Research Journal of Applied Sciences, Engineering and Technology 8(10): 1244-1249, 2014
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: April 12, 2014 Accepted: August 27, 2014 Published: September 15, 2014

Measuring the Value-added of Oil Palm Products with Integrating SCOR Model and Discrete Event Simulation

[1]Fitra Lestari, [1]Kamariah Ismail, [1]Abu Bakar Abdul Hamid and [2]Wahyudi Sutupo
[1]Faculty of Management, Universiti Teknologi Malaysia, Malaysia
[2]Department of Industrial Engineering, Sebelas Maret University, Indonesia

Abstract: Oil palm processing industry in Malaysia can directly distribute the finished products in exporting without considering the transformation value of the product to the end customer. Nevertheless, it influences the configuration of the supply chain strategy. The purpose of this study measures the performance of supply chain configuration in oil palm business. The model use tools for measuring supply chain configuration with integrating SCOR models and discrete event simulation. Finding of this study revealed that the highest value-added of oil palm derivative product is scenario 5 which it proposes 100% CPO and CPKO deliver to the local refinery without distributing to the export and its finished products are distributed to the export through the port. Finally, it gives consideration to the stakeholders in controlling the system and then makes sure the business process keeps running on the track.

Keywords: Discrete event simulation, oil palm industry, SCOR model, supply chain configuration

INTRODUCTION

The oil palm business is started with producing the Fruit Fresh Bunch (FFB) from the plantation and delivers to several processing industries involving Milling, Crushing, Refinery and Oleochemical. The main products of this business are Crude Palm Oil (CPO) and Crude Palm Kernel Oil CPKO that have the highest value-added product than other derived products of oil palm (Proforest, 2011). In addition, these products will be transformed into finished products of the oil palm industry that distribute not only to the local market but also to the export.

According to report of the Malaysian Palm Oil Board (MPOB) (2013), there are several processing industries involving 434 milling, 45 crushing, 55 refineries and 17 oleochemical. Most of processing industry can directly export their finished products without considering the transformation value of oil palm product to end customer which it becomes a business chain (Sazmand-asfaranjan and Ziaei-moayyed, 2012). The relationships of these processing industries into business chains influence the configuration of the supply chain. Thus, to win competition of the market, it will require a method to evaluate the performance of the business chain.

This can be done by measuring the supply chain configuration. Thus, purpose of this study will measure the performance of supply chain configuration in Malaysian oil palm business. Measurement done based on the flow of transformation product of FFB from plantation into finished product in several processing industries. Thus, it will show the difference in value-added products in every processing industry within its supply chain configuration.

This case is conducted using Supply Chain Operations Reference (SCOR) methodology in order to analyze, design and improve supply chain strategy (Bolstorff and Rosenbaum, 2007). Nevertheless, SCOR model cannot evaluate the existing strategies and propose several alternatives of improvement in the decision making process (Huan *et al*., 2004). The gap of this knowledge is lack of measuring performance in order to optimize the supply chain configuration. To simplify this gap, it can be measured using simulation modeling. Then, it will be integrated with discrete event simulation in order to represent the overall process flow of raw materials into finished products (Marreiros *et al*., 2006).

Indeed, this study is directed to propose a model that can be used as a tool for measuring supply chain configuration in the oil palm industry using hybrid SCOR models and discrete event simulation. Thus, integration of these methods in the supply chain configuration is expected to determine the value-added palm oil derivative products which it will be developed into several scenarios. In addition, it will give consideration to the stakeholders in controlling the system and then make sure the business process keeps running on the track.

METHODOLOGY

Supply chain in oil palm business consists of relationship between stakeholders, business process and

Corresponding Author: Kamariah Ismail, Faculty of Management, Universiti Teknologi Malaysia, Malaysia

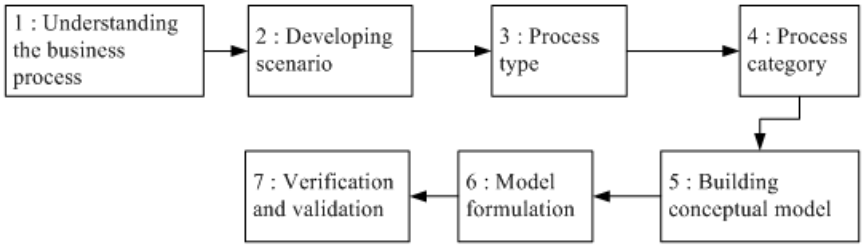

Fig. 1: Simulation process based on SCOR model

resources in transforming crude palm oil into finished products (Lestari *et al*., 2013). To optimize the supply and demand within this business, determination of strategy in supply chain configuration is important in order to develop collaboration with other entities in business process (Bhakoo and Chan, 2011). Thus, it requiresa technique for reengineering business process in order to analysis and design of workflows to improve customer service and productivity.

There is one framework to measure performance in supply chain configuration which called methodology of Supply Chain Operations Reference (SCOR). It was built by the Supply Chain Council (SCC) as a tool to diagnose the business activities in supply chain management. This method is used to investigate the relationship between suppliers, manufacture and customers (Wang *et al*., 2010). In addition, the reengineering business process is based on the stages that have standardized involving Plan, Make, Source, Deliver and Return.

Supply chain case in achieving the goal is supported by tools and method which used to optimize performance the system. Most of the reviewed papers used analytical approaches, then followed by the use of simulation models (Li *et al*., 2009; Chen *et al*., 2013). Furthermore, the cases which descriptions of material flow from upstream to downstream are suggested using simulation modeling rather than other approaches (Klug, 2013). This approach can predict the performance of a process without having to go through actual implementation (Tarvo, 2011). Implementation of simulation model using software which can reduce the time to develop model encourage more the utilization of this technique in process improvement (Levent and Mehmet, 2011). Thus, integration method of SCOR model and discrete event simulation are expected to support the detail in operational level. The following simulation process based on several stages for developing supply chain configuration that can be seen in Fig. 1.

Step 1: Understanding the business process on distribution CPO and CPKO to processing industry in oil palm supply chain involving milling, crushing, refinery and oleocehnical.

Step 2: This step buildsseveral scenarios to determine the value-added of palm oil derivatives products which it is deliveredfromprocessing industry to the port and local industry.

Step 3: SCOR model will be implemented by using the Process Wizard Software, which adoption SCOR model version 8.0. The software provides modules to build a business process model into supply chain configuration. This tool describes business process into several levels. Level 1 is process type which defines the scope and content of the SCOR model involving Plan, Source, Make, Deliver and Return.

Step 4: Level 2 is process categories which a company configure the supply chain structure from 30 process categories. It means the operational strategy for supply chain is developed through the configuration that their own choice. Summary of reengineeringbusiness process can be show through the thread diagram. It serves to build a block diagram of SCOR model. This tool show interconnected flow material between operations of the supply chain involving the relationship between supplier, manufacturer and customer.

Step 5: Developing concept of the simulation modelis done by building a model into simulation software. The model will represent the real system. Simulation modeling use method of discrete event simulation that will be built using simulation software in Arena 14.

Step 6: The model that has been built will run represent the real system. Thus, it makes model formulation that connected relationship between entities within a model. This relationship is evaluated based on data collected from the real system.

Step 7: Verification is used with debugging the simulation software to ensure the model working properly and the operational logic is correct. The software represents the entity with block diagram that is shown by animation using routing of flow product to calculate variable cost. Furthermore, validation aims to provide an accurate model in representing the real system. Output from simulation will compare with records within actual system. Thus, this result can be discussed with stakeholders in order to validity the model.

Table 1: Scenario of supply chain configuration in oil palm business

Scenario	(%)	Product	Destination	
I	100	CPO	Port	
II	20	CPO	Port	
	80	CPO	Refinery	- Port
III	20	CPO	Port	
	80	CPO	Refinery	- Port
	100	CPKO	Port	
IV	20	CPO	Port	
	80	CPO	Refinery	- Port
	100	CPKO	Refinery	- Port
V	100	CPO	Refinery	- Port
	100	CPKO	Refinery	- Port
VI	100	CPO	Refinery	- Port
	100	CPKO	Refinery	- Local
VII	100	CPO	Refinery	- Local
	100	CPKO	Refinery	- Port
VIII	100	CPO	Refinery	- Local
	100	CPKO	Refinery	- Local

CASE STUDY

The main products of oil palm industries are Crude Palm Oil (CPO) and Crude Palm Kernel Oil (CPKO). In addition, the CPOis obtained from the extraction of FFB in the milling industryand has average Oil Extraction Rate (OER) of FFB is 20.25%. In other side, CPKOis obtained from the extraction of Kenel in crushing industry and has average Oil Extraction Rate (OER) is 45.83% (Malaysian Palm Oil Board (MPOB), 2013). Furthermore, both of them are processed in the refinery industry through the stages of Refining, Bleaching and Deodorization to produce Olein that can be used as raw material for cooking oil and Stearin for margarine shortening and specialty fats (Sulaiman *et al*., 2012). The byproduct of refinery such as PFAD will be processed by the oleo chemical industry.

Supply chains of oil palm derivative products have the difference configuration. As the result, it causes the difference of value-added products because it is also affected due to the demand from the export and local market. This research will build several scenarios of transformation of value-added product in processing industries using integration methods of SCOR model and discrete event simulation. Scenarios are created based on transformation of value-added oil plam derivative productsof CPO and CPKO. The followings scenarios will be built using the software simulation that can be seen in Table 1.

Supply chain configuration: This part conducts integration method of SCOR model and discrete event simulation which it is adopted for a case study in oil palm business in order to measure supply chain configuration.

SCOR model: Reengineering business process using SCOR model is done based on process type in level 1 involving Plan, Source, Make, Deliver and Return that it can be shown in Fig. 2. Then, it breakdown into process categoriesin level 2 which all of these describe the flow of distribution product to the customer. To achieve the target, it need schedule to balance demand and supply of product. Thus, the plan of the supply chain (P1) is the more important to win the competition.

Furthermore, Milling industry obtains raw material directly from the plantation as FFB. All of raw material will source stocked product before running production activity (S1). Then, it will be processed to produce CPO using Make-to-stock strategy (M1). Finished products are distributed based on Delivering stocked product (D1) and Deliver Make-to-Order product (D2) through the port, crushing and refinery.

Kernel which becomes sources of crushing will be processed to produce CPKO. There isthe product return to the supplier and from the customer (SR1 and DR1) whenever the source or finished product is defect. Nevertheless, there is differentiation of returning the product than the milling process as return access product (DR3). It means the finished product will return whenever number of products isexcess. In crushing industry, the finished products are assumed no export product through port because all of them will deliver to refinery process.

Refinery industry process two main feedstock such as CPO and CPKO. The finished products have high demand in export and local market and require advance processes in oleochemical in order to produce end products. Shipping in exporting is done through ports so this entity only serves as loading and unloading activity for oil palm derivative products. Therefore, it does not occur transformation of value-added product. The detail process categories through thread diagram in SCOR model can be seen in Fig. 3.

Discrete event simulation: SCOR model has five main process types involving Plan, Source, Make, Deliver and Return. To measure the performance of supply chain configuration, it conducts production activity between entities to represent process flow of material using discrete event simulation method. The events or production activities that occur on every oil palm processing industries will be simulated using Arena simulation software based on SCOR methodology.

Plan: This step function for taking actual demand data and generating the supply chain plan including marketing, sales event and operations planning. It constraint based on availability of resources involving inventory, manufacturing capacity and transportation. Thus, it is aggregate demand and supply in each processing industry that process CPO and CPKO.

Source: It describes to characterize purchasing raw material and finished goods. There are several parameters in type of source involving price of raw material and production rate. Nevertheless, raw materials are influenced by ability of Oil Extraction Rate (OER) in each industry. Thus, all of them will calculate into total cost of source.

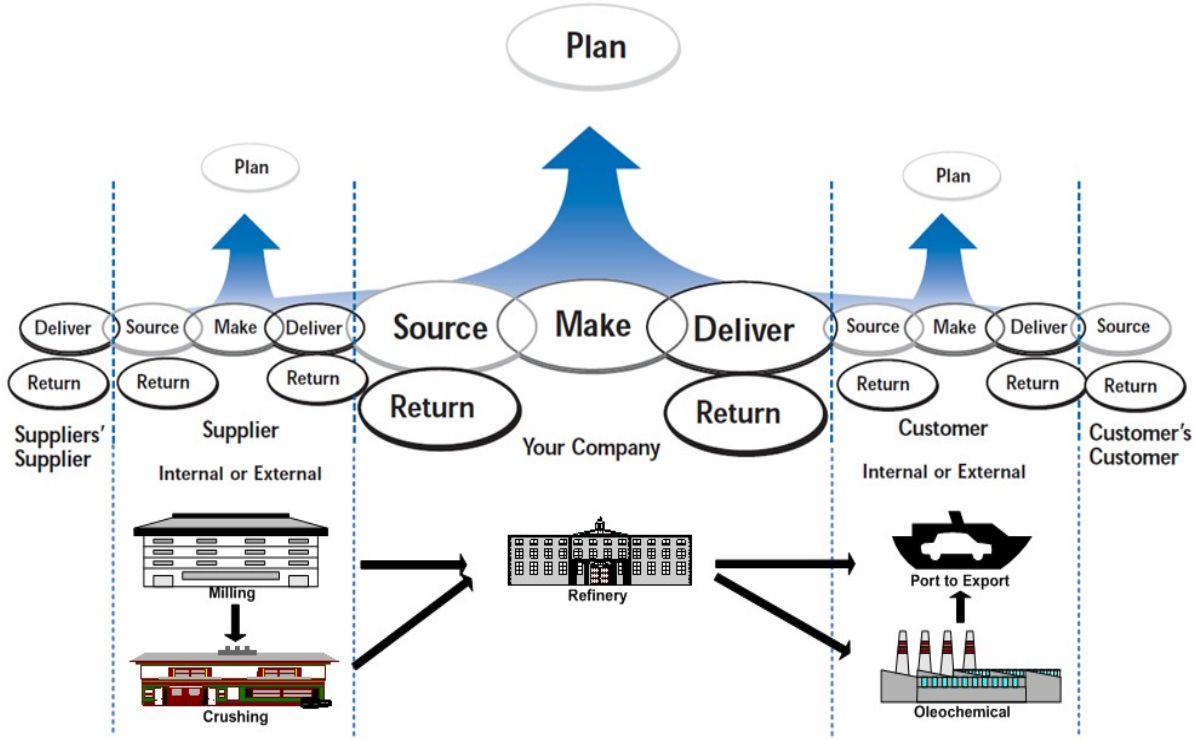

Fig. 2: SCOR model based on process type in oil palm industry

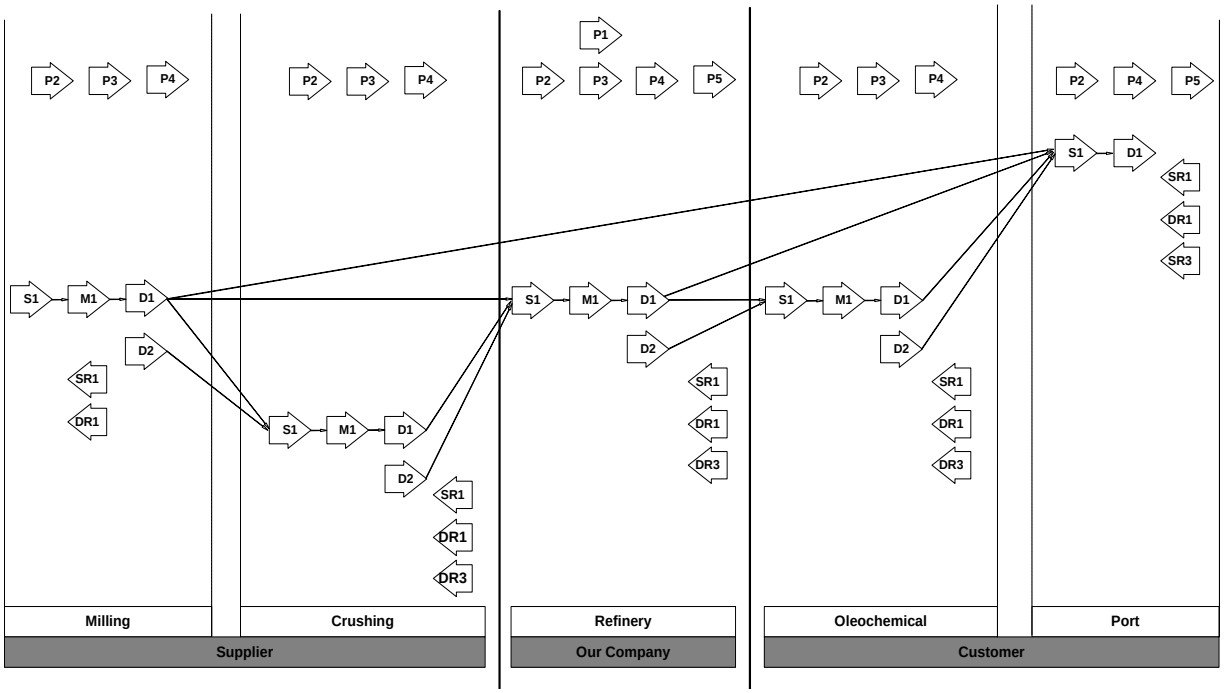

Fig. 3: Process categories based on the thread diagram in SCOR model

Make: Make describe ability to convert raw material to work in process to finished goods. The conversionprocess generally is located in the oil palm processing industry. In addition, there are the differences between the price of finished product whenever sell in local industry and export which it influences the total cost of make.

Deliver: It serves to determine how the industry process its finished goods in response to customer

Table 2: Summary of data collection

Parameter	Item
FFB production	(ton/h)
Working time	(h/year)
No of milling, crushing, refinery and oleo-chemical	(industry)
Percentage OER (CPO and CPKO)	(%)
Price of FFB, CPO, CPKO, olein, strearin and PFAD	(RM/ton)
Transportation cost to local and port	(RM/ton)
Production olein, strein, and PFAD	(ton/h)
Capacity lorry tanker and bonded box	(ton/tank)

order. Total cost of deliver considers transportation models, capacity and number of vehicle and Transportation cost. This study cover transportation cost, including processing industry to the port and the local industry.

Return: This process attempts to return its finished goods in response to customer return authorizations. The item described returning based on the quality of the product, defective product, maintenance event and complaint customer of contract agreements and warranty claim.

Process type in SCOR models will be breakdown into process categories. It can be done by determining parameters to measure performance system that has been built which it can be shown at Table 2. In addition, production activity and its parameter will entry in Arena simulation software in order to ensure that the model represents the real system. Finally, the model requires verificationto validate the method of discrete event simulation describing as conceptual of SCOR methodology.

DISCUSSION

Figure 4 show the result of measuring performance of supply chain configuration based value-added of oil palm derivative product into several scenarios using hybrid SCOR model and discrete event simulation. This model is supported by PROCESS WIZARD software and ARENA SIMULATION Software. According to this research, the highest of value-added of oil palm derivative product is scenario 5 which it is 90 times. This proposes that 100% CPO and CPKO deliver to the local refinery without distributing to the export. Then, the finished products such RBD Olein, RBD Stearin and PFAD as will distribute to the export through the port. In other hand, result of software showsthe lowest is scenario 1 which it is 60 times. It describes that if Malaysia is still focus explore upstream sector, such as deliver 100% CPO to export and do the expansion in plantation without consider continue to the advance processing industry, They do not earn the maximum profit.

In addition, there are other scenarios that representMalaysia process the entire CPO and CPKO until end finished product and distribute to local market. The result revealed palm oil industry is not ready yetto process the oil palm derivative products.

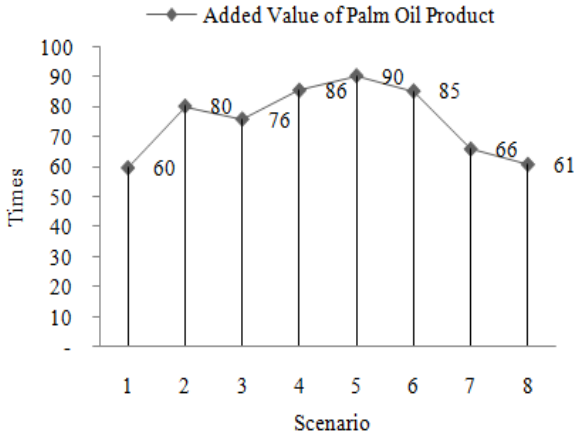

Fig. 4: Value-added of palm oil derivative products into several scenarios

Therefore, there is the high cost of delivering because the logistic infrastructure does not yet support for the entirecrude palm oil produced into end products in Malaysia. Then, the price of finished productsin the local market is lower than international market. Thus, currently Malaysia stills ends a lot semi-finished productsto the international market.

This research gives suggestion to policy maker for increasing logistic infrastructure to reduce cost of distribution and develop advancedtechnology processing for oil palm industry to minimize cost of production.

CONCLUSION

This paper shows the integration of SCOR model and discrete event simulation that serve for measuring performance of supply chain configuration in Malaysia oil palm industry. Indeed, SCOR model is not only used to develop the configuration using process categories involving Plan, Source, Make, Deliver and Return but also it can hybridize with simulation modeling in order to represent process flow within business processes. The result can measure transformation of value-added of oil palm product into several processing industries. Thus, this study revealed the optimal scenario is 100% CPO and CPKO processed in local refinery and its finished products deliver to export through the port.

Further research is suggested to compare this result using analytical model such as deterministic model and stochastic in order to obtain the optimal solution.

ACKNOWLEDGMENT

The authors thank to the Amanah Pelalawan Foundation for giving PhD Degree Scholarship Program.

REFERENCES

Bhakoo, V. and C. Chan, 2011. Collaborative implementation of E-business processes within the health-care supply chain: The Monash Pharmacy project. Supply Chain Manag., 16(3): 184-193.

Bolstorff, P. and R. Rosenbaum, 2007. Supply Chain Excellence : A Handbook for Dramatic Improvement Using the SCOR Model. 3rd Edn., Amacom, New York.

Chen, G., G. Zhang and J. Pang, 2013. Study on modeling and simulation of reliability diagnosis of supply chain based on common cause failure. Res. J. Appl. Sci. Eng. Technol., 5(3): 922-928.

Huan, S.H., S.K. Sheoran and G. Wang, 2004. A review and analysis of Supply Chain Operations Reference (SCOR) model. Supply Chain Manag., 9(1): 23-29.

Klug, F., 2013. The supply chain triangle: How synchronisation, stability and productivity of material flows interact. Model. Simul. Eng., 2013(2013): 10, Article ID 981710.

Lestari, F., K. Ismail, A.B.A. Hamid and W. Sutopo, 2013. Designing supply chain analysis tool using scor model (case study in palm oil refinery). Proceeding of IEEE International Conference on Industrial Engineering and Engineering Management (IEEM, 2013), pp: 1-5.

Levent, K. and A. Mehmet, 2011. Simulation modeling for process improvement in a general surgery service. Curr. Res. J. Soc. Sci., 3(2): 114-125.

Li, J., M. González and Y. Zhu, 2009. A hybrid simulation optimization method for production planning of dedicated remanufacturing. Int. J. Prod. Econ., 117(2): 286-301.

Malaysian Palm Oil Board, 2013. Overview of the Malaysian Oil Palm Industry 2013, pp: 1-6.

Marreiros, G., P. Novais, J. Machado, C. Ramos and J. Neves, 2006. An agent-based approach to group decision simulation using argumentation. Proceeding of International Multiconference on Computer Science and Information Technology, pp: 263-270.

Proforest, 2011. Mapping and Understanding the UK Palm Oil Supply Chain. Department for Environment, Food and Rural Affairs, London, pp: 27-88.

Sazmand-asfaranjan, Y. and A. Ziaei-moayyed, 2012. Assessing export opportunity of Malaysia's palm oil products: Using shift-share technique. Eur. J. Sci. Res., 70(2): 323-333.

Sulaiman, M., A. Oni and D.A. Fadare, 2012. Energy and exergy analysis of a vegetable oil refinery. Energ. Power Eng., 4: 358-364.

Tarvo, A., 2011. Using Computer Simulation to Predict Performance of Parallel Programs. Brown University, Providence, RI, USA, pp: 1-13. Retrieved from: http://cs.brown.edu/research/pubs/theses/masters/2011/tarvo.pdf.

Wang, W.Y.C., H.K. Chan and D.J. Pauleen, 2010. Aligning business process reengineering in implementing global supply chain systems by the SCOR model. Int. J. Prod. Res., 48(19): 5647-5669.