An interpretive structural modelling (ISM) approach for institutional analysis of Gadung Yam (*dioscorea hispida* dennst) chips supply chain in SMEs Tulungagung, East Java, Indonesia

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Abstract

UKM Indah Lestari is one of SMEs in Tulungagung, East Java, which produces gadung yam chips. Having good institutional structure is one of the supporting success of this SMEs development. All this time, this SMEs has no inter-party relationship and institutional structure in integrated supply chain. The aim of this study were to determine the institutional structure of the supply chain and to show the relationship between elements on the institutional supply chain. Interpretive Structural Modeling (ISM) approach was a term used to analysis it. The results indicated that the institutional of gadung yam chips consists of suppliers, SMEs, retailers and government who are directly involved in the supply chain of gadung yam chips. The relationship among agents in the institutional structure of gadung yam chips supply chains has influence and linkage with each other that will move the business progress of that SMEs. Relation to the needs element and all sub-elements are key elements. In constraint element, sub-element consistency of quality and quantity of gadung yam tubers as well as lack of capital become sub-key elements. In the objective element, the availability of guaranteed raw materials becomes the key sub-element. It shows that government becomes the key sub-elements. Meanwhile within the element of improvement which is possible for all sub-elements has key sub-element.

Keywords: *key sub-element, interpretive structural modeling, supply chain institutional.*

Introductions

In the current global era, the government continues to carry out empowerment by moving the people's economy through facilitating Micro, Small, and Medium Enterprises (MSMEs) so as to contribute greatly in strengthening the people's welfare (Fitriani, 2014). The effort to develop and strengthen the people's economy is proved by the increase in the formation of GDP (Gross Domestic Product) in 2011 in which MSMEs could contribute 57.60% (Binarto and Retno, 2013). Tulungagung Regency is one of the areas in East Java that has superior MSME potentials. The physiological condition of the region is quite supporting in which almost ± 40% of the total area is limestone mountains which are rich in mining and forestry products (the Central Bureau of Statistics of Tulungagung Regency, 2015). UKM Indah Lestari is a large manufacturer of gadung yam chips. This SME, in one day, can bring in ± 2 - 4 tons of raw gadung yam. In its marketing, the gadung yam product is sold in a semi-finished or half-raw form. UKM Indah Lestari*,* besides becoming a manufacturer, also serves as a supplier of raw gadung yams and a collector of gadung yam chips produced by several surrounding SMEs. The partnership of UKM Indah Lestari with several parties in a complex supply chain, with a considerable quantity of raw gadung yams and finished gadung yam products, becomes one reason why the researchers selected this SME as the research object, especially related to its supply chain institution.

Success in SME development is supported by several factors, one of which is a good institutional structure. Institutions are a very important goal which can be achieved by a system of norms, habits, and also relations between business people (both individuals and agencies) in natural resource management (Ruhimat, 2016). According to Anatan (2010), a simple supply chain has components called channels consisting of suppliers, manufacturers, distribution centers, wholesalers, and retailers who work together in meeting consumer needs. According to Rahayu and Lindawati (2015), integrated institutions can improve competitiveness and streamline supply chains. A supply chain institution refers to the relationship between two or more agencies or entities (components) in supply chain activities. Therefore, it is necessary to have a clear institutional structure, where the institutions cover mechanisms, patterns of interaction of all relevant supply chain actors, and the impacts on the improvement of competitiveness and welfare of the actors in the supply chain.

Currently, UKM Indah Lestari still has no consistent quantity of raw materials to be processed so that the production process does not run optimally. Besides, the relationship between parties in the supply chain and the institutional structure in the production of gadung yam chips are not well integrated, automatically reducing the efficiency and effectiveness of activities in UKM Indah

Lestari so as to trigger problems in the supply chain. The relationship between the parties or agencies needs to be maintained so that all members of the supply chain can be well-accommodated in the supply chain institution and ultimately enable the development and high competitiveness of the SME towards similar industries.

One commonly used approach in analyzing supply chain institutions is Interpretive Structural Modeling (ISM). ISM is a methodology that helps identify relationships based on ideas and structures towards complex issues between contextual elements (Indrawanto, 2009). ISM analyzes system elements and solves them in the form of graphs and sentences based on relationships between elements and hierarchical levels by transforming unclear mental models to clear system models. Decision making with the ISM method is based on the group (Sanipar, 2012). According to Rasdan *et al.* (2013), elements analyzed in ISM include influenced public sectors, program needs, main constraints, possible changes, program objectives, benchmarks, measures to evaluate results, and involved institutions. The advantages of ISM are that it can identify structures in a system to formulate the system effectively and make better decisions (Attri *et al.,* 2013). Thus, the ISM approach was selected to be used in this research with the aim to identify and evaluate structures and elements in the supply chain institutions, solve problems and constraints, and determine which institutional elements are appropriate factors to be developed in the SME. This research aimed to determine the institutional structure and the relationship between elements in the gadung yam chip supply chain of UKM Indah Lestari.

1. Materials and methods

This research was conducted in January – February 2018 in UKM Indah Lestari, Tulungagung Regency. The use of the ISM method in this research started from determining the variables or elements and sub-elements to be analyzed. The determination was based on the results of interviews with expert respondents and adjusted with the problems experienced by UKM Indah Lestari. After the elements and sub-elements were identified, the determination of the contextual relationship between the elements was then arranged in the Structural Self-Interaction Matrix (SSIM) (Shahabadkar, 2012). In the SSIM arrangement, symbols of V, A, X, and O were used to show the type of the existing relationship (Potdar *et al.,* 2017). The SSIM was hereafter converted into Reachability Matrix (RM), then tested using the transitivity rule and converted to the Driver Power (DP) and Dependence (D) values (Chandramowli *et al.,* 2011). Lastly, after the DP and D values were known, the next step was making a hierarchical structure and classification of the sub-elements (Attri *et al.,* 2013).

The respondents of this research were selected purposively (purposive sampling method), meaning that there was no definite provision related to the number of expert respondents used. The considerations in determining the respondents are as follows (Nedi, 2012):

1. The respondents should be well-experienced and competent in the field studied.
2. The respondents should have a high reputation, position in the competence, and credibility in the field studied.
3. The respondents should reside in the research location and are willing to be interviewed.

Based on the criteria, the respondents selected in this research amounted to 7 experts, including 1 Academician, 2 people from UKM Indah Lestari, 1 person from the Department of Industry and Trade of Tulungagung Regency, 1 person from the Department of Cooperatives and MSMEs of Tulungagung Regency, 1 retailer and 1 supplier. The determination of the number of respondents was done to facilitate decision making.

2. Results and discussion

The supply chain in UKM Indah Lestari involves several actors, namely suppliers, manufacturers, retailers, and the government. Each actor has overall control and coordination of all business activities in the supply chain as shown in the supply chain scheme (**Figure 1).**
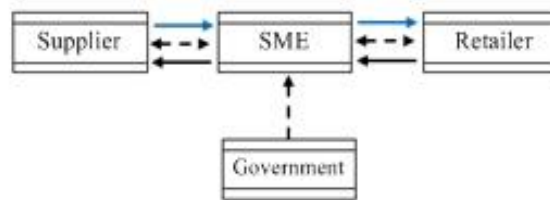

Figure 1. Scheme of gadung yam chip supply chain

Description:　→ : Product/ Material Flow
　　　　　　◀--▶ : Information Flow
　　　　　　◀— : Financial Flow

According to Tubagus *et al.* (2016), a supply chain has 3 activity mechanisms, namely *product flow, information flow*, and *financial flow.* These mechanisms can be depicted in the form of supply chain structures of the actors involved in it, followed by the mechanism of activities occurring. The

results showed that in the supply chain structure of UKM Indah Lestari, there are 6 activities related to the supplier and retailer.

a. The supplier plays a role in sending or supplying gadung yams in the amount as needed by SME *Indah Lestari.* The information flow runs in two directions between the two while the financial flow runs in one direction (from the SME to the supplier), that is when the payment of raw materials. According to Hasibuan and Agus (2011), suppliers as an element playing an important role from the upstream must have good quality so that supply chain activities can run smoothly.

b. UKM Indah Lestari plays a role in distributing products in the form of gadung yam chips to the retailer and receiving the raw material (raw gadung yams) from the supplier. The financial flow from the retailer to the SME is at the time of paying or depositing the result of gadung yam chip sales while that from the SME to the supplier runs when the payment of raw materials (raw gadung yams). Meanwhile, the information flow occurs in two directions, which are from UKM Indah Lestari to the retailer and supplier. According to Hadiguna (2016), the speed of response from manufacturers to the information flow is highly expected by customers to avoid shortages and backorder.

c. The retailer plays a role in distributing products from UKM Indah Lestari to consumers. The information flow between the retailer and the SME took place in two directions. The financial flow runs from the retailer to the SME at the time of paying or depositing the results of products sales. Puryono *et al.* (2016) argued that communicating effectively with retailers can improve the efficiency of supply chain management, especially regarding the reception, verification and delivery of products as well as the payment authorization.

d. In the gadung yam supply chain activities, the government involved here refers to the related departments, namely the Department of Cooperatives and MSMEs and the Department of Industry and Trade of Tulungagung Regency. The government has a role in providing information flow to UKM Indah Lestari, such as counselling related to business development, work healthy dan safety, and PIRT (Home Industry Product) certification, and socializing entrepreneurial bazaars or exhibitions held by the government in Tulungagung Regency. According to Saptana and Rangga (2016), the facility and policy from the government can strengthen the growth and development of agribusiness industrial partnership through an integrated supply chain management approach. Furthermore, Santoso *et al.* (2013) explained that an integrated relationship between suppliers, manufacturers and customers makes the supply chain run well. Information is needed to support good coordination in supply chain activities carried out.

2.1. Analysis of the element of needs

Based on the structural model diagram of the element of needs shown in **Figure 2** (a), it can be seen that there are 5 sub-elements on the same level. That is, all the sub-elements (5 sub-elements) are key sub-elements in the element of needs. The relationship between sub-elements in the element of needs is equally important. The five sub-elements are what UKM Indah Lestari needs in carrying out its business. In other words, all of these sub-elements must be fulfilled so that the supply chain activities for the SME can run smoothly. In addition, the fulfilment of all the needs becomes an important factor for developing UKM Indah Lestari*'s* business as well as has a strong driver power for the success of the SME business. According to Indriyatni (2013), business capital, workforce skills, business location, and government support are factors significantly lead to the success of micro and small businesses. The availability of natural resources or raw materials, managerial capabilities in accessing markets, and marketing capabilities owned by small industries are determinants of the development of SMEs (Toyib, 2017).
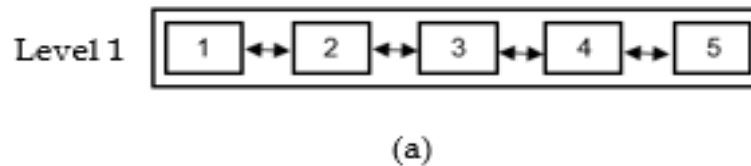

(a)

Figure 2. (a) Structural Model Diagram of the Element of Program Needs

The DP-D matrix shown in **Figure 2** (b) suggests that all the sub-elements of needs are within the Linkage sector, indicating strong driver power and dependence. The fulfilment of the five sub-elements of needs can positively influence the business development of UKM Indah Lestari if handled properly. According to Trivedi *et al.* (2015), Sub-elements included in the Linkage sector have high driver power and dependence values.
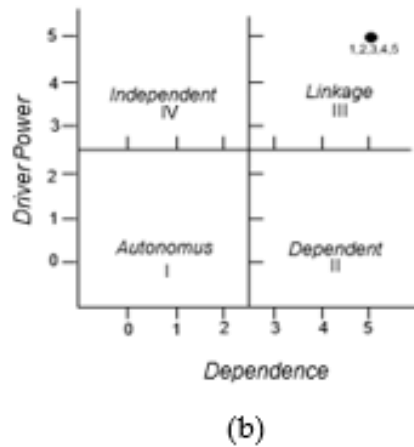
(b)

Figure 2. (b) DP-D Matrix of the Element of Program Needs

Description: (1) Availability of raw materials (raw Gadung yams), (2) Capital adequacy, (3) skilled workforce, (4) Innovative marketing strategies, and (5) The government support

According to Widiyati *et al.* (2009), sub-elements included in this sector must be carefully studied because changes in these sub-elements have an impact on other sub-elements and eventually will also generate feedback impact on the concerned sub-elements. According to Layaman and Nurlatifah (2016), factors of productions, such as raw materials, capital, skilled workforce, and marketing, are highly necessary to be considered because these factors greatly influence industrial development.

2.2. Analysis of the element of constraints

The structural model diagram of the element of constraints is shown in **Figure 3.** (a). The figure depicts 2 levels of sub-elements. The sub-elements in Level 2 are key sub-elements in the element of constraints that affect those in Level 1. The key sub-elements are (1) consistency of raw Gadung yam quality and quantity and (2) capital adequacy. In other words, the two sub-elements have a strong driver power to the emergence of other constraints in UKM Indah Lestari.
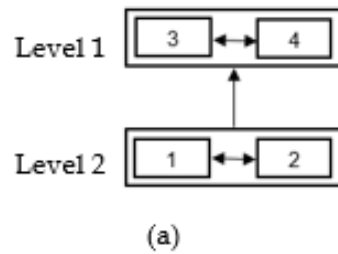
(a)

Figure 3. (a) Structural Model Diagram of the Element of Program Constraints

UKM Indah Lestari requires good-quality raw gadung yams in a quantity according to the production need so that the production process can run smoothly and the products produced are maximal. Additionally, UKM Indah Lestari also requires adequate production capital for maintaining the production rotation worked. Some of the constraints experienced by UKM Indah Lestari such as the high product marketing competition and the lack of skilled workers are influenced by lack of capital and inconsistent quality and quantity of raw materials. According to Budiman (2015), raw materials are the basic factor in increasing industrial sector productivity. Besides, high-quality raw materials and maximum processing will produce products according to consumer desires. Meanwhile, Lamayan and Nurlatifah (2016) stated that capital plays an important role in industries. The production will be difficult to proceed without capital.

Seen from the DP-D matrix in **Figure 3** (b), the sub-elements in the element of constraints are classified into Dependent and Independent sectors. The sub-elements in the level 2 (key sub-elements), covering (1) consistency of raw Gadung yam quality and quantity and (2) capital adequacy, are in the independent sector. In other words, these two sub-elements are constraints potentially hampering the smoothness of UKM Indah Lestari*'s* production process. Raw materials and capital are very important for the sustainability of SMEs.
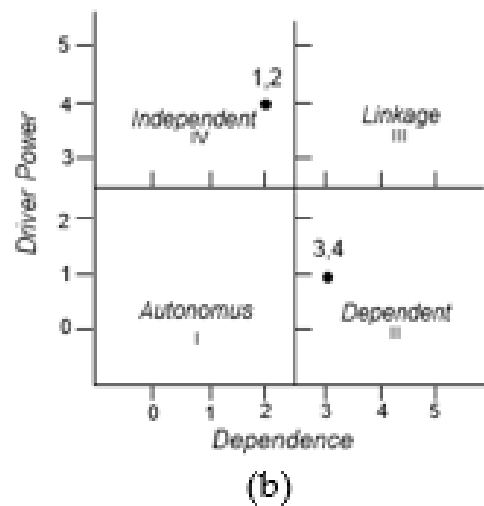
(b)

Figure 3.(b) DP-D Matrix of the Element of Program Constraints

Description: (1) Consistency of raw Gadung yam quality and quality, (2) Capital Adequacy, (3) Product marketing competition, and (4) Skilled workers

Without raw materials, the production process cannot run, and capital is used to purchase raw materials, pay workers' salary and other operational costs. If the constraints related to the quality and quantity of raw materials and capital are not minimized, other constraints are potential to occur. UKM Indah Lestari must notice the two sub-elements so as not to negatively affect other sub-elements. According to Digalwar and Ganneri (2015), sub-elements in the independent sector have a considerable driver power and less dependence on other sub-elements. Furthermore, Mirah (2014) asserted that sub-elements in the independent sector are independent variables, which can be considered as key factors. Meanwhile, according to Puspika and Desi (2013), raw materials are an important element in industries, thus raw materials need to be considered in terms of planning and management. The production process of an industry will not work without raw materials.

The sub-elements included in the Dependent sector are (3) product marketing competition and (4) skilled workers. According to Mirah (2014), sub-elements categorized into this sector do not or less influence other sub-elements. Moreover, Trivadi *et al.* (2015) explained that sub-elements in this sector are more dependent on other sub-elements and have a weak driver power. That is, the emergence of these constraints (high competitive product marketing and lack of skilled workers) does not or less potentially trigger other constraints. In linear, Purwaningsih and Pajar (2015) stated

that product marketing and workforce increase are factors affected by internal factors such as capital, technical production and operations.

2.3. Analysis of the element of objectives

The structural model diagram in **Figure 4** (a) shows that there are three levels of sub-elements in which (1) the guaranteed availability of raw materials (in Level 3) becomes the key sub-element that has an influence on other sub-elements in the element of objectives. The guaranteed availability of raw materials can encourage quality assurance for the product produced, automatically leading to increased income due to increased consumer purchasing power as a result of the better product quality.
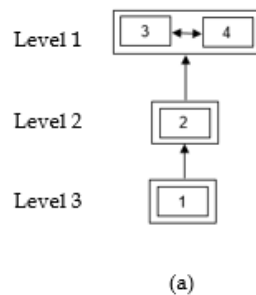

(a)

Figure 4. (a) Structural Model Diagram of the Element of Objectives

Considering that the product quality is getting better, UKM Indah Lestari seeks to expand its marketing scope. This is evidenced by the *PIRT* certification owned by UKM Indah Lestari. The retailer of gadung yam chips from Surabaya requires the SME to have a guaranteed product quality, at least evidenced by the *PIRT* certification. The SME *PIRT* certification can facilitate the retailer in product selling. According to Fitriana (2015), in business improvement and development, business owners will try to improve their products by using high-quality raw materials because it can stimulate the human resources owned to be more creative and innovative in marketing products. Furthermore, Salin and Jimmy (2016) argued that raw materials that meet predetermined quality can increase productivity. Raw material quality greatly influences the production process in the manufacturing industry. On another side, manufacturers should continue striving to improve product quality with efficient utilization of raw materials and reduce costs to be as minimum as possible.

As shown in the DP-D matrix of the element of objectives in **Figure 4** (b), the sub-elements of the program objectives occupy both the Dependent and Independent sectors. The sub-elements

included in the independent sector are (1) guaranteed availability of raw materials and (2) guaranteed product quality. These sub-elements have a big potential to affect other sub-elements and have a big driver power as UKM Indah Lestari*'s* objectives.
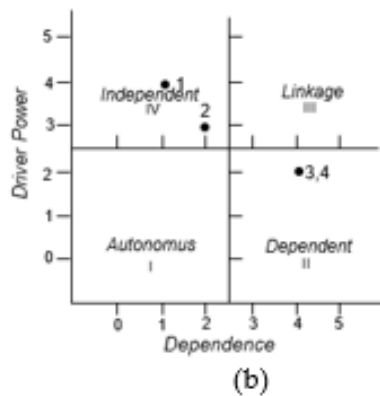

Figure 4. (b) DP-D Matrix of the Element of Program Objectives

Description: (1) Guaranteed availability of raw materials, (2) Guaranteed product quality, (3) Increase in business income, and (4) Marketing scope expansion.

Guaranted availability of raw materials is the key sub-element and an objective that must be prioritized by UKM Indah Lestari. Without the guaranteed availability of raw materials, the production process will not run well. Although it is in the same sector, the (1) guaranteed availability of raw materials has a stronger driver power than (2) guaranteed product quality. Currently, UKM Indah Lestari is always trying to maintain and even improve the quality of its products. According to Gan *et al.* (2018), the sub-elements in this sector have a strong driver power and do not depend on other sub-elements. Furthermore, Indrawanto (2009) found that sub-elements in the independent sector, such as guaranteed product quality, are the main objectives that must be achieved for developing an industry. The achievement of guaranteed product quality can encourage the achievement of other objectives such as marketing scope expansion, increased income, and other pre-programmed objectives.

As for the dependent sector, the sub-elements include (3) increased business income and (4) expansion of marketing scope. As explained by Trivedi *et al.* (2015), the sub-elements included in this sector have weak driver power and high dependence. In other words, both objectives are highly not free or dependant. The increased income of UKM Indah Lestari will occur if the product quality gets better. The objective to expand the marketing scope will arise if encouraged by the availability

of raw materials and product quality. UKM Indah Lestari, which currently has a *PIRT* number for its products, keeps making effort to reach a wider market because this objective is still not yet realized so far.

2.4. Analysis of the Element of Involved Agencies

The structural model diagram in **Figure 5** (a) shows that there are two levels of sub-elements in this element in which (4) the government becomes the key sub-element (level 2). That is, the business success of UKM Indah Lestari is inseparable from the government role. UKM Indah Lestari requires government support in production activities, work skill improvement, capital and technology assistance, and marketing expansion.
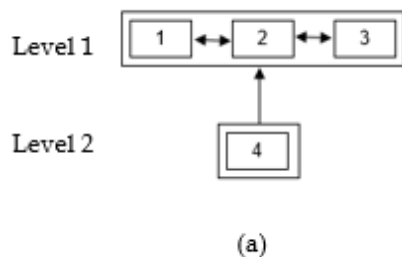

(a)

Figure 5. (a) Structural Model Diagram of the Element of Involved Agencies

Currently, the support provided by the government to UKM Indah Lestari includes providing counselling related to work health and safety and involving UKM Indah Lestari*'s* products in bazaar activities. Therefore, in SME development, the government role is highly required. The supply chain activities in UKM Indah Lestari have been running even though the government has not provided special attention. A good and integrated relationship between UKM Indah Lestari and the government will positively influence the supply chain activities in the SME as well as support the SME success in developing the business. According to Irdayanti (2012), the government as a facilitator has an important role in empowering SMEs. The increased local industrial position in the global market chain is also inseparable from the contribution and interference of the local government. Furthermore, Ariani and Bambang (2013) suggested that supply chain integration is known from the well-managed collaboration between suppliers, industries, and consumers that ultimately leads to increased profitability.
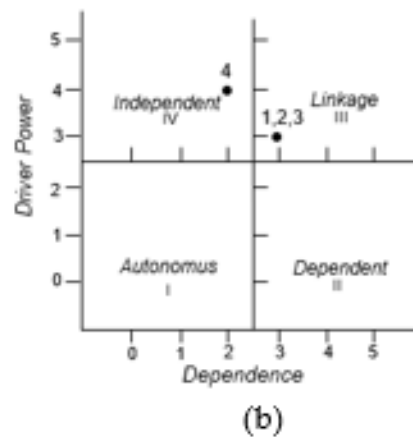
Figure 5.(b) DP-D Matrix of the Element of Involved Institutions

Description: (1) supplier, (2) SME, (3) retailer, and (4) government

Based on the DP-D matrix of the element of involved agencies presented in **Figure 5** (b) below, the sub-element classification covers Linkage and Dependent sectors. The sub-elements included in the Linkage sector are (1) the supplier, (2) the SME, and (3) the retailer. The sub-elements in this sector must be carefully examined.

According to Upadhye *et al.* (2011), sub-elements included in the Linkage sector have a strong driver power and dependence. Any actions on these sub-elements will potentially generate problems on other sub-elements and create feedback impacts on the concerned sub-elements, which can strengthen any steps or actions. In supply chain activities in UKM Indah Lestari*,* the supplier, the SME itself, and the retailer are the main actors who directly involve, related, and depend on each other in the production to marketing activities. The supplier plays a role in meeting the needs of raw materials to maintain the production stability of UKM Indah Lestari*.* Meanwhile, the retailer is responsible for optimizing the selling of UKM Indah Lestari*'s* products so that the product flow can run continuously and the product stock will not remain long in the storage warehouse. Actions on these three sub-elements must be highly noticed so as not to increase the negative effect resulted on other sub-elements. According to Martadisastra (2017), in a supply chain, all interactions starting from suppliers, manufacturers, distributors, modern retailers, and consumers are very necessary for stabilizing the supply chain activities carried out. The chain includes transportation, scheduling information, cash and credit transfers, ideas, ideas, designs, raw material transfer to product marketing.

The government sub-element is in the independent sector is the independent variable. This sub-element is also considered as a key factor of the system because the government is indicated to have a big driver power on the other 3 sub-elements. According to Gan *et al.* (2018), sub-elements in the independent sector have a strong driver power and do not depend on other sub-elements. The attention and encouragement of the government to other sub-elements can help smoothen the business development of UKM Indah Lestari and establish a better-integrated relationship between agencies involved in the supply chain. Moreover, according to Irdayanti (2012), through its big contribution in the people's economy strengthening, the government is expected to develop a cluster-based strategy for the local economy empowerment by putting forward synergies between the government, the private sector, the community and various multi-stakeholders.

2.5. Analysis of possible changes

As seen in **Figure 6** (a), the structural model of this element has only one level. In other words, the four sub-elements are key sub-elements to be noticed due to having strong driver power and dependence. The SME should pay attention to each of the existing sub-elements and the size of the effects generated.
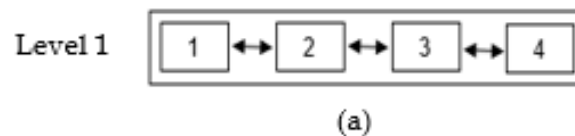

(a)

Figure 6. (a) Structural Model Diagram of the Element of Possible Changes

These changes (improvements) need to be carried out by UKM Indah Lestari to develop the business far better. This structural model can be used by UKM Indah Lestari as a reference to taking actions in making decisions for improvements. According to Rasdan *et al.* (2013), this hierarchical structure shows a direct relationship and relative position of a sub-element with other sub-elements. According to Digalwar and Ganneri (2015), any changes occurring to sub-elements existing in the element of possible changes can have an impact on other sub-elements or even on the concerned sub-elements.

As seen in the DP-D matrix in **Figure 6** (b), all the existing sub-elements in the element of possible changes, including (1) the speed of program changes, (2) production system improvement, (3) product marketing networks, and (4) the government's commitment to promote SMEs, are in the Linkage sector, serving as the key sub-elements.
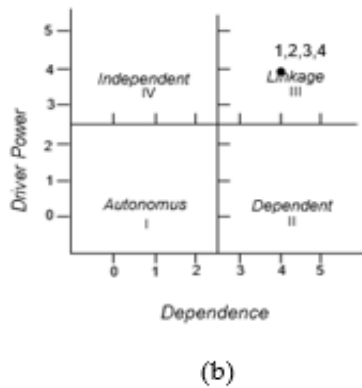
Figure 6. (b) DP-D Matrix of the Element of Possible Changes

Description: (1) The speed of program changes, (2) production system improvement, (3) product marketing networks, (4) the government's commitment to promoting the SME

Sub-elements included in Linkage sector have a strong driver power and dependence on other sub-elements. It means that all the four sub-elements of possible changes are strongly driven by the emergence of other sub-elements and, at the same time, also encourage the emergence of other sub-elements. If the programs in UKM Indah Lestari can take place quickly and alternately, it can lead to other improvements such as improvements in production systems, product marketing networks, and the government's commitment to promoting the SME and vice versa. According to Upadhye *et al.* (2014), sub-elements in this sector have high driver power and dependence values. Meanwhile, Widiyati *et al.* (2009), any actions on these sub-elements will have an impact on the other sub-elements, and the feedback effect can even increase the existing impact. This is due to the unstable relationship between the sub-elements.

Conclusion

Based on the research results, we can draw several conclusions as follows:

1. The supply chain institution of UKM Indah Lestari consists of suppliers, UKM Indah Lestari itself, retailers, and the government directly involved in the supply chain activities.
2. The supply chain institutional structure of UKM Indah Lestari, namely suppliers, UKM Indah Lestari, and retailers, are influenced and related each other, automatically stimulating the business operation of gadung yam chips. Viewed from the relationship on each element, it can be explained as follows:

a. All the sub-elements in the element of needs are at the same level, meaning that these sub-elements are the key sub-elements. These sub-elements are included in the Linkage sector.

b. In the element of constraints, there are two levels of sub-elements. The key sub-elements are those at Level 2, namely consistency in the quality and quantity of raw materials as well as capital adequacy. These sub-elements are classified in the Independent sector.

c. In the element of objectives, there are three levels of sub-elements. The key sub-element is at Level 3, namely the guaranteed availability of raw materials, classified in the Independent sector.

d. In the element of involved institutions, there are two levels of sub-elements. The key sub-element is at Level 2, namely the government, classified in the Independent sector.

e. In the element of possible changes, all the sub-elements are at one level, meaning that these sub-elements are the key sub-elements. These sub-elements are included in the Linkage sector. In other words, these sub-elements must be carefully examined.

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