Supply Chain Performance Measurement and Improvement for Sugarcane Agro-industry

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***Abstract*— The supply chain performance is an indicator of success company in conducting the business process. The measurement of supply chain performance is required to take control and recognize the company's performance position. The objectives of this research were to identify business process value-added within the supply chain, to measure the supply chain performance, and to formulate strategies for improving the supply chain performance. The value-added measurement was conducted by Hayami method [15]. The supply chain performance was measured by Supply Chain Operation Reference (SCOR) combine with fuzzy Analytic Hierarchy Process (AHP). Strategies for supply chain performance improvement were formulated by SWOT analyses combine with fuzzy-AHP. The value-added analysis result showed that the sugarcane factory was the highest value-added ratio in the supply chain. The supply chain performance measurement result showed that the sugarcane factory has poor performance while plantation was in very low performance. Evaluation of supply chain's internal and external factors indicated a strong condition and would deal with possibly great threats. This study suggested to conduct follow up research in the sugar production system in order to maintain improvement on qualities, yields, and performance which eventually lead to supply chain performance improvement.**

***Keywords*—** *fuzzy AHP, SCOR, sugarcane agro-industry, supply-chain performance, SWOT*

1. Introduction

Sugar cane constitutes a strategic agro-industrial product in fulfilling basic needs of community as well as for food industry. Indonesian domestic sugar demand is in increasing condition, cause of a population rising, sugar consumption, better social welfare and their revenue. To accommodate this demand, it is necessarily to be accompanied with a growth of producer's productivity, otherwise, Indonesian sugar factories are only able to meet half of domestic needs [12]. Domestic sugarcane production in 2015 was 2.86 million tons [41], Indonesian government have to import 2.93 million tons of sugar to meet the demands. On the other hand, it rose by 14.71% which was US$1.25 million worth, then it sets Indonesia as a sugar importing country worldwide moreover the domestic sugar factories position increasingly complicated.

Some efforts to accompanied Indonesian sugarcane demand, such as productivity improvement in plantations, quality improvement in raw materials, revitalization of old and poorly maintained factories and establishing new factories outside Java Island in Indonesia had been applied. Theses effort have to continue over the year, cause of an attempt to keep up with domestic sugar demand generates an extremely high cost [17]. By this reason, another way had to found in solving this problem, then we suggest to optimize supply chain performance on sugar cane agro-industry through measurement and improvement in supply chain performance.

Measuring of supply chain performance aims to support goal construction and work evaluation then decide strategy, tactic and operational levels [44]. Measurement of supply chain performance is necessary to be carried out in order to solve some problems that may arise out of the supply chain before the widespread impacts are realized. Supply chain performance measurement would organize supply-chain coordination to cope with consumer demands [9], [31], evaluate holistically supply-chain performance, and create more efficient supply chain integration [2]. Besides that, for future development, supply chain performance measurement also determines improvement direction to create competitive excellence and optimize supply-chain models which applied in an industry.

The equality of cost distribution and profit by supply-chain members also might be conducted through a value-added analysis. A fair value added and profit by stakeholders in supply chain are able

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to preserve cooperation, sustainability and gain economic value of the business process [21] as well as attract investors to be incorporated in the business process. The effort to preserve domestic sugar cane agro-industry can be viewed from cost distribution and equal profit throughout the supply chain [5].

This study was carried out overall performance measurement and decided efforts for an improvement in supply-chain performance of sugarcane agro-industry in Indonesia. In addition, equality of cost distribution and profit throughout the supply chain that could be recognized by value-added analyses. The method of value-added analyses had been introduced by Hayami (1987) and modified by [15], however when it comes to this research some adjustment and modifications are needed according to results of the supply-chain and identification of operational production. Strategies for an improvement in supply-chain performance were evolved through a SWOT analysis then the strategy was prioritized through a fuzzy-AHP generated from expert opinions. The strategy for supply chain improvement hopefully have to be easy and consume minimum time to implement, and satisfy company's objectives [1].

This research was aimed to identify and analyse supply chain configuration and value added of sugarcane agro-industry, perform supply-chain performance measurement and formulate strategies for an improvement in supply chain performance on sugar cane agro-industry. This paper comprises of 5 chapters, i.e. Introduction, Methods, Results and Discussion as well as Conclusion and Recommendation. The introduction explains the background, purposes and benefits of this research. The methods explain the framework and methods of data collecting and analysis. The results and discussion explains measurement results of supply-chain performance and formulation of an improvement in supply-chain performance. The conclusion and recommendation is the final chapter summarizing results and containing suggestion for further researches.

2. Literature Review

2.1 Supply Chain Performance

Various studies related to the supply chain management has been widely and systematically studied. The ease of access to information, trend of raw material and manufactures inter-connection also the increasing of supply chain model management in some company, encourage researchers to concern in this study [48], [49]. Furthermore, supply chain model analysis has a great opportunity to increase efficiency of the company business process [22]. The main role of supply chain management study in strategy formulation is to achieve supply chain goals, make this field always developed by researchers.

Various application of supply chain management has been widely applied in various companies, namely construction companies, food industry and agriculture and textile industries [48] that each has a different application of different supply chain models. Chopra and Meindl [9] argued that a supply chain involved all direct and indirect stakeholders to fulfil customer needs. The main objective of a supply chain model is basically to transfer product of a business process to meet the costumers' needs. Supply chain can be interpreted as a large number of value chain that are connected to inter-organizational to ensure the smooth flow of money, materials, products and information from providers of raw materials to the final consumer or flow instead and involvement of the entire stakeholders included in the stream [50], [51].

Agro-industrial supply chain management has a different model from conventional manufacture, that perishable raw materials and product, business activity depends on seasonal condition, raw material varied size and quality, voluminous and hard handling [24]. By these constraints, the complexity of agriculture and agro-industrial supply chain has not been studied and reviewed widely [16], [25]. Sugarcane agro-industry supply chain as a business process to produce sugar from cane -a product of agriculture- has many constraints and differences with other supply chain model. The complexity of sugarcane supply chain model can be seen as agricultural product characters, involve multi-actor and multi-sector to make a business decision, and uncertainty supply chain business process input and output factors [8], [40].

Supply chain performance measurement is needed to ensure the supply chain objectives achievement and to know the company's capabilities to overcome the supply chain problem. According to Bittencourt and Rabelo [3], performance measurement in complex business processes requires performance measurement matrices. Basically, a supply chain business process model had the unique characteristic, then performance measurement matrices has a level of importance (weight) depending on the characteristics of business processes [27]. In this case, we adopt supply chain performance matrices from Supply Chain Operation Reference (SCOR) while the weighting matrices of performance measurement is obtained by fuzzy-AHP.

SCOR (Supply Chain Operations Reference) is a standard guideline that can assist companies in evaluating performance through identification and supply chain performance matrices measurement [20]. SCOR model consists of three levels, namely process type, process category and process activity. Implementation of SCOR model for supply chain performance evaluation would be more efficient in redesign and optimize supply chain network model [42]. The stage of evaluating supply chain performance based on SCOR matrices begin with identification at each level of the hierarchy in accordance with the business processes [26].

2.2 Fuzzy-Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a Multi-Criteria Decision making that introduce by Saaty. AHP can simply a complex problem by translate it to a hierarchy level model. The elements of this hierarchy are performed pair-wise comparison in order to obtain the value of the nominal scale in each element [4]. The nominal scale of each element of the hierarchy can be used as an alternative decision by comparing with other factor in a hierarchy [43].

Fuzzy AHP is a technique to reduce the confusedness, time consuming to achieve consistent value and inability to solve the uncertain decision making problems of AHP [7] [14]. Ravil and Kant [32] explained that there are four weakness of AHP developed by Saaty, they were (1) AHP mostly used in a certain decision-making application; (2) AHP was built for unbalanced naturally assessment; (3) AHP was not able to resolve expert assessment which might be uncertain and ambiguous; (4) the subject and expert assessment greatly influenced to AHP results.

Fuzzy-AHP assessment was essential to anticipate AHP weakness purposed by Saaty and Vargas [36]. AHP is not capable to address problems of making uncertain and ambiguous decisions which is happening in real world problem [52], [32]. Fuzzy-AHP and conventional AHP basically has the same steps, but fuzzy AHP allows linguistic variables utilization in assessment and has different assessment scale [37]. The assessment scale of Fuzzy-AHP is following the concept of fuzzy system as described in Table 1.

Table 1. The Expert assessment scale and definition of Fuzzy AHP

Assessment scale	Fuzzy number	Definition	Membership function
1	~1	Equally important	(1,1,2)
3	~3	Slightly more important	(2,3,4)
5	~5	More important	(4,5,6)
7	~7	Much more important	(6,7,8)
9	~9	Absolutely important	(8,9,9)

Fuzzy AHP solves problems by using the confidence index (α) and the optimism index (ω). The expert assessment for the AHP hierarchical problem based on Table 1 then was calculated with Eq. 1-6.

$$\sim 1_{\alpha} = [1, 3-2\alpha] \quad (1)$$

$$\sim 3_{\alpha} = [1 + 2\alpha, 5-2\alpha] ; \sim 3_{\alpha}^{-1} = \left[\frac{1}{5-2\alpha}, \frac{1}{1+2\alpha}\right] \quad (2)$$

$$\sim 5_{\alpha} = [3 + 2\alpha, 7-2\alpha] ; \sim 5_{\alpha}^{-1} = \left[\frac{1}{7-2\alpha}, \frac{1}{3+2\alpha}\right] \quad (3)$$

$$\sim 7_{\alpha} = [5 + 2\alpha, 9-2\alpha] ; \sim 7_{\alpha}^{-1} = \left[\frac{1}{9-2\alpha}, \frac{1}{5+2\alpha}\right] \quad (4)$$

$$\sim 9_{\alpha} = [7 + 2\alpha, 11-2\alpha] ; \sim 9_{\alpha}^{-1} = \left[\frac{1}{11-2\alpha}, \frac{1}{7+2\alpha}\right] \quad (5)$$

$$\sim \alpha_{ij}^{\alpha} = \omega \sim \alpha_{iju}^{\alpha} + (1-\omega) \sim \alpha_{ijl}^{\alpha} ; \forall \omega \in [0,1] \quad (6)$$

2.3 Value-added

Increasing end product value added for consumers is an objective of general supply chain [10]. Value added defined as increasing value of raw materials because of a process series in a production scheme [34] [44]. The value added in the supply chain can be analysed in each stakeholder which has a different value depend on the input of the production process [23]. Furthermore, Zhang and Huang [47] simplified the definition of value added as the difference of output and intermediate input in the production activity. The increasing of value-added occurs in the whole supply chain [15], but it depends on the inputs, process and specific treatment in each stakeholder.

Analysis of the value added in the agro-industry supply chain is needed to get information and to identify the benefits and costs distribution among stakeholders. A healthy benefits and costs distribution in the whole supply chain also guarantee the sustainability of the business process [5]. Besides that, value added distribution information is also necessary to be understood by investor as an attraction to invest in the sector and to know which business process that is ineffective in the entire value chain [30] [35].

Various supply chain value added models had been developed to get information of the business process values. The value-added calculation method by Hayami is often used to explain supply chain value added distribution. Hidayat and Marimin [15] also developed value added model analysis by modifying Hayami value added model for Palm oil agro-industry supply chain. Hidayat and Marimin [15] defined value added as benefits of a stakeholder in the supply chain that Selling Price of the product (SP) and Quantity of Product (QP) are revenue for stakeholder. Then, the revenue is deducted with Total Fixed Cost (TFC), Variable Cost (VC) and Quantity of Variable (QV) as described in Eq. 7.

$$VA = SP \times QP - TFC - VC \times QR \quad (7)$$

3. Methodology

3.1 Research Framework

The increasing sugarcane demand in Indonesia has not been able to be accommodated by domestic cane sugar agro-industry. The Indonesia's sugar agro-industry needs to enhance its productivity while it still has a great potential to implement. Thereby, the sugarcane industries are capable to fulfil domestic sugar needs and to reduce the amount of sugarcane import. The escalation of sugar productivity may be executed by optimizing sugar supply-chain management so a better integration of upstream and downstream in business process can be achieved.

This research began with collecting data related to sugarcane agro-industry supply chain management. Data collection, identification and validation of the research were carried out at RAB Ltd in East Java and SBG Ltd in West Java, Indonesia. The supply-chain configuration of sugarcane agro-industry was analysed by viewing four aspects, namely the network structure, the business process, resources and supply-chain management; therefore, the objective condition of a model for the supply chain could be identified. An analysis of supply chain value added is required to identify the sustainability of the supply chain, calculated through models evolved from [15] value-added mathematic models on Cultivations and Processing of the RAB Ltd plant. Measurement of supply-chain performance with SCOR (Supply Chain Operation Reference) approach was performed to analyse the supply chain performance for each performance matrices at SBG Ltd. The actual values in supply-chain performance matrices were combined with the results of fuzzy-AHP weighting value which is obtained by organizing expert opinions. Strategies for an improvement in supply chain performance was obtained from the SWOT (Strength Weakness Opportunity Threat) analysis and was aimed to formulate alternative strategies. The formulated alternative strategies were selected by means of organizing expert opinions through fuzzy-AHP technique. The research framework can be seen in Figure 1.

3.2 Data Collection Procedure

Source of data that used in this study were obtained from primary and secondary data sources. The primary data was obtained from field observation, stakeholder interviews, questionnaires and discussion with experts. Field observation was implemented in SBG Ltd in West Java and RAB Ltd in East Java, Indonesia. The primary included data and information of supply chain configuration from all sugarcane agro-industry supply chain stakeholders, expert assessment for supply chain performance measurement matrices model and internal and external supply chain factors to formulate supply chain performance improvement.

The secondary data was obtained from scientific journals study, results of previous research study, and data documentation from relevant institution. The secondary data included value added variables from sugarcane supply chain stakeholder in 2016, sugarcane supply chain performance matrices data from data documentation, data of sugarcane yield and productivity, data of sugarcane import quantities, data of factory efficiency and production quantities, data of sugarcane auction price, and sugarcane price at farmer level.

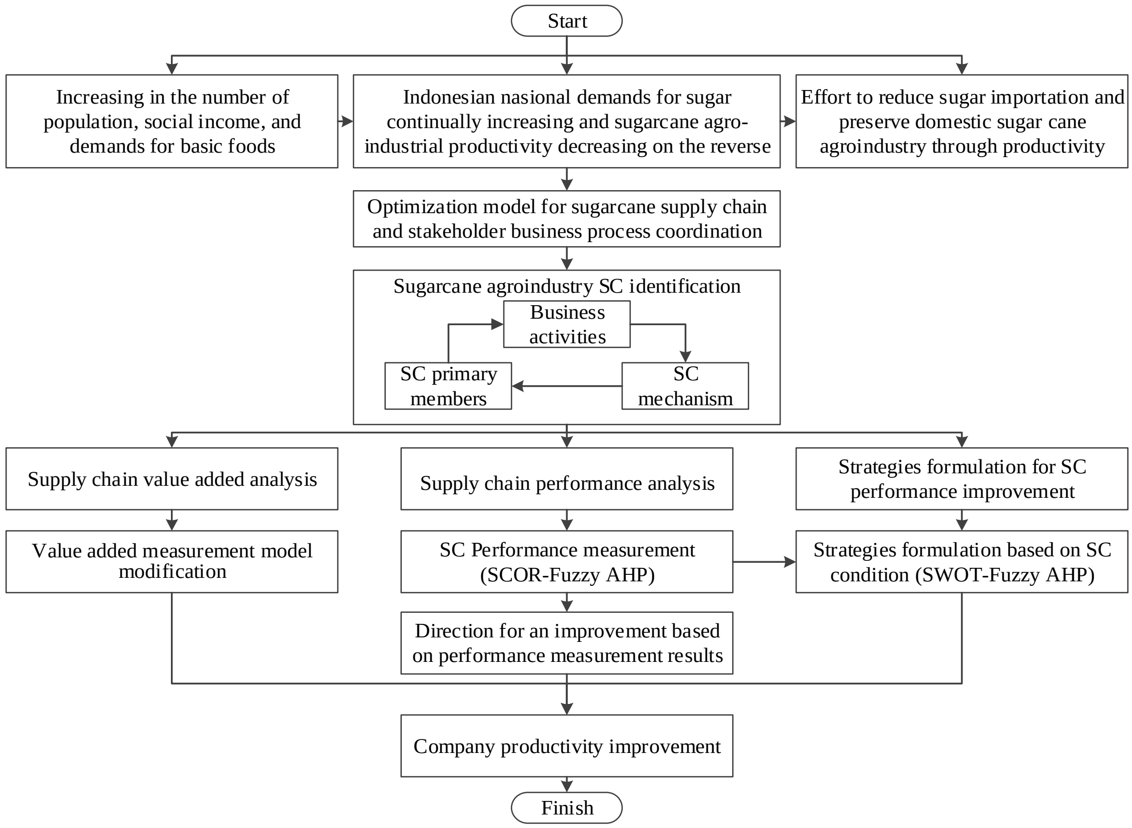


Figure 1 Research Framework

3.3 Data Analysis

3.3.1 Sugarcane Agro-industry Supply Chain Identification

The supply chain of sugar cane agro-industry was identified descriptively and was adapted from supply-chain development methods reported by Vorst [44]. This approach described the supply chain through the four main elements, they are chain structure, chain business process, chain management and chain resources.

3.3.2 Supply Chain Value Added analysis

The objective of value-added analysis is identifying the amount of income earned by each member of supply chain. The supply-chain stakeholders value added calculation and analysed is adopted from Hayami's mathematical model and had been modified by Hidayat and Marimin [15]. In this research, we also suggested some assumptions to accommodate Hayami's method for value added analysis of sugarcane agro-industry supply chain, that is detailed in section Results and Discussion.

3.3.3 Supply-Chain Performance Analysis

Measurement of supply-chain performance was developed by following SCOR (Supply Chain Operation Reference) model and constructed into four hierarchical levels of fuzzy-AHP decision comprising the business process, performance parameters, performance attributes and performance matrices. The expert opinions were required to classify models while hierarchical weighting was composed using α value of 0.5 and ω value of 0.5. Furthermore, expert opinions were translated in Eq. 1-6 in line with fuzzy-AHP assessment framework with the consistency index of <0.1.

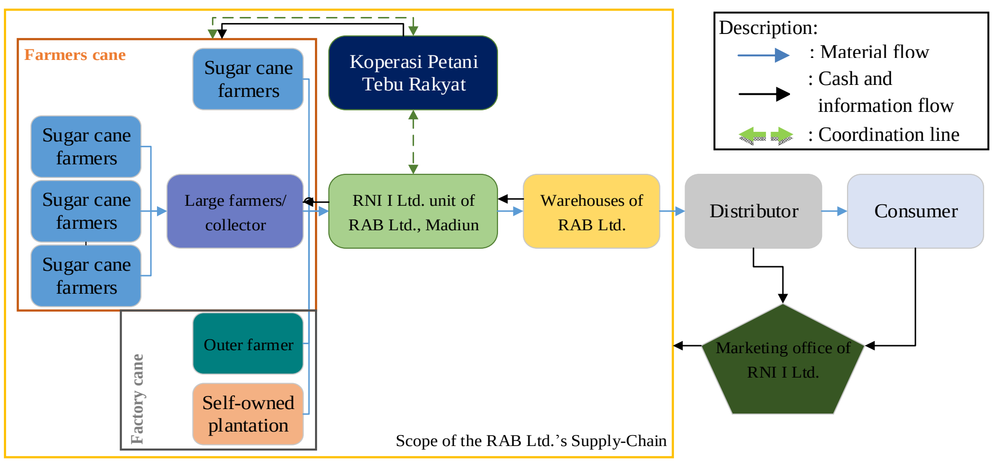
3.3.4 Strategies Formulation for Supply Chain Performance Improvement

Strategies for an improvement in performance was formulated with SWOT analysis and prioritized the best strategy for an improvement in performance through a fuzzy-AHP analysis. Strategy formulation through the SWOT analysis was made up of three stages, namely evaluation of company's internal and external factors, matrices construction and decision making to [38]. SWOT analysis might be a preferable way of learning organization situation and position [13] also designing future procedures towards an organization improvement in a strategic way [39]. In this step, we arranged SWOT matrices containing alternative strategies for an improvement in supply-chain performance. The decision-making step was performed with the fuzzy-AHP technique which is arranged in SWOT matrices then would be confirmed by experts and evolved into a hierarchical decision.

4. Results and Discussion

4.1 Supply-chain Configuration of Sugar Cane Agro-industry

RAB Ltd. is a business unit which operates on processing of cane into sugar in line with qualities of White Crystal Sugar (WCS) as Indonesian standard [53]. The production process and supply chain incorporated at RAB Ltd. starts from ensuring availability of the sugar cane raw material from plantation then product storage in warehouses. Availability of the raw materials is fulfilled by farmer's community plantation and self-owned plantation. Almost all sugarcane materials are provided through a cooperation with sugarcane farmer cooperatives *(Koperasi Petani Tebu Rakyat–KPTR)*. In addition, RAB Ltd. is supplied with sugarcane farmers outside the region in case of lacking sugarcane supply. Sugar cane produced from the processing plant then is distributed to consumers under the coordination of parent company. RAB Ltd. is in charge of ensuring qualities of the sugar produced until it is stored in company's warehouses. The distributor company assigned by parent company using a Delivery Order (DO) letter to pick up the sugar from warehouses. The distributor distributes it up to the hands of end consumers through their owned networks. The supply-chain mechanism existing at RAB Ltd. and Indonesian generally is illustrated in Figure 2.



Source: Results of field observation (2016)

Figure 2 Sugarcane agro-industry supply chain in Indonesia

In the business process point of view (push/pull system) [9], the sugarcane supply chain at RAB Ltd. classify in 3 main process, namely procurement/cultivation cycle, processing cycle and consumer order cycle. The procurement/ cultivation cycle and the consumer order cycle define as pull process which means it begin after the demand. The processing cycle as push process which means it is executed as an anticipation of future demands. The pull/push cycle in the supply chain of sugar cane agro-industry at RAB Ltd. is shown in Figure 3.

4.2 Sugarcane Agro-industry Supply Chain Value-Added Analysis

The value-added is defined as an addition of value to certain commodities or semi-finished products after being processed in a series of production. Value added in supply chain is necessarily be fairly shared among stakeholders [21]. This might be performed by determining the value added which is earned by each stakeholder relied his role in supply chain. Furthermore, sugarcane value added analysis in this case is carried out at each stakeholder involved supply chain through RAB Ltd, including sugarcane farmers and processing plant companies.

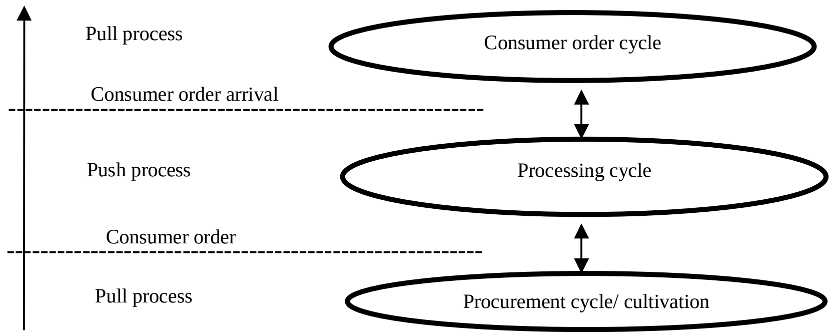


Figure 3 The pull/push cycle at RAB Ltd

The value-added analysis method had been applied widely which known as Hayami's value-added calculation methods. Moreover, this method does not accommodate value-added calculation for long-term and products by yield as well. Hidayat and Marimin [15] had modified the Hayami's value-added calculation which was applied in the palm commodity based. To accommodate the analysis, we re-formulate value added analysis formulation by some conditions and assumptions based on aforementioned value added model. Furthermore, based on the supply chain identification, the value-added analysis in this research was analysed at farmers and processing plant.

The value-added calculation and analysis at sugarcane farmers turns to be more complex due to government regulations for sugarcane price and yields of farmers' sugarcane investigation results. In case to accommodate value-added analysis of sugarcane farmers and supply chain, assumptions as follows are defined.

1. Value-added calculation of sugarcane farmers took into account of sugarcane yields that yielded by farmers and also the auction price of sugar.
2. The basis for plantation productivity of sugarcane cultivation took into account *Ratoon* cane activities performed by farmers. Based on field observation, the *Ratoon* cane up to six times period, on average.
3. The added value of sugarcane farmers was calculated on the basis of productivity in every Hectare of farmer's land in a year.
4. Production needs and sugarcane cultivation of farmers were counted for necessity 1-time planting period commencing from the process of seed-planting to the harvesting.

Table 1 presents calculation results of sugarcane farmer's value added following a value-added calculation model modified by [15] which has accommodated assumptions aforementioned. The first component counted from the value-added analysis of sugarcane farmers at the farmer level was the sugarcane cultivation process. The input price specifically the primary input of cultivation process referred to sugarcane seeds. While the output price was conducted from sugarcane selling price which set by farmers to sugar factories. The sugarcane selling price at farmer level was determined by acquisition of farmers' sugarcane yields and the auction price of sugar with the yield sharing relied on government provision. In this case, farmers' sugarcane yield sharing with companies was 66%:34% based on government regulation. Accordingly, in the presence of the sugar price provision highly determined by the auction price of sugar farmers were encouraged to only pursue quantities of sugarcane sold. Consequently, sugarcane yields and quality was in low performance leading to decreased sugar factory efficiency.

Table 1 Result of sugarcane farmer's value added

Variables	Units	Values
Supply-Chain Interaction		
Material purchase price	IDR/Kg	7 500
• Auction price of sugar	IDR/Kg	12 500
• Yields of investigation results	%	6.50
Yields owned by farmers	%	4.29
Farmer sugarcane price	IDR/Kg	4 933.50
Outputs, Inputs and Costs		
• Output (Sale volume)	Kg/Ha	8000
• Output (Sale value)	IDR/Kg	39 468 000
Basic Raw Materials	Kg/Ha	6 000 000
Direct workforce	HOK	267
Conversion factor	%	6.58
Coefficient of direct workforce	IDR/HOK	22 471.91
Wage of direct workforce	IDR	13 350 000
Incomes and Value Added		
a. Other input prices (Production)	IDR	17 800 000
b. Other input prices (Operational)	IDR	6 000 000
a. Added value	IDR	9 668 000

The input, output and cost components consisted of labour needs and wages that should be paid by farmers. Labours in the plantation were recruited from outside the region whose payment was based on their work productivity. The need for a workforce was calculated in a man-day (*Hari Orang Kerja*–HOK) unit and the average wage of IDR (Indonesian Rupiah) 50 000 was known. The output section was the amount of harvested sugarcane and the amount of money earned from each Hectare of land. The amount of sugarcane cultivation is based on the average farmers' Ratoon up to 6 times which is 800 Kg/ Ha. The amount of money (operational output) gained from each Hectare of land was derived from the number of sugarcane output (Kg) and the sugarcane purchase price by factories in accordance with yields which is yielded from the section I (supply chain interaction).

The remuneration and value-added components made up input raw materials required, value-added gained as well as the value-added ratio earned by farmers. Other input materials in sugarcane cultivation were costs of fertilizer and water to improve land productivity. Value added was gained from the sale value earned by farmers after it is deducted by needs for the main raw material and other input materials. As presented in Table 1, value-added ratio is 24.50% for sugarcane farmer.

At the processing plant value added analyses, the result showed that the added value ratio is 42% and profit level at 42% which is higher than farmer level. Actually, if we look from the value-added ratio point of view, it means that the processing plant is not in good condition and in decreasing efficiency. The value-added ratio in the whole supply chain especially processing sugarcane plant is conducted by worst yield process. It known that yield process in this step just only 5.6% which below Indonesian national target (8-10%) [33].

4.3 Supply-Chain Performance Analysis

4.3.1 Supply-Chain Performance Measurement Matrices

Sugarcane supply chain has a complex situation, include multi-actor and multi sector to achieve supply chain objective. Bittencourt and Robelo [3] stated that for the complex supply chain, we need supply chain matrices to assess supply chain performance. Furthermore, some research [23], [27] submitted that supply chain performance matrices had distinction importance level in each business process, then we need to asses it by weighted value. In this research, we apply Supply Chain Operation Reference (SCOR) for performance matrices and organize four expert opinions to assess the supply chain performance matrices through fuzzy-AHP. Matrices hierarchical and weighting results of supply-chain performance measurement are shown in Figure 4.

The consistency was 0.032, which mean that experts had been consistent in providing ratings. Supply-chain performance matrices weighted results exhibited that the processing cost matrices was weighted the highest, 0.168. Furthermore, the essential performance matrices conforming by experts were delivery precision and flexibility in the production rate weighted at 0.157 and 0.114, respectively.

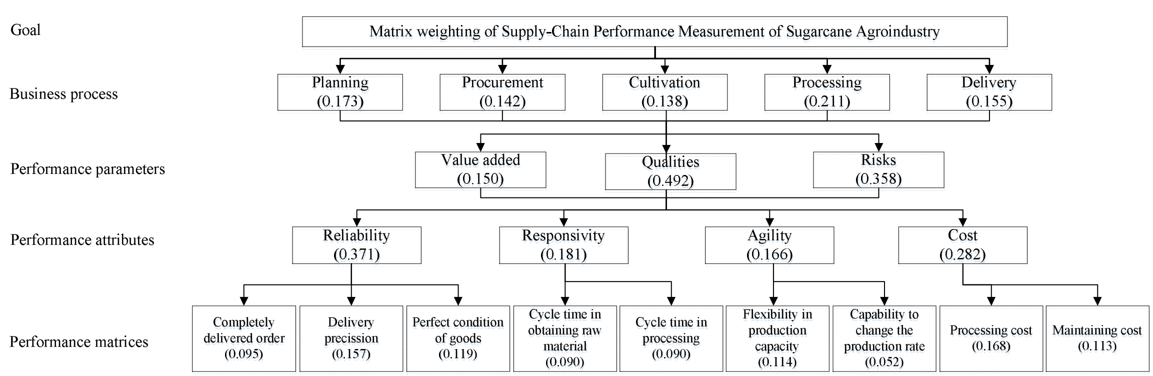


Figure 4 Matrices weighting results of supply-chain performance measurement

4.3.2 Supply Chain Performance Analysis

The sugarcane agro-industry supply chain performance analysis in this study was performed at SBG Ltd. Supply-chain performance at SBG Ltd. was calculated from 2 years' data of each section against supply chain performance matrices which results is depicted in Table 2.

Table 2 Sugarcane supply-chain performance results

Supply chain stakeholders	First year		Second year	
	Results (%)	**Description**	**Results (%)**	**Description**
HGU	71.97	Low	73.04	Low
Drip	58.93	Poor	70.09	Low
KSO	46.08	Poor	45.98	Poor
TRB	70.16	Low	52.11	Poor
Average plantation	61.79	Very low	60.30	Very low
Factory	63.06	Very low	56.79	Poor

The performance levels might be noticed from each section of the supply chain both plantations and processing plant, then HGU, Drip, KSO and TRB are names of plantation section at SBG Ltd. Measurement results of supply-chain performance first year indicated that the KSO and Drip sections had the lowest performance. Further, conforming to the measurement results both of two sections was not capable to well anticipate changes in demand at the appropriate time. Whereas low performance at the factory in first year was influenced by the low matrices performance score for the completely delivered order on reliability supply chain performance attribute. The factory could not able distribute the product in a better way and appropriate time then leading to build-up in warehouses.

Supply chain performance measurement in second year exhibited that KSO, TRB and factory performance had poor scores. Performance at plantation section underwent a decrease from the previous year. It known as a consequence of the low performance score on processing and maintaining costs matrices. In addition, it has the highest weighted value proposed by expert's assessment.

Overall, the performance in each section of SBG Ltd. supply chain was predisposed by the low matrices performances score on processing and maintaining costs, performance on the reliability attribute and performance on company responses to possibility of changes. Technical improvement that might be conducted, such as more-organized and controlled cost management, maintaining consumer trust through ensuring product availability in the markets and finding a better sugarcane distribution way. This supply chain performance measurement results may be noticed that general supply-chain performance was at the very low level. Then, an improvement in performance was required in order to achieve an efficient supply-chain and better sugarcane productivity.

4.4 Supply Chain Performance Improvement Strategy

4.4.1 Sugarcane agro-industry position and condition

Strategies for an improvement in supply-chain performance were formulated through a SWOT analysis for affecting on the supply-chain system and an appropriate base in developing a company [6]. In this case, employment of the SWOT analysis was in three stages, i.e. evaluation of company's internal and external factors, formulation of strategies through SWOT matrices and selection of strategies through the fuzzy AHP.

As stated in Table 3, total scores of sugarcanes agro-industrial supply chain's internal and external factors were below the average since pursuing [11] that a good average score of internal and external factors is 2.50. In fact, the present results showed that the internal weakness and strategies applied by the company was not capable to take advantage of opportunities and avoid existing threats. Table 3 also demonstrated that the company position was in Quadrant II (+0.681; -0.195) which mean it is in the strong condition and would deal with possibly great threats also supporting diversification strategic.

Table 3 Summary of the supply chain internal and external factor evaluation results

	Internal Factors	**External Factors**
Total Scores	2.348	2.449
Strength-Weakness Scores	+ 0.618	
Opportunity-Threat Scores		-0.195
Description	Quadrant II	

4.4.2 Strategies for an Improvement in Supply-Chain Performance through fuzzy-AHP

The results of internal and external supply chain evaluation are formulated into SWOT matrices to attain alternative strategies for an improvement in supply-chain performance. Formulation alternative strategies was undertaken through in-depth discussion with the company and experts also supported by the literature study. The SWOT matrices formulation produced ten alternative strategies for an improvement in supply-chain performance comprising two SO (Strength-Weakness) alternative strategies, three WO (Weakness-Opportunity) alternative strategies, three ST (Strength-Threats) alternative strategies and two WT (Weakness-Threat) alternative strategies.

A SWOT model analysis is unable to be employed quantitatively for each factor, therefore it is hard to observe the greatest effect of factors on results of strategy formulation [28]. Pursuing to [19], [18] the SWOT analysis does not provide a systematic way in determining relative interest of criteria or assessing alternative decision. Furthermore, the SWOT framework had been changed into the hierarchical structure and integrated models and then analysed using AHP or ANP [46]. The purpose of AHP employment in the SWOT framework was to fulfil requirements of SWOT factors and equate the intensity [45].

The idea to compile SWOT factors and AHP assessment might be assessed SWOT factors systematically and compatibly. This way also provides potentially quantitative measures in selecting the strategy for an improvement in supply-chain performance by organizing opinions from three experts. The hierarchical decision and results of expert assessment for strategies formulation in supply chain performance improvement are completely presented in Figure 5.

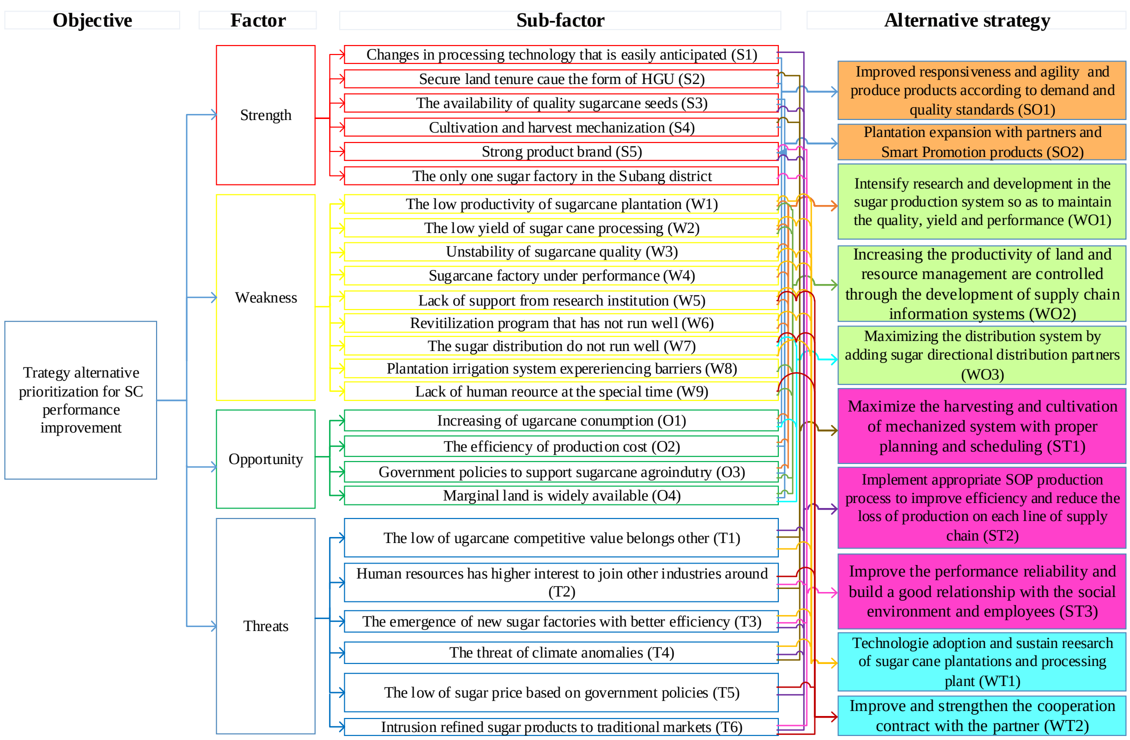


Figure 5 Hierarchy of strategy formulation to improve supply chain performance

Assessment result of alternative strategies demonstrated that the WO_1 (Weakness-Opportunity) strategy, which was encouragement of research and development in the sugar production system so as qualities, yields and performance were possibly maintained as a best strategy. It was strongly suggested by experts in 0.258 weighted. The next suggested strategy was WT_1 which was adoption of sustainable technology and internal research on plantations and sugarcane processing (0.148) and SO_2 which was expansion of the plantation area through partnerships and product Smart Promotion (0.139).

Experts suggested necessity of further reviews as one form of company development, particularly those paying attention to quality and yield aspects. As a food product, the quality aspect is profound in preserving consumer trust as well as efficient production. Yield enhancement in sugar cane agro-industry is one determining aspect of company productivity enhancement which know under national yield target level. While product marketing to consumers should be undertaken with smart promotion efforts such as digital or printed marketing, market operations or other smart operations enhancing consumer attraction.

4.5 Managerial Implication

Measurement of supply chain performance on sugar cane agro-industry may be conducted regularly as an evaluation and control on efficiency of the business process. A model for performance measurement adapting from SCOR, which is extensively able to control each dimension of the supply chain and easily detected at whole activities of the business process. Value-added enhancement on plantations potentially could be executed by performing a better-quality seed which is appropriate to the land characteristics and climate. Furthermore, the value-added improvement had to control plantation irrigation system well. Value-added enhancement on processing plant potentially was executed by yield enhancement followed by factory revitalization and human resource performance enhancement.

Results of internal and external factor analyses showed that the company had the internal weakness and was not able to take advantage of opportunities to avoid existing threats. Internal and external factor evaluation demonstrated that the company was in Quadrant II, which mean it would deal with relatively great threats. Some attempts that might be performed such as an improvement and sustainable investment and continual evaluation. The company should take advantage of many outside opportunities to help the company position strengthening amidst of competition.

Performance improvement of the supply chain would be executed by implementing alternative strategies and accompanied with a good control as well as paying attention to implications that might be generated. Results of expert opinions illustrated that strategy execution of encouraging research and development and performance was the most suggested to be implemented. Qualities, yields and performance are key factors for enhancing supply-chain performance and enhancing consumer trust. Research and development for quality and yield basically had been accommodated by the research and development section. Improvement measures necessarily are that the research and development do not merely focus on plantations but on processing by incorporating with research centres and partnerships. For further application, we have to applied research centre and control management for all chain, not only focus on plantation but also for minimizing quality and yield degradation in processing then distribution to consumer. Furthermore, the company have to pay attention to internal strategic integration, which would improve company's financial performance [29] as impact of strategies implementation.

5. Conclusions and Recommendations

The supply-chain for sugarcane agro-industry ranged from ensuring sugarcane raw materials availability, processing plant and packaging then storage in warehouses. Results of the value-added analysis showed that processing plant had a greater profit percentage rather than plantations and potentially took advantage of the value-added ratio, moreover it is needed to improve. Sugarcane agro-industrial supply-chain performance demonstrated in very low and poor performances or were in critical condition. Such a condition required strategies for an improvement in supply-chain performance for the purpose of preserving the company and enhancing productivity. The SWOT analysis indicated that the company was in Quadrant II which means it was in strong condition and would encounter considerable threats. The present research suggested an alternative strategy of encouraging research and development in the sugar production system so as qualities, yields and performance would be retained as an effort to improve supply-chain performance.

One challenging area for further research is to investigate the revenue and value added sharing in order to increase sugarcane supply chain performance and productivity. The research can include larger samples and area of supply chain network due to accommodate supply chain performance analysis and value added sharing among stakeholders.

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