Supply improvement of cacao agro-industry using an Interpretive Structural Modelling (ISM): a case study of cacao supply from Indonesia

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Abstract: Indonesia is the third largest cacao producer in the world, yet raw material availability has been decreased by 14% over the past 6 years. This has resulted in imports of 100,000 tons of cacao in 2014. Such an issue happens due to many factors, for instance fluctuation of cacao prices, low farmer income and land conversion. The cause of land conversion is that cacao crops are no longer attractive to farmers, thus many of them are turning to other commodities. The objective of this research is to analyze the basic needs of farmers in order to determine the optimal quantities that farmers should supply. The methodology adopted for the research is Interpretive Structural Modelling (ISM) to determine the basic needs of farmers in the cacao supply activities. Based on the results, there are 5 basic needs of the farmers in supporting the activities of cacao Supply Chain, which are counselling, fair profit distribution, price guarantee from government, industry coordination and development of transparent information system. Among the main results, the development of fair profit distribution and price guarantee from governments are at the lowermost hierarchical level. Micmac diagrams show that it is laid in the independent sector (sector-IV). Thus, they become key elements of the cacao supply and need to be necessarily implemented. The implementation of both programmes will motivate farmers in doing their production activities. Sub-elements of counselling are the activities required in the linkage sector (sector-III) characterized by its instability. Furthermore, coordination to get transparent information between the cacao plantation and the industry are laid in the dependent sector (sector-II).

Keywords: Cacao Supply, Interpretive Structural Modelling, fair profit distribution

1. Introduction

Cacao is one of the main commodities in Indonesia, with a considerably large distribution. Cacao has become a leading plantation commodity in several regions in Indonesia, one of which is Sulawesi (Bahri, 2014). Suprapti *et al.*, (2013) point out that 70% of Indonesian cacao beans are produced from people plantations in Sulawesi, while the remaining ones are from Government and private plantations. Sulawesi is the largest plantation, accounting for about 56% of the total plantation areas in Indonesia. Sulawesi contributes to 70% of Indonesian cacao production with varying qualities and even with poor quality (not being fermented perfectly). Plantation statistics state that in 2012 cacao production originating from Sulawesi reached 555,460 tons or about 70 percent of national cacao production (Susilo, 2013).

In the opinion of 2013 LAKIP APBD, national cacao production has not been optimal because it is still below 1 ton/ha/year. South Sulawesi's cacao production in 2004 is 198,079 tons, while in 2010 it reached only 173,555 tons. In proportion, South Sulawesi's cacao production to national cacao production also declined from 22% in 2004 to 19.2% in 2010. The decrease of cacao supply was caused by several things, such as fluctuation of cacao prices, low farmer income and land conversion.

Such conditions have led to a real pressure on the price at the farmer level and have further led to the farmers having insufficient capital to maintain the garden, making them unable to produce cacao supply. As a result, there are only very few farmers who are interested in producing cacao, especially that of good quality, whilst the availability assurance for quality cacao beans will affect the cocoa processing industry (semi-finished) in producing cocoa liquor, cocoa butter, cocoa cake and cocoa powder, which are highly-valued export commodities. The availability of cacao beans has a highly crucial role in the sustainability of the cacao agro-industry supply chain, and it has been pointed out that the lack of sustainable suppliers at the upstream level will result in the non-sustainability of the cacao agro-industry supply chain (Bag and Anand 2015).

In the view of Sriwana *et al.*, (2017), the most influential actors in producing cocoa beans are farmers. Based on the explanation presented, the upstream problems that occur with farmers may result in problems throughout the supply chains (Savino *et al.*, 2015). To overcome these obstacles, the basic needs to be prioritized must be identified for the farmers and this research examined farmers' basic needs necessary to produce optimal cacao quantities.

This is done to motivate farmers in providing cacao supply. With the availability of cacao supply, the continuity of the cacao agro-industry supply chain can be maintained. The management of the supply chain indicates the fulfillment of the needs of the downstream industry and this demonstrates the ability of competition in the globalized market, as stated by Ouzrout *et al.*, (2009).

One method that can be used to identify the need is Interpretive Structural Modelling (ISM). The ISM methodology is well established in literature, and according to Jadhav *et al.*, (2013) ISM is one of the most appropriate techniques to be applied in various fields.

According to ISM, the required opinion of the experts should be representative of each sector, i.e. industry, academic etc. In this study, we have chosen three experts coming from three different areas, namely *Academics*, *Industry* and *Government*. Opinions of the expert from each sector is included. The opinion has been pooled by the questionnaire is presented in Table 1.

2. Literature Review

According to Attri, Dev and Sharma (2013a), the ISM approach begins with identifying the variables, determining the relevant contextual relationship, followed by Structural Self-Interaction Matrix (SSIM) design, which is paired-comparison of the variables, and then the Reachablility Matrix (RM) is designed. ISM analyses system elements and breaks them down into a graphic form of direct relationships between the elements and hierarchy level. Pfohl, Gallus and Thomas (2011) also convey that the ISM describes the comprehensive structure of all complex elements by considering all possible paired interactions of these elements, and it is done by experts who truly comprehend the problems that occurred. Previous research associated with ISM was conducted by Bag and Anand, (2015) who used ISM and MICMAC (*Matricided Impacts Croises Multiplication Appliqueeaun Classement*) to identify the contextual barriers that affect sustainable supply chain design and analyse the high cost of sustainability in the economic dimension, social and supply chain environment. The research results conclude that the lack of continuous suppliers at the upstream level, the lack of regulation for internal process and policies to support a sustainable supply chain, and a lack of knowledge to combine the interests of supply chain actors are sensitive elements for consideration in the sustainability of cacao agro-industry Attri and Grover (2015) also use ISM and MICMAC to classify factors into different categories and determine their effects on the scheduling system. Shahabadkar, Hebbal and S. Prashant (2012) review the ISM literature in the supply chain. The literature describes 3 perspectives: the ISM application's concepts and examples, ISM usage by some researchers, and ISM usage in applications in the supply chain. Interpretative Structural Modeling (ISM) can be used to identify essential elements within a system. Mahajan (2013) employed ISM to develop and analyse the interaction between challenging issues in the implementation of supply chain based on Just In Time. Shahabadkar, Hebbal and S. Prashant, (2012) employed ISM to determine the variables on supply chain management in the improvement of supply chain performance. Utomo, Putro and Hermawan, (2009) adopted ISM to review the improvement efforts of crumb rubber agro-industry based on system structure. Eswarlal, Dey and Shankar (2011) used ISM to describe the variables for sustainable renewable energy.

3. Methodology

The ISM developed in this research has been aimed to analyse the needs of farmers in supporting the implementation of production activities, thus the farmers can increase the amount of cacao production.

The first step of the methodology begins by conducting interviews of the three experts. These experts developed the contextual relationship among the variables to prepare sub-elements related to the institutional structure on sustainability cacao supply chain agro-industries.

The second step is to perform an expert opinion analysis to be made into the Structural Self-Interaction Matrix (SSIM).

The third step of this research's methodology is to make the Reachability Matrix (RM). At this step, the SSIM turns into the RM through a conversion that is made using 4 symbols (V, A, X and O). It is implemented to analyse the contextual relationship between i- and j-sub-elements. The data that are used are obtained from experts who give their opinions by filling out a questionnaire with symbols as follows:
V : sub-element i supports the existence of sub-element j, but not vice versa
A : sub-element j supports the existence of sub-element i, but not vice versa
X : sub-elements i and sub-elements j support each other's existence
O : sub-elements i and sub-elements j are not interconnected

The fourth step is relative to generate level partitions. Starting from the final Reachability Matrix (RM) of step 3, we obtained a RM partitioned into different levels.

The fifth step regards the conical matrix. Subclass classification refers to the processed results of the Reachabilty Matrix (RM) that meet the transitivity rules. From the processing results, the Driver Power (DP) value is obtained, and a single sub-element value is classified into four sectors namely:

- The sub-elements belonging to sector I are weak driver-weak dependent variables (Autonomous) is where sub-elements belonging to this sector are generally unrelated to the system and may have little association although the relationship may be strong. The sub-element belongs to Sector I if the value is DP≤0.5X and D≤0.5X, where X is the number of sub-elements.

- The sub-elements belonging to sector II are weak driver-strongly dependent variables (Dependent/D) in this sector are generally not free variables. The sub-element enters Sector II if the value is DP ≤0.5X and D> 0.5X, where X is the number of sub-elements.

- The sub-elements belonging to sector III strong driver-strongly dependent variables (Linkage), the variables in this sector should be studied carefully because the relationship between the variables is unstable. Any action on the variable affects other variables, and the feedback magnifies the impact. The sub-element enters in Sector III if the value is DP> 0.5X and D> 0.5X, where X is the number of sub-elements.

- The sub-elements belonging to sector IV are strong driver-weak dependent variables (Independent), in this sector the variables are the remaining part of the system, hereinafter called the free variables. The sub-elements enter Sector IV if the value is DP> 0.5X and D≤0.5X, where X is the number of sub-elements.

The final step regards the conversion to ISM model the Digraph generated previously.

4. Results and Discussions

The first stage is to conduct interviews with experts. Based on the results of the interviews with the 3 experts, there are 5 basics needs in supporting the activities of cacao products. The five basic needs are then assessed by the experts and the analysis results can be seen in Table 1.

Table 1: Structural Self-Interaction Matrix (SSIM) on sustainability cacao supply chain

	5	4	3	2	1
1. Counselling	V	V	A	A	
2. Fair profit distribution	V	V	X		
3. Price guarantee from governments	V	V			
4. Coordination between the plantation and the industry	X				
5. Development in the more transparent information system					

By transforming the information of each cell of Structural Self-Interaction Matrix (SSIM), into binary digits (1 or 0), one can obtain the initial Reachability Matrix from the SSIM format.

This transformation has been done by substituting V, A, X, and O with 1 and 0 as per the following rules. Rules for transformation are given in Table 2

Table 2: Result of transformation

	1	2	3	4	5	DP	R
1	1	0	0	1	1	3	2
2	1	1	1	1	1	5	1
3	1	1	1	1	1	5	1
4	0	0	0	1	1	2	3
5	0	0	0	1	1	2	3
D	3	2	2	5	5		
L	2	3	3	1	1		

On the basis of results, using ISM at a 97% consistency index, it is found that development in the definitely fair profit distribution (2), price guarantee from governments (3) has the lowermost hierarchical level. Thus, we may argue that these two sub-elements become key sub-elements of the sustainable cacao agro-industry and keys of activities required allowing them to be necessarily implemented (figure 1).

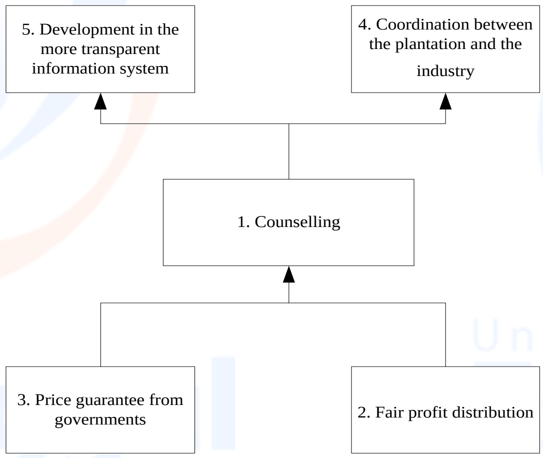

Figure 1: ISM-based model

This is also in accordance with the opinion delivered by Bolarinwa and Fakoya (2011) who stated that some problems occurring in the cacao agro-industry in Indonesia, among others, are farmers occupying a weak bargaining position, development in partnership cooperation between farmers (as raw material producers) and nonoptimal pro-farmer industries as well as weak control taken by governments over the cacao supply chain, therefore farmers are not at an advantaged position. Pursuant to Abubakar, Yantu and Asih (2013), cacao farmers deal with problems in principal-agent institutional marketing, namely a sales contract. Sales performed by farmers to traders are bound by a contract regulating farmer behaviour from becoming dependent on traders. This means that farmers cannot determine the price which allows traders to have a stronger bargaining position.

Darnall, Jolley and Handfield (2008) claim that farmers' access to acquire tools of production, which are required at a reasonable price, is relatively low. Such a condition results in farmers that must individually seek their requirement for production facilities at the nearest farm stalls and farm shops in the downtown area, or wait for middlemen coming to provide loans for those tools of production under a payment agreement that the loans would be paid after harvesting.

On the other hand, the mapping diagram (driving power-dependence) shows that it is laid in the independent sector, or Sector IV, as given in Figure 2.

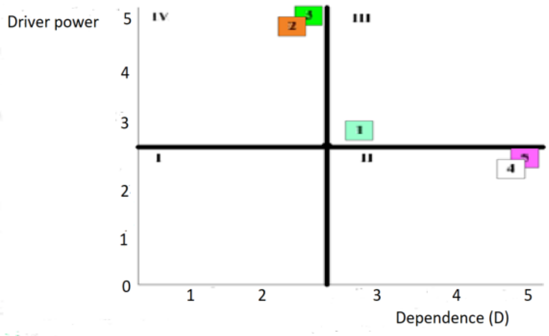

Figure 2: MICMAC Diagram

As seen in Figure 2, counselling is a required activity which is laid in the linkage sector, or Sector III, characterized by its instability. This demonstrates that extension is a benchmark that should be reviewed thoroughly considering that it would have effects on other sub-elements, including feedbacks, and those effects could make significant impacts on the system or have high-driving power in spite of high dependency. Moreover, sub-elements of coordination between the plantation sector and the industry sector (4), and development in the more transparent information system (5), are laid in the dependent sector, or Sector II. The two sub-elements in this sector are showing considerably high dependency on other objective sub-elements that are still having low driving power.

Based on the results of the research conducted by Sriwana *et al.*, (2017), farmers belong to the most affected community sector in which capital and loan facilities constitute the most required programs and farmers are the community sector most affected in which capital and loan facilities constituted the most required by programs. Potential alterations included increasing farmers' income and welfare with the programs objective being to increase balanced profit distribution, and the benchmark is an increase in farmers' income and welfare. A sustainable cacao agroindustry requires price guaranteeing provided by the government and fair profit distribution.

This study was intended to discuss the basic needs of farmers to motivate them in carrying out production activities. In the extant body of literature, there is no specific study with implementation of ISM on cacao supply chain in Indonesia. However, there are studies in literature discussing the use of ISM in supply chain. The results of those studies are compared in Table 3.

Table 3: Comparative method analysis

Author (Year)	Problem discussion	Stakeholders (participant)	Method	Result
Fadjar (2008)	The social analysis of the cocoa farmer community and its implications for the differentiation of farmers' welfare	Interviews of 30 respondents per village	Statistic	The emergence of layers of farmers with poor welfare status
Drajat (2011)	Analysis the opportunities for Increasing Domestic Added Value of Cocoa Through Trade Regulation	Interview with the Chairman and Secretary of ASKINDO, 4 cacao bean exporters, Chairman Farmer and several traders	Statistic	Farmer's bargain power are still weak.
Putri (2013)	Cultivation farming income analysis in parigi regency - moutong	60 cocoa farmers from several villages in Parigi Moutong	Statistic	Prices of agricultural commodities generally decline during the harvest season

Author (Year)	Problem discussion	Stakeholders (participant)	Method	Result
Astuti (2011)	Factors affecting food-land functions to palm oil in bengkulu.	Interviewed farmers in the village of Kungkai Baru, Bengkulu	AHP	The prices obtained by the farmers are unstable and there is a low price of food crops especially at harvest time
Arsyad and Kawamura (2015)	Reducing Poverty of Cocoa Smallholders in Indonesia	Interviewed 152 cocoa smallholder households	Statistic	The average income of farmers does not reach the National Poverty Line (NPL)
This Research (2018)	Supply improvement of cacao agro-industry	Discussion with 3 expert from the three different fields (academics, industry and government)	ISM	Fair profit distribution and price guarantee from governments are the key elements of the cacao supply

However, the implementation of ISM in a supply chain discussing with the government, academic and industry is not visible in extent literature, to the best of authors knowledge. To be specific, the contributions of these are :

1. Implementation of ISM was conducted to determine the basic needs of farmers in the cacao supply activities
2. Fair profit distribution among stakeholder will motivate an improve production of cacao at farmer's level
3. ISM will be implemented to the government, industries and farmers at the same time.

5. Conclusions

Implementation of ISM in this study was conducted to identify the basic needs of cacao farmers. Based on the results, the basic needs of the farmers to improve their production activities are fair profit distribution and price assurance from the government. The implementation of both programmes will motivate farmers in doing their production activities, while the programs will give a significant impact on the system, or those with high boosting force in enhancing their production, are on-site counselling. Another basic need of the farmers is the coordination among the garden sector, the industrial sector and the development of a more transparent information system, is included in the dependent sector or Sector II. The two sub-elements in this sector are the sub-elements with extremely high dependence on other sub-elements, but with low boosting force. Due to the paper objectives, , this study did not consider the quality of cacao, thus future research should explore ways to increase farmers' motivation to improve the quality of cacao

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