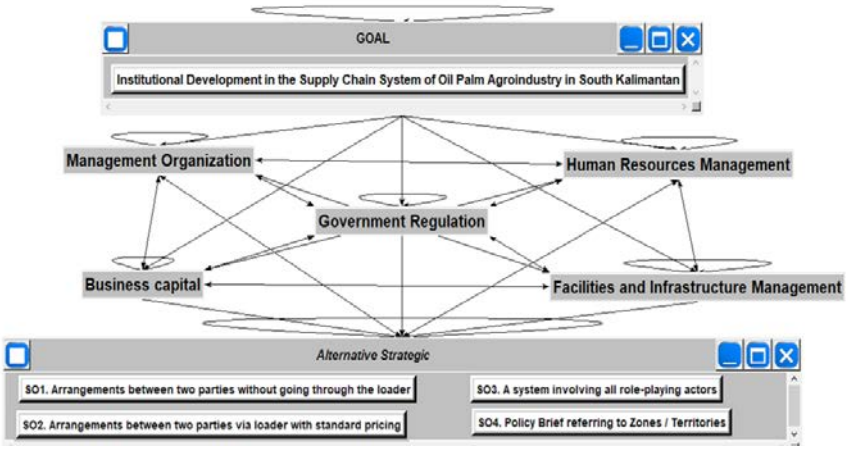


Figure 1 Model institutional development network in the supply chain system in the oil palm agroindustry in South Kalimantan

2.3. Determining the Relationship between Sub-criteria and Alternatives

The method in determining criteria, sub-criteria and alternatives referring to goals involved 178 respondents consisting of 5 academics, 5 government officials, 6 oil palm mill managers, 6 cooperative managers, 6 FFB traders and 150 independent oil palm farmers in the study area. The fulfilment of primary and secondary data required 24 surveys. For the pairwise comparison rating scale in the network model referred to Table 1 (Saaty, 2016).

Table 1 Pairwise Comparison Rating Scale

Level of Importance	Definition	Explanation
1	Equal importance	Both elements have the same effect
3	Slightly more importance	Assessment favours one element less than its partner
5	More importance	Assessment is very sided with one element than its partner
7	Very importance	One element is very influential and its dominance is evident
9	Absolutely more importance	One element is more important than its partner at the highest level of confidence.
2,4,6,8	Mean among the *judgments* above	There is doubt between 2 adjacent assessments.
Opposite	aij = 1 / aij (if for activity i gets one point when compared to activity j, then j has the opposite value compared to i).	

2.4. Determining the Weighting of Sub-criteria and Alternatives in the Network Model

In the ANP method using Super Decisions software version 2.10.0. weighting was carried out on all inter-cluster linkages and between nodes having more than one linkage from the network model questionnaire which had been assessed by including priority and alternative criteria (Ervural et al., 2018). The stages started from:

1) Weighting using the pairwise comparison method between two elements on a scale of nine until all elements were included.
2) Calculating the consistency ratio which stated whether the assessment given was consistent or not. The consistency index (CI) of a comparison matrix was calculated by the formula Equation 1:

$$CI = \frac{\lambda \max - n}{n-1} \quad (1)$$

λmax = the largest eigenvalue of the Matrix Pairwise Comparison n x n.
n = number of items being compared.

Consistency ratio (CR) was obtained by comparing the consistency index with the value of the random consistency index (RI), with the formula Equation 2:

$$CR = \frac{\text{CI}}{RI} \quad (2)$$

The random index was shown in Table 2, where N was the size of the matrix and IR was the random index. The value of the Random Consistency Index (RI) depended on the number of criteria used.

Table 2 Random index

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

The results were acceptable if the consistency ratio (CR) was 0.1 or not more than 10%. If the CR value was > 0.1, it was necessary to make improvements in filling out the questionnaire.

3) Next, a supermatrix was made, a matrix containing the eigenvector values and the relationships contained in the criteria and alternatives. In the cluster matrix, the results of the priority weights were obtained from the weighting of the linkages between nodes arranged in a matrix corresponding to the cell (unweighted supermatrix).
4) Then weighted supermatrix step was carried out whose value was obtained by multiplying the paired cluster comparison matrix.
5) It was continued with the normalized weighting by priority clusters to get the ideal alternative priority weights. Alternative rankings were shown in the normal column and the highest value was the best alternative.
6) Finally, did a sensitivity analysis to see how sensitive the network model with the resulting sub-criteria weights affected the alternative decision recommendations which would be implemented.

2.5. Supply Chain Performance Analysis

In developing and implementing the system in the field, the research team measured supply chain performance as institutional strengthening through a model framework Supply Chain Operation Reference (SCOR) designed by the Supply Chain Council (2012) and the SCOR model version 12.0 developed by supply chain professionals APICS Association (2017) taking into account the supply chain structure in each region (Palma-Mendoza, 2014; Marimin et al., 2020; Yadav et al., 2020). The calculation of the SCOR value was based on the supply chain scheme which had been made with the formula Equation 3:

$$Delivery\ Quantity\ Accuracy = \frac{Total\ number\ of\ order\ delivered\ match\ the\ order\ quantities}{Total\ number\ of\ order\ delivered}\ x\ 100\% \quad (3)$$

2.6. Strategic Assumption Surfacing and Testing (SAST)

To build strategic assumptions in the preparation of the program to strengthen the supply chain of independent smallholders, the Strategic Assumption Surfacing and Testing (SAST) method was used by Kholil and Sulistyadi (2017) and Rachmayanti et al. (2015) through FGD to experts, namely Academic, Business, Community and Government (ABCG). Determining the value of importance and certainty was with an ordinal scale for the importance of a scale of 1 – 7 (very unimportance-very importance). Likewise, for certainty, an ordinal scale of 1 – 7 was used (very uncertain-very certain).

3. Results and Discussion

3.1. Institutional supply chain of oil palm agroindustry in South Kalimantan Province

Development of a sustainable was to ensure traceability of the supply of fresh fruit bunches from plantations to oil palm mills. Traceability of the origin of fresh fruit bunches was important in efforts to prosper independent oil palm smallholders. The problem in the field was that external suppliers were not identified in the supply chain which had to be resolved by inviting them to join the cooperative.

Sources of fresh fruit bunches in Tanah Bumbu Regency were from Satui District, Angsana District, Kusan Hulu District, Mentewe District, Kusan Hilir District, Sungai Loban District, and Karang Bintang District. Meanwhile, for Tanah Laut Regency, they were from Batu Ampar, Kintap, Pelaihari, Jorong and Tambangre Districts. Cooperation for the fulfillment of FFB was also carried out by oil palm mills with intermediary traders for the delivery of FFB harvested by Independent Smallholders to oil palm mills.

The activities of strengthening the palm oil supply chain institutions were supported by associations, government, financial institutions, and primary actors to ensure the smooth running of the supply chain. The research team won the trust of the Oil Palm Plantation Fund Management Agency (BPDPKS) to successfully design an information system for assessing the performance of the palm oil supply chain with the website https://kinerjasawit.org/ as a strengthening of palm oil institutions.

The results of data and information collection through Focus Group Discussions (FGD) revealed that 80% of palm oil independent smallholders in the study area had joined as members of a cooperative (core-plasma partnership of palm oil companies) in supporting institutional strengthening of the supply chain of the agroindustry. The advantage was getting information on the source and location of palm oil commodities which was more transparent and easy to track. This was to ensure that fresh fruit bunches were produced from legal gardens, where smallholders had registered their plantations through a Cultivation Registration Certificate (STD-B).

As an effort to increase global competitiveness, the Government of Indonesia had developed the Indonesian Sustainable Palm Oil (ISPO) system for the demands of sustainability and legality on independent palm oil smallholders (McCarthy et al., 2012; Lee et al., 2014). Based on the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 21/Permentan/Kb.410/6/2017 concerning Guidelines for Plantation Business Licensing, it was stated that Farmers who cultivated oil palm less than 25 hectares were required to submit a Plantation Registration Certificate (STD-B).

3.2. Institutional supply chain of oil palm agroindustry in South Kalimantan Province

There were five clusters of criteria used in institutional development in the palm oil supply chain system as shown in Figure 1. Information on the relationship between sub-criteria was obtained from interviews and FGDs with decision makers. The decision-

making process would compare each alternative strategy based on existing criteria or sub-criteria and compare several sub-criteria with special reference to certain strategic alternatives. The results of the pairwise comparison questionnaire filled out by 178 respondents in the network model showed there was an inner dependence relationship, the relationship occuring between sub-criteria in a criterion on several criteria (organizational management, human resource management, facilities and infrastructure management, government regulations, and venture capital). In addition to the inner dependence relationship in the network model, there was an outer dependence relationship occurring among sub-criteria in different criteria with alternatives. It was influenced by the best alternative institutional development strategy in the supply chain system in the oil palm agroindustry in South Kalimantan.

In assessing and selecting institutional development in the supply chain system based on criteria and sub-criteria, according to Karlsson and Eriksson (2017) the capital and human resources sub-elements had a major influence on the success of supply chain activities. Sufficient sources of capital could guarantee a sufficient amount of supply to serve consumer demands.

3.3. Weighting of Criteria and Alternatives in Assessment of Institutional Development in the Supply Chain System

The assessment was carried out in pairwise comparisons using the Super Decisions software version 2.10.0. In the results of pairwise comparisons, the consistency ratio (CR) value of 0.0578 (5.78%) was presented in Table 3. This showed that respondents were consistent in assessing which indicated the effect of interaction between sub-criteria on alternatives in institutional development in the supply chain system.

Table 3 Inconsistency value of pairwise comparison results

Inconsistency: 0.057	
Criteria cluster	Consistency ratio (CR) value
Joining the Farmer Group / Cooperative	0.223
Partnership Cooperation with Oil Palm Mill	0.286
Partnership Cooperation with Oil Palm Companies	0.394
Standard TBS Price Stability and Quality	0.095

Source: Primary data processed, 2021.

The next stage was the priority weighting of the sub-criteria and the five highest priority sub-criteria were obtained. The 1st rank was on the replanting program sub-criteria 0.662, the 2nd rank was the access to funding sub-criteria 0.661, the 3rd rank was the oil palm cultivation training sub-criteria 0.614, the 4th rank was the ISPO training and outreach sub-criteria 0.358 and the 5th rank was the means of transportation number sub-criteria of 0.354 as presented in Table 4. The results obtained were in line with the expectations of the Ministry of Finance of the Republic of Indonesia through the Public Service Agency of the Oil Palm Plantation Fund Management Agency, namely the replanting program. For capital support, it could be done together with People's Business Credit. All of them were expected to support other policies such as green diesel, green gasoline and green fuel, so that it became an energy-independent country. The Indonesian government was pursuing the target of the community oil palm rejuvenation program. Its way was through the community oil palm rejuvenation partnership program. Based on the results of the study, independent oil palm smallholders had been officially registered as members of the cooperative and had a Certificate of Ownership or Cultivation Registration Certificate accompanied by a coordinate map. According to Hidayati et al. (2018) the

plantation rejuvenation program was very important in the success of the oil palm plantation revitalization program, and increasing productivity and financing factors.

Table 4 Cluster priorities for institutional development in the supply chain system in the oil palm agroindustry in South Kalimantan

No	Sub-criteria	Normalized By Cluster	Limiting
1	R1. Rejuvenation Program (Replanting)	0.662	0.088
2	U1. Funding Access	0.661	0.088
3	P1. Oil Palm Cultivation Training	0.614	0.122
4	P2. ISPO Training and Outreach	0.385	0.077
5	S2. Means of Transportation Number	0.354	0.047

Source: Primary data processed, 2021.

Table 5 showed the final results of the alternative synthesis. The first alternative in the system which involved the roles of all relevant actors was 0.391, the 2nd rank of policy brief referred to the zone/region of 0.326, the 3rd rank was the arrangement between two parties involving the Trader/Loader with standard pricing of 0.200 and the 4th rank was the arrangement between two parties without involving a Trader/Loader of 0.081.

Table 5 Synthesis of alternative final results on institutional development in the supply chain system of oil palm agroindustry in South Kalimantan

No	Alternative	Ideals	Normals	Raw	Ranking priorities
1	SO1. Arrangements between two parties without going through the loader	0.207	0.081	0.016	4
2	SO2. Arrangements between two parties via loader with standard pricing	0.513	0.200	0.040	3
3	SO3. A system involving all role-playing actors	1.000	0.391	0.078	1
4	SO4. Policy Brief referring to Zones/ Territories	0.835	0.326	0.065	2

Source: Primary data processed, 2021.

Furthermore, in Figure 2, the sensitivity of the network model, seen in the black node with an alternative weight of 0.081-0.391 meant that the main priority was a system involving the roles of all relevant actors between local governments and associations, PKS partners with cooperatives.

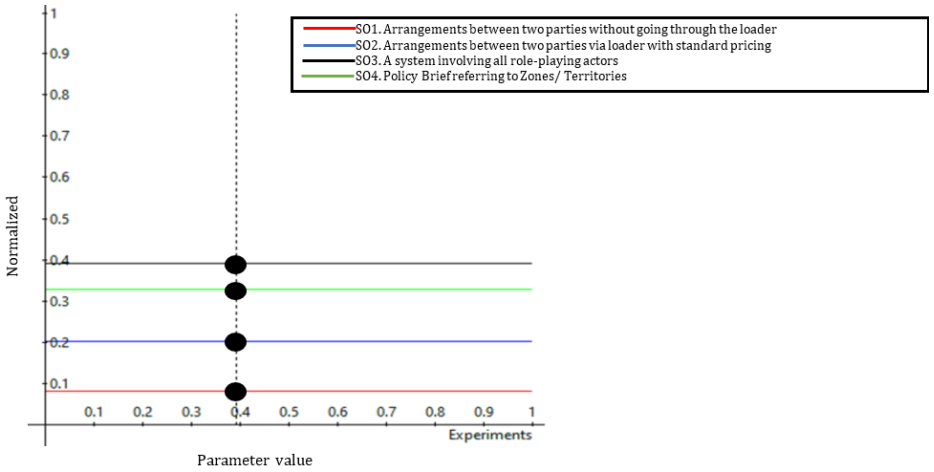


Figure 2 Sensitivity graph for independent smallholder palm oil supply chain institutional development

3.4. Actor Performance Measurement on Institutional Development in Supply Chain Information Systems

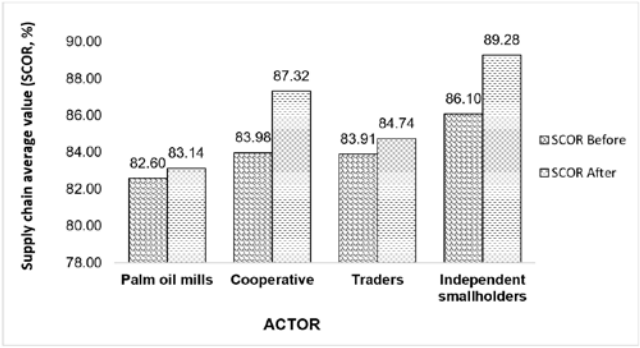
Performance measurement in strengthening palm oil supply chain institutions in Tanah Bumbu and Tanah Laut regencies can be seen in Table 6.

Table 6 Actor Performance Measurement

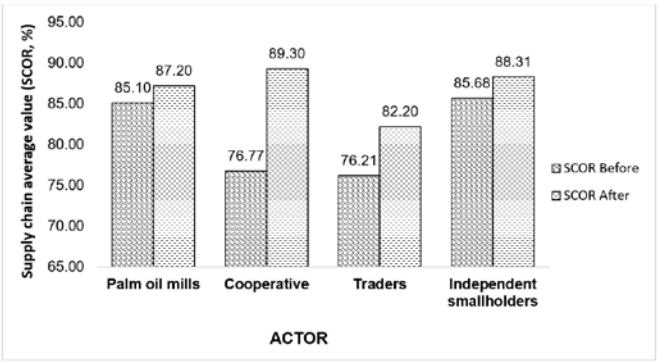
Regency	Actor	Performance Value
Tanah Bumbu	PT. Buana Karya Bhakti	87.40
	Perkebunan Buana Sawit Sejahtera Cooperative	82.60
	Petani	82.11
Tanah Laut	PT. Perkebunan Nusantara XIII PKS Pelaihari	84.00
	Sawit Makmur Cooperative	89.13
	Farmers	83.55

Source: Primary data processed, 2021.

For the results of the effectiveness analysis including the attributes of responsiveness, agility, reliability and efficiency including the attributes of cost, and assets in each actor in Tanah Bumbu Regency and Tanah Laut Regency, there was an increase in Figure 3.



(a)



(b)

Figure 3 (a) SCOR Performance per Actor in Tanah Bumbu Regency, (b) SCOR Performance per Actor in Tanah Laut Regency.

In the development of supply chain institutions using information systems, the actor's role was seen in the results of the effectiveness and efficiency test. The results of the research showed that the acquisition of effectiveness and efficiency values in the performance of the palm oil supply chain based on the SCOR value. In Tanah Bumbu Regency which previously was 84.15% (good) experienced an increase in the SCOR value to 86.12% (very good) and the SCOR value in Tanah Laut Regency which was previously 80.94% (good) to 86.75% (very good).

3.5. Prioritizing Strategic Assumptions on Institutional Development through the implementation of Supply Chain Information Systems

Strategic assumptions in efforts to strengthen independent oil palm smallholders in the supply chain were presented in Table 7.

Table 7 Strategic assumptions in an effort to strengthen independent smallholder institutions through the implementation of the palm oil supply chain information system

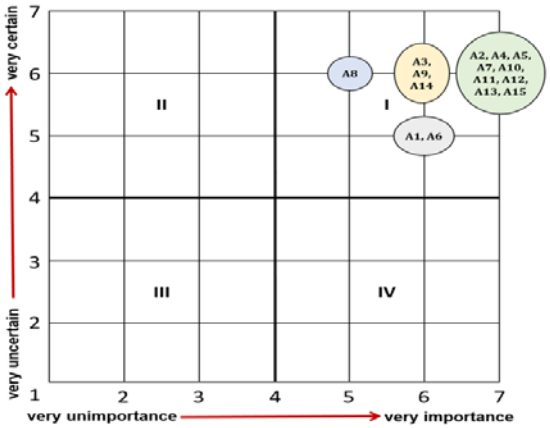
No	Strategic Assumptions
A1	Policies and mandates related to ISPO/RSPO certification more binding and beneficial to many parties, both for the government, independent smallholders, cooperatives and mills
A2	There is a regulation and policy on FFB price incentives from independent smallholder oil palm plantations certified by ISPO
A3	The realization of policies clarifying the position and role of traders/platforms in the supply chain of independent oil palm smallholders
A4	Harmonization and collaboration of the role of the government (Deptan and Depkop) in efforts to strengthen the institutions of oil palm independent smallholders
A5	Increasing the role of the government in providing financial assistance for the preparation of ISPO certification for independent smallholders and cooperatives
A6	Collaborative partnerships between associations and companies in efforts to develop oil palm independent smallholders (GAP, Postharvest, quality standards and certification
A7	Funding support from the government and the private sector in realizing the STDB program for Oil palm independent smallholders
A8	Revitalizing and increasing the role of APKASINDO in the effort to foster and empower oil palm independent smallholders
A9	Development program from the local government in various fields for oil palm independent smallholders supported by the availability of an adequate budget
A10	Utilization of oil palm company CSR funds more in favor of efforts to increase capacity building of oil palm independent smallholders
A11	Synergy of institutional roles between cooperatives as the core organization and Bumdes in business and financial management of independent smallholder palm oil supply chains
A12	Provision of information technology and technology utilization development programs in an effort to achieve clarity (transparency), traceability and fairness of prices and quality standards of FFB
A13	The realization of a monitoring system for the government related to the implementation of benchmark prices in every transaction between actors in the field
A14	Availability of a digital contract system in an effort to increase the efficiency and effectiveness of transactions between business actors in an independent smallholder palm oil supply chain
A15	Establish long-term contracts among oil palm business actors (farmers, cooperatives and PKS) referring to quality standards and agreed FFB selling prices

Level of Importance: 1: Very Unimportance; 2: Unimportance; 3: Slightly Unimportance; 4: Neutral; 5: Somewhat Importance; 6: Importance; 7: Very Importance
Degree of Certainty: 1: Very Uncertain; 2: Uncertain; 3: Somewhat Uncertain; 4: Neutral; 5: Somewhat Certain; 6: Certain; 7: Very Certain

Furthermore, the results of the priority assessment using analysis Strategic Assumption Surfacing and Testing (SAST) by taking into account the level of importance and certainty. From the SAST analysis obtained the level of certainty and importance of assumptions. The determination of strategic assumptions was described in the Cartesian quadrant (Kholil & Sulistyadi, 2017; Rachmayanti et al., 2015).

The results obtained with the position in Quadrant I (Figure 4) showed the strategic assumptions applied as shown in Table 7 to achieve the goal of institutional development of independent oil palm smallholders, having the highest level of importance and certainty with a value of 7.6 (very important – definitely), namely for A2, A4, A5, A7, A10, A11, A12, A13 and A15. For implementation purposes, operational implications were needed,

namely building palm oil supply chain partnerships, strengthening the role of the government through coaching and mentoring programs.



Source: Primary data processed, 2021.

Figure 4 SAST priority assessment based on the level of importance and level of certainty in the institutional development of independent smallholders through the implementation of the oil palm agroindustry supply chain information system in South Kalimantan Province

4. Conclusions

Based on the results of pairwise comparisons on the network model, the highest priority weight for the sub-criteria cluster, namely the replanting program on government regulatory criteria, is 0.662. The alternative strategy with the highest priority weight is a system which involves all actors playing a role of 0.391, a policy brief refers to an area of 0.326, arrangements between parties involving traders with standard prices are set at 0.200 for third place and arrangements between parties without involving Traders are 0.081 in the final rank. The sensitivity test results of actor involvement as a priority in the network model are relevant. The results of the analysis of effectiveness and efficiency before and after implementation show an increase in the SCOR value for all actors. The results of the SAST analysis are in quadrant I with the highest level of importance and certainty at a value of 7.6 which means very important and definite. It means that the assumptions applied are relevant in the implications of FFB price incentive policies, funding support from the government and the private sector in realizing the STDB program for independent oil palm smallholders, technology utilization development programs in an effort to achieve transparency, particularly regarding the price and quality of FFB, traceability, establishment of monitoring system for policymakers regarding the application of benchmark prices in every transaction involving actors in the field. The limitation of the research is because it is based on IoT, of course, it requires an internet network and assistance so that the system is felt to be more user friendly.

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