A Review of Cassava Supply Chain Performance Improvement: A Case of Cassava Supply Chain in Thailand

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***Abstract*— The purpose of this study is to review the previous studies on the supply chain management (SCM) contexts by applying to the cassava supply chain and focuses on the case study in Thailand with the objective to improve the performance of the supply chain. Literature reviews on the previous SCM contexts have been undertaken a thorough search of articles on selected journals relevant to SCM and cassava supply chain during the past 20 years (1998-2018). This paper aimed to provide information about the cassava supply chain and use SCM contexts to improve the supply chain performance in order to sustain the competitive advantage to the future.**

***Keywords*—** *Supply chain management (SCM), SCM contexts, Performance improvement, Collaboration, Sustainable, Future competition, Cassava supply chain, Cassava roots and Cassava products*

1. Introduction

Supply chain management (SCM) have been presented by many researchers, which mostly defined as synonym for logistics, and supply chain (SC) control. SCM is the designing and management of all activities involved in sourcing and purchasing, transformation, and all logistics management activities [1]. It linked the relationship between the buyers, the sellers, and relationship with its network partners i.e. middlemen, suppliers, transportation and customers [2].

Cassava supply chain starts from the raw material (cassava roots) which are cultivated by the farmers. They can be supplied directly by the farmers or from the middleman who collected cassava roots from the farmers and supplied to the manufacturing [3].

Most of cassava studies in Thailand are to improve the production yield, enhance the supply chain efficiency, reduce total cost, increase the percentage of starch content, have the resistance to pests and diseases, etc. Most of the problems resulted from there are no collaboration in the supply chain which they made the problems occur repeatedly. Many problems that found today need more improvement, and it is the burden to the supply chain.

The purpose of this study is to review the previous studies on the SCM contexts by applying to cassava supply chain focuses on the case study in Thailand with the objective to improve the performance of the supply chain in order to sustain the advantage for the future competition [4]. It involves various study on SCM such as collaborate among all parties in the supply chain, select the strategy, manage the cost by using financial management concept, inventory management, use software & technology in managing the supply chain, use green logistics in order to reduce cost and able to sustain the competitive advantage to the future [5].

2. Literature Review

A supply chain (SC) is the integration of various parties to work together in order to acquire raw materials, utilize and transform them into finished products, by adding value to these products and deliver them to the customers [6]. The supply chain is the method of transforming supply chain inputs flow (information, materials, and finance) into supply chain outputs (products, service) [7].

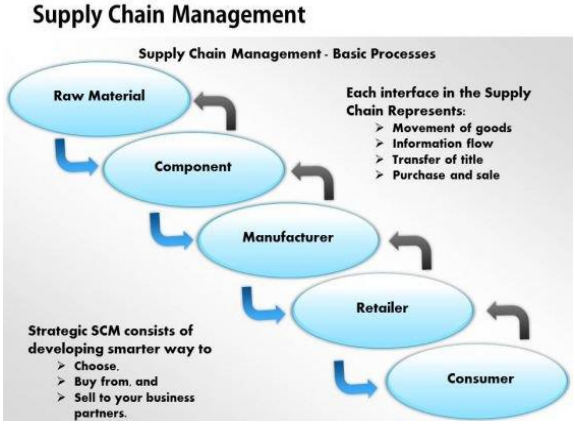

Figure 1. Supply Chain Management Flow Movement

The goal of SCM is to improve its competitiveness by raising the level of customer services and lowering the total cost of the chain. To achieve the objectives, it is necessary to integrate and synchronize the activities and processes of all parties in the whole supply chain, from strategic to operational [8]. All related parties are collaborated to increase the overall performance of the supply chain. It is guided by the decisions on five supply chain drivers [9].

1. Production – decisions about production by defining products and production in the supply chain, it will define the facilities to make those products.

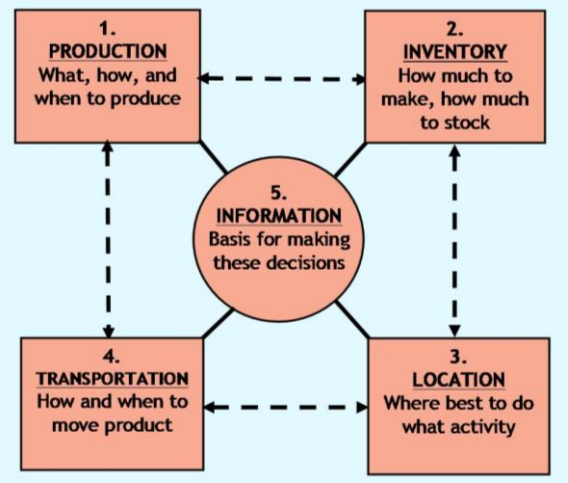

Figure 2. 5 major supply chain drivers, Five supply chain drivers

2. Inventory – decisions about inventory management on setting production and demand levels and manage on the stock on-hand amounts throughout the supply chain.

3. Location – decisions on the facility location (factories, warehouses and stores), and the storage capacities and operating expenses.

4. Transportation – decisions in the modes of transportation that are selected to move products between facilities, and the frequencies of those deliveries.

5. Information –sharing information technology, easier to use, and less expensive. Information, much like money, is a very useful commodity because it can be applied directly to enhance the performance of the other four supply chain drivers.

In SCM processes, inventory management is so challenging because it directly impacts both cost and service [10]. Uncertain in demand & supply and production cycle times make it necessary to hold certain amount of inventory in the supply chain to provide adequate service to the customers [11].

Most of the supply chain problems start with the order from the customers which the manufacturing will have the production plan to produce the products as the orders are obtained from the customers. The supply chain starts from the movement of the raw material until it is delivered to the customers. The supply chain in production systems is an integrated set of business processes that guide all activities of the enterprise, from forecasting, planning, and inventory management to the delivery of finished products to the end users.

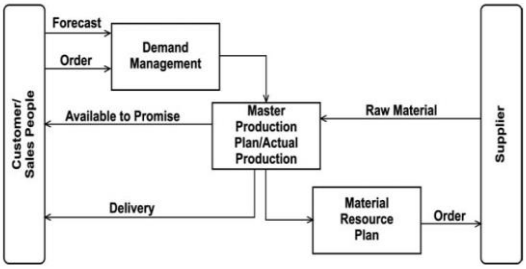

Figure 3. Supply chain planning and execution

Many studies about SCM by applying SCM contexts, which in this paper the study will be divided into assorted broaden topics, i.e. frameworks in SCM (to get the overall concept of SCM), performance measurement in SCM (to measure the performance of the supply chain), supply chain collaboration (SCC) (to improve the efficiency of the supply chain), SCM strategy (SCMS) (to determine in using the strategy according to the objectives of the management, SC finance (SCF) (to generate higher profit), sustainable SCM (SSCM) (to improve the long-term performance to the supply chain), SCM future trends (to know the directions of the future of and the organization), etc.

2.1 Framework in Supply Chain Management Context

SCM is a complex topic to understand because it encompasses the management of many activities and involves multiple role-players across divisional functions and organizations [12]. Most studies on SCM Framework are to improve the performance of the supply chain and make them have the competitive advantage to the chain.

To facilitate the comprehension of the scope of SCM research and the supply chain elements and activities, the overview of the SCM Framework is displayed in Figure 4, which it provides the framework of both problems and opportunities that related to SCM. It will be classified into four streams of research efforts: (1) strategic purchasing, (2) supply management, (3) logistics integration, and (4) supply network coordination.

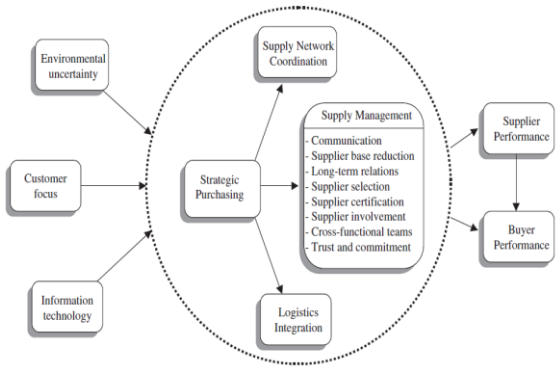

Figure 4. Theoretical framework for SCM research

For the review of SCM literature studies which classify into each category, the category of supply chain strategy is the most attention from the researchers, and SCM frameworks, trends and challenges are the next most attention [13].

2.2 Performance Measurement in Supply Chain Management Context

The objectives of SC measurement are to improve the firm performance. Most studies on SCM performance measurement were intended to use the performance measurements as the tools to improve the SC performance by identify the gap between planning and execution, analyze the problems and propose the improvement [14]. SCM performance is to identify the supply chain gap and share the best practices by using SCOR Level I for measurement [15] and develop supply chain framework.

Benchmarking is a popular tool which is used as a tool to improve organizations' performance and competitiveness. Tools that were commonly used in benchmarking consist of graphical techniques (radar diagram, Z-chart), ratio analysis, balance scorecard (BSC), data envelopment analysis (DEA) [16].

2.3 Collaboration in Supply Chain (SCC) Context

The collaboration is to create a set of strategies in which two or more external and internal firm achieve their common aspirations and goals [17]. The collaboration is very important to the organization or the supply chain. Internal collaboration must be coupled with external collaboration, in terms of developing closer relationships, integrating processes and sharing information with customers and suppliers.

The collaboration is a long-term relationship among SC partners to gain mutual benefits [18]. It is integrated of all activities, with the flow and transformation of goods, information, and money, to improve SC relationships of all involved parties. The interpersonal types of collaboration and five key indicators consist of: (1) joint actions (2) information sharing (3) interpersonal integration (4) gains and cost sharing, and (5) strategic integration [19].

2.4 Supply Chain Management Strategy Context

Several factors that can be considered when determining an optimal supply chain strategy: (1) product characteristics (2) manufacturing characteristics (3) decision drivers [20]. There is some gap between operation strategies and supply chain strategies (SCS), the conceptual frameworks and interaction models are developed to help the manufacturing to manage with the internal operations and SCSs for dealing with suppliers and customers.

To justify which strategy to be used depends on the output that the organization needs. If it needs to achieve mass volume or gain market shares, focus on the cost leadership or product differentiate, able to predict or unpredict SC demand, and SC strategy approaches are efficiency and lean or responsiveness and agile SC.

SCS consists of developing in choosing, buying from the suppliers and selling to the customers. It consists of the movement of goods, information movement, transfer pricing & information and sometimes the transportation, inventory. are also involved. The strategic that formulated by top management should be implemented in organizational practices. To effectively manage the supply chain, the firm has to adjust the appropriate SCF to SCM practices [21].

2.5 Financial Management in Supply Chain Context

Supply chain financial management approach is to use with SCM such as cash-to-cash cycles, cash flow, and weighted average cost of capital (WACC) to manage its cost & cashflow. Cash-to-cash (C2C) is a composite metric that the company converts the money or cashflow invested in raw material into the cashflow collected from the customers. The concept of C2C leads to the premise that a reduction in the cash conversion cycle time will lead to financial and operational improvement.

Firms can generate higher profits by recognizing and cultivating financially based advantage often overlooked by their competitors. This is accomplished by utilizing C2C metrics, and financial management techniques to identify and quantify potential opportunities to increase profitability throughout the supply chain [22].

Supply chain financing (SCF) is an important issue since it improves supply chain efficiency, and

strengthen the SC by collaborative management of C2C, and sharing WACC concept. It involves the financing arrangements and transactions among suppliers, buyers, banks and logistics service providers [23], [24]. The SCF approach often improves trust, commitment, and profitability throughout the chain [25].

2.6 Sustainable in Supply Chain Management Context

Sustainability of supply chain management (SSCM) is the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social which derived from customer and stakeholder requirements [26], [27].

Sustainability is an interesting thing for the supply chain since it will be linked to the future and the competitive advantage of the firm [28]. A number of studies that related to sustainability in the supply chain are related to lower cost and neutral or positive effect on value.

There are many approaches to support SCM to achieve a better performance which the most common used are: (1) Key performance indicators (KPIs) (2) Total cost of ownership & Life cycle assessments (TCO/LCA) (3) Balanced scorecards (BSC) [29].

2.7 Future Trends in Supply Chain Management Context

The supply chain in the future has to be adjusted in order to sustain the competition i.e. product and process design to reduce resource use, more collaboration to reduce costs. Supply chains of the future will focus on developing creative ways to collaborate vertically and horizontally to increase supply capacity and improve efficiency. SC excellence is the key to have the competitive advantage by reducing cost, increase customer satisfaction, and asset utilization [30].

Best value supply chain differs from traditional supply chains in at least four key areas i.e. strategic sourcing, logistic management, supply chain information systems and relationship management [31]. Some shift in strategies from the past that the focus of logistics & SCM are on the efficiency, and the present is on designing and operating the SC to enhance the revenues in order to maximize profit. Collaboration and coordination are the keys to achieving the benefits of SCM [32].

Most of SCM studies are to improve the competitiveness of the supply chain by having the highest customer service satisfaction and decrease the total cost of the supply chain by focusing on raising the level of customer services. Some study aims to have the competitive advantage by having the collaboration of the related supply chain functions. The well plan of business processes, sales and production plan can also improve the efficiency of SCM.

3. Cassava supply chain

Cassava is cultivated in many tropical countries situated in the equatorial belt. The best time to harvest cassava is about 7-18 months after planting [33]. However, harvesting can be any time between six months to two years. Cassava can grow and produce dependable yields in places while other crops will not grow or produce well. It can tolerate drought and grow on soils with low nutrient capacity.

Many countries in the world have demands and uses of cassava differently depend on their needs. The farmers' perceptions of cassava cultivation and the results showed that the farmers' reasons for growing cassava are (1) ease of growing (2) good price (3) ease of selling and (4) ability to grow on poor soils [34].

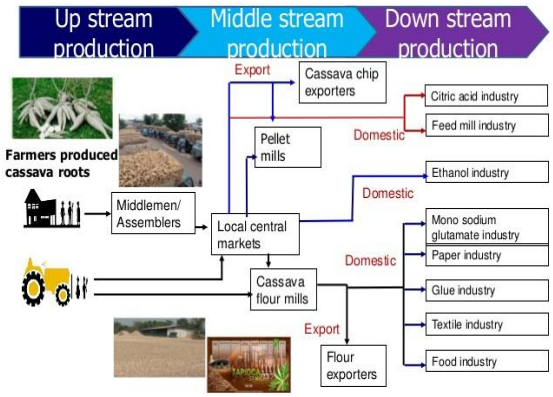

Figure 5. The logistic flow of cassava industry supply chain

The flow of cassava supply chain starts from the up-stream production (cassava roots). They are carried by the farmers/middleman to produce next stage of cassava products in the middle-stream production and down-stream production respectively [35].

Related to the requirement of cassava as raw material, availability of cassava including quantity and quality was the most problem faced by the industry [36]. As the demands in cassava products are increasing, cassava roots production has to be improved to serve the higher demands.

The major factors that determine the price of cassava products are market demand while other factors i.e. demand frequency, production costs have less concern. It's important to note whatever factors affect market price will greatly affect demand for cassava products.

3.1 Cassava roots

Cassava roots are the main raw material to other cassava products, they are highly perishable. One to three days after harvesting the roots start to deteriorate if they do not receive any special treatment. International trade in fresh cassava roots is mostly confined to transactions between neighbouring countries. It has been hampered by the bulkiness and perishability of the roots, which make them a risky product to market.

As a result of poor and inefficient storage systems together with cassava roots are the perishable product. If there are no treatment on good storage keeping, it will be fermented by itself, so the post-harvest storage is an important part of food processing that keep the quality of food. Post-harvest storage systems are usually used to maintain quality of agriculture products [37]. Some studies on diverse techniques to extend cassava shelf-life to keep the longer period of cassava [38]. Many countries that have the most cassava plantation in the world face the problems how to minimize the loss during harvest and post-harvest [39].

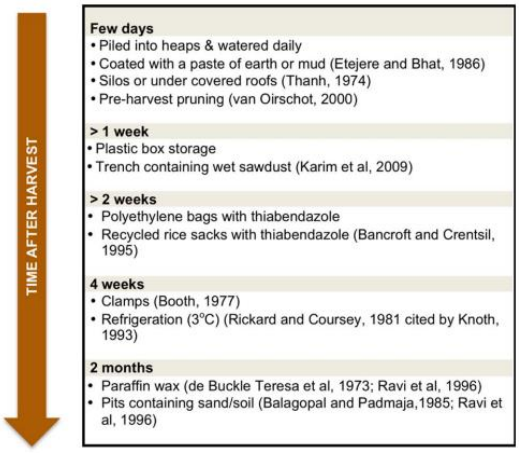

Figure 6. Various techniques to improve cassava shelf-life extension

Most study about the cassava roots are to extend the shelf life of the cassava roots, reduce the loss during harvest or post-harvest, improve the efficiency of cassava production, increase the yield in cassava plantation and increase the percentage of starch content [40].

3.2 Starch

Cassava is one of the most important food crops in the humid tropics, it can be used as a component of food or produce starch for industrial use. Cassava starch processing starts from (cassava roots by extracting the starch from cassava.

Cassava starch currently has its largest use in making sweeteners. Sweeteners is followed by Monosodium Glutamate (MSG), food industry, paper industry, modified starch, sago pearl and textile. The utilization of cassava starch in Thailand and China are similar since both countries use almost half of their starch consumption to produce sweetener products [41].

Most users use cassava starch by substitute with corn starch, and vice versa. Both starch can be use as the substituted, although they have differences in physical and chemical characteristic. The products that use corn starch will have some yellow on their products, while the products that use cassava starch have more white colour. Both dry and wet bonding strengths of cassava starch adhesive were higher than that of corn starch. Moreover, cassava starch generates more viscosity than corn starch. There is some price correlation between cassava starch and corn starch [42].

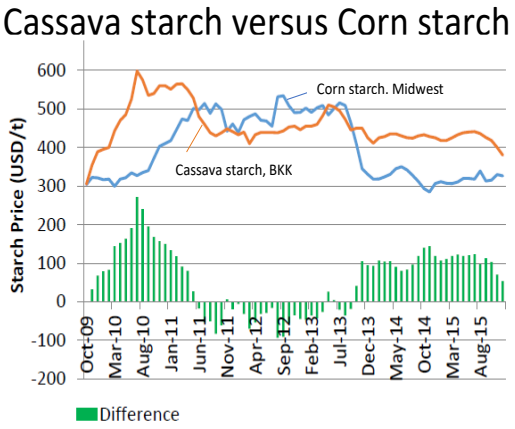

Figure 7. Compare the pricing between Cassava starch vs Corn starch

3.3 Chips

Cassava Chips is another product derived from cassava, they are unfermented white dried products of cassava. The demand for Cassava Chips as an industrial product is wide, it can be used in various industries i.e. distilleries, pharmaceutical, food and

animal feed. Presently, there is a high export demand in China especially for ethanol production.

Farmers primarily use sun for drying which it is time-consume and there's a greater risk of spoilage. It's difficult to dry cassava during the rainy season. Quality is very important for cassava products especially on drying, processing and storage which have major impact on product quality [43].

The largest export markets for Thailand's cassava chips are China. One concern on the trade is the quality of contamination in chips. In order to keep the market, Thailand's producers have to focus on the quality of the product.

3.4 Pellets

Cassava chips are used as the starting point to produce cassava pellets. Pellets are produced by feeding dried cassava chips into the pelleting machine, followed by screening and bagging for export. Cassava pellets are regarded as a superior value-added product than cassava chips. The demand for cassava pellets are driven by the consumption of livestock products, and their price compared to substitute products.

3.5 Ethanol

Ethanol is a type of alcohol derived from plant fermentation to change starch from plant to sugar, then sugar will be converted to alcohol and purified to be 95% alcohol by distillation which can be used as fuel. Ethanol manufacturing to produce fuel in Thailand. Ethanol from cassava can be produced from cassava roots or cassava chips as the feedstock depend on the availability of the feedstock.

The main objective of the development of ethanol production technology from cassava is to produce high yield of ethanol, to save energy and water. Moreover, the biomass residues are to be used efficiently with minimum costs of production as much as possible [44]. For the ethanol plant which uses cassava as the raw material, the cassava-to-ethanol conversion ratio has the greatest leverage on optimal plant capacity, and the next important determinant of the optimal size is the ethanol price [45].

Using cassava to produce Ethanol depends on the availability and price competitive with other alternative products. The trend of gasohol consumption requires a large number of cassava and sugarcane as raw material and cassava industry is worried that there may be insufficient cassava roots in the future if there's no collaboration among the related party in the supply chain [46].

3.6 Cassava supply chain in Thailand

Cassava is one of the most important economic crops in Thailand and is mainly grown by smallholders. Cassava is not widely consumed as a food product in Thailand, almost all productions are sold with industrial purposes. Cassava is an easy crop to grow. It can grow in poor soils and produces high yields with suitable management.

The demand of cassava in Thailand is high, which needs more of cassava starch for food, construction of related industry, animal feed and ethanol production. As the demands in many industries are also increasing, cassava roots production has to be improved to match high demand [47].

In Thailand, cassava plays a major role in the economy of the country. Cassava is mainly used for food, feed and fuel. Cassava starch are used in both food and industry sectors. For ethanol production, cassava is used as raw material due to the low input costs of production. Cassava roots and chips are the major raw materials for ethanol manufacturing. Based on the types of raw materials, the yield of ethanol and production costs are different. Cassava is an important crop commodity of Thailand. It is not only an important material for domestic agriculture. business, but it also brings in revenues for the country [48]. The collaboration in the cassava supply chain included all stakeholders; government, academic and private sector, have to work collaboratively to strengthen the industry competency.

3.7 Risk assessment to cassava supply chain

There was a study on the presence of market and production risks which they resulted in farmers temporarily changing the market in which they sell their cassava and diversifying into other crops. As it regards production risks faced, pest attacks are the most outstanding. Traders like the farmers, are prone to market risks, poor storage and generally post-harvest handling constitute a significant source of risk for traders as any changes in market demand results in either build up in stocks requiring additional storage and increased risk for spoilage, while reduced demand in the market equally results in longer storage time and by extension increased risk of spoilage [49].

One of the key risks in cassava supply chain was cassava products demand and cassava roots supply. The analysis of data indicated the highest risk for the industry were the economic environment, and price fluctuate of cassava products and roots. Minimizing risks is one of the most important purposes in business management

One study on an increase on production yield increases income and also improved standard of living, Farmers wanted to increase their yield, followed by starch content improvement. Moreover, the farmers also required the assistance on best practices. Price is the important role in making selling decisions.

The price of cassava and its products depended on demand and supply in the supply chain. The price was fluctuated from time to time, and there are many factors that are related to the price. Many study on cassava supply chain are related to improve the plantation yield, increase the plantation areas, more investment by adding soil & water & fertilizer to cassava plantation, ability to compete with other agriculture products (better return on investment to farmer), mitigate the risk of the fluctuated price, increase percentage of starch content, dispose of waste water and pulp, by having more collaboration among all parties in the supply chain, etc. All these factors affect the risk management in the supply chain which all parties have to be concerned and work together to improve the efficiency on the supply chain.

4. Discussion and Recommendation

Many studies in the scope of SCM with the objectives to improve the efficiency of the supply chain by applying SCM contexts study i.e. define framework, having performance measurements, apply strategy concept, financial management, collaboration, and sustainable competitive advantage to the future competition.

From the study, it is found that many problems in the cassava supply chain needed more analysis and improvement. Presently, there are no benchmarks to be used as tools to help the related party cope with the supply chain problems. Most problems occur regularly and no systematic solution planning by not allow the problems to occur repeatedly.

One of the major problems in the cassava supply chain is the fluctuation of the cassava price, they are so volatile that the farmers may switch to cultivate other kind of agriculture products when cassava price is low. The main reasons are the payoff return to the farmers which resulted from Thai farmers are poor. They can't afford with the low price of cassava for the extended period, they have to switch to cultivate other agriculture products that generate better return.

Another crucial problem of cassava supply chain is the short shelf life of cassava roots since they are the perishable products. Many experts try to keep and extend the shelf life of cassava roots to prolong the cassava use to be available for the longer period. Moreover, most of the problems that found in the cassava supply chain in Thailand are the lower efficiency of cassava production, lesser yield in cassava plantation and low percentage of starch content. All of these problems can be improved if there are the collaboration among all parties consist of the government sector, technician expert, academic expert, manufacturers, farmers, etc. They should have the organization/association that will oversee/monitor the operation of the cassava supply chain, and ready to provide the support to the farmers & related parties once they have the problems. This association will delay/relax he farmers from switching to cultivate other agriculture products, by provide the support the farmers to keep on cultivating the cassava. Furthermore, it also needs the decision support tools that will be used to help them justify the cassava supply chain situation. It has to encourage the farmers to harvest and sell the cassava roots on the high percentage of starch content, by not having the early harvest on the young cassava in order to have better percentage of starch content and selling price.

Financial management is very important issue for cassava supply chain, especially in Thailand since the competition of cassava not only compete with the players in the same industry, but they also have to compete with other substitute agriculture products especially with corn. The related parties in the supply chain have to manage the cost with effectiveness and efficient, otherwise, they will lose the competition ability. By setting high efficiency on performance measurement i.e. KPIs, SCOR model, suitable strategy, or use the technology to help in managing the supply chain, etc., these will allow the related party in the supply chain to have the ability to compete in the market.

The price of cassava and its products depended on demand and supply in the supply chain. The price was fluctuated from time to time, and there are many factors that affected the price.

Most studies are intended to improve the production efficiency, the plantation yields, and find the reasons to support whether cassava was well harvested by the farmers in the world. Some study on the presence of market and production

risks which they resulted in farmers temporarily changing the market in which they will cultivate or switch to other agriculture product. As it regards production risks faced, pest attacks are the most outstanding. Traders like the farmers, are prone to market risks, poor storage especially on post-harvest handling constitute a significant source of risk for traders as any changes in market demand results in either build up in stocks requiring additional storage and increased risk for spoilage.

The study on this paper on the SCM context by apply to cassava supply chain, it allows the related parties in supply chain to analyze the markets and competitions, in order to have the competitive advantage over other competitors in the industry and other competitors in the related industries. This study, it will be able to apply to other country's cassava supply chain, by not specific only in Thailand.

Moreover, the researcher hopes that this study will be used as the groundwork to other researchers who interested to study in cassava or other agriculture products. They can apply by using some concept from this study; the factors that affect the performance of the supply chain are addressed and know how to improve the efficiency to the supply chain.

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