

Sustainable Supply Chain Management for Make To Stock-Make To Order Production Typology Case Study: Batik Industry in Solo Indonesia

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Abstract

Batik industry is one of industries that absorb a lot of non educated labors. There are 120,000 labors do his life in this industry. Recently, this industry is facing serious problems, that is, associated with the demands of the industry to be environmentally friendly and the existence of the social responsibility Research that is intended to design a sustainable supply chain management in batik industries. There are three aspects that will be analyzed, namely the economic aspect, environmental aspects and social aspects. The economic aspect uses SCOR model, the aspect of environmental is focused on liquid waste, while the aspect of social welfare analyzes the factors of company's employees. Clustering k means is used to determine productions typology. From samples as many as 124 companies in batik industry in the Surakarta region, show that there are 5 clusters namely MTS (10.49 %), MTO (19.35 %), a combination of MTS-MTO (32.26 %), a combination of MTO-ETO (12.09 %) , and a combination of MTS-MTO-ETO (25.8 %). The focus of this research is MTS-MTO production typology. The results of SCOR value are formulated as follows; reliability 85.58 %, responsiveness 86.22 %, cost 94.09 %, agility 100%, asset management 74.41 %. The value of liquid waste is BOD 100 %, COD 0 %, TSS 0 %, Acidity 37.7 %, and Temperature 100 %. The value of the employee welfare factor are health insurance 100 % , safety tools 100 % , basic allowance 70 % , annual allowance 100 % , work hours 67 % , and rewards 70 %.

Keywords: Sustainable Supply Chain, Batik Industry, Clustering, SCOR Model

1. INTRODUCTION

Surakarta is known as Batik City. There are many batik industries, more than 200 industries are scattered in small medium enterprise. After UNESCO inaugurated batik Indonesia as masterpieces of the oral and intangible heritage of humanity on the October 2, 2009, batik demands in Indonesia increased significantly. It can be seen from the growing number of sales volume that have reached more than 200% in 2011 (Disperindag Solo). Currently batik industry is absorbing more labors with low skill. There are about 120,000 people depend on the batik industry (Kementrian KUKM 2012). The development of imported batik fabric and local is worrying, because it threatens national batik market. The competitions among companies both inside the country and overseas especially China and Malaysia put all to compete in depressing the price. This condition pushes the company to sacrifice the right of employee and environment. For long time business, this cannot run well without sustainability. There are three aspects of the industry that could be continued, namely the aspect of economic, environmental aspects and social aspect.

Sustainable development becomes the major attention in these recent years. In the past of 25 years, there are numerous industries realize that the level of sustainability has reached the board-level concern. This generated

questions about how the sustainability concept can be implemented. In specific, how it should be involved in the strategic levels and operational levels of management decision making. For the internal of the organization, this is acknowledged as sustainable operations management (Gimenezet *et al.*, 2012), while for the external of the organization, the effects related to the value chain and supply network are defined as Sustainable Supply Chain (SSC) (Carter and Rogers, 2008). Based on those elaborations, it can be recognized that the concept SSCM becomes the updating issues to be discussed.

The developments do always exist by the idea generation of some researchers, since the environmental awareness of people also increases related to the supply chain impact of industries. Zailani *et al.* (2012) stated that there is a rapidly increasing awareness in industry that today's supply chains are flawed. In recent years, sustainable supply chain (SSC) has been gaining attention because of increasing level of environment damage and social conflict in a production system. (Jaya R, 2014)

Nowadays, many manufacturing companies create waste and pollution and are threatening the existence of life on earth. These concerns push firms into seriously considering the environmental impact while doing their business. The implementation of SSC is a key enabler that could push organizations to focus on alleviating environmental issues, and providing economic and social benefits.

From the companies' perspective, they must be acquiring the environmentally friendly image of products, processes, systems and technologies, and the way business is conducted (Vachon and Klassen, 2006). According to Porter and Kramer (2006), companies are increasingly expected to extend their sustainability efforts beyond their own operations to include those of their suppliers and to meet their customer's sustainability expectations. Forward thinking companies are already taking steps to develop sustainability within their supply chains. These concerns push firms into seriously considering the environmental impact while doing their business. The implementation of SSC is a key enabler that could push organizations to focus on alleviating environmental issues, and providing economic and social benefits.

The purpose of this research is to design the sustainable supply chain management in Batik not only economic perspective but also environment and social perspective as government regulatory and social responsibility as seen in Figure 1. Research contribution are to conduct the performance measurement of SSC by using SCOR 11.0, liquid waste, and social responsibility types of production in case of Batik industry with MTS – MTO type of production.

2. LITERATURE REVIEW

SCM is defined as the management of exchanges of materials and information in the logistics process stretching from the purchasing of raw materials to the delivery of end-products to end customers, so linking several firms (Cooper *et al.*, 1997). These concerns push firms into seriously considering the environmental impact while doing their business. The implementation of SSC is a key enabler that could push organizations to focus on alleviating environmental issues, and providing economic and social benefits.



Figure 1 The integration of SSC aspects

Boukherroub *et al.* (2014) elaborates about an integrated approach for sustainable supply chain planning. It designed a method that links sustainability performance to supply chain decisions, and allows setting coherent performance measures. The result is supply chain planning is optimized while the economic, environmental and social performances are all coherently integrated into the model.

2.1. SSC Assessment

2.1.1. SCOR 11.0

SCOR model was created in 1996 by the Supply Chain Council (SCC, 2012) as a standard framework for companies, see at Figure 2. It defines a method, reference processes, key indicators and best practices to represent, assess and diagnose the supply chain. The SCOR model proposes five families of metrics for assessing supply chain practices: reliability, responsiveness, flexibility, costs, and asset management as seen in Figure 3. The version of the SCOR 11.0 model also includes the Green-SCOR. This added module underlines some best practices like implementation of an Environmental Management System, development of partnerships with suppliers, identifying green materials, maximization loadings, etc. The SCOR model is unquestionably the main world reference for supply chain assessment, as the 800 or so participating companies attest. The best practices are linked to sustainable development and five environmental indicators: carbon emissions, air pollutant emissions, liquid waste generated, solid waste generated and percentage of recycled waste.



Figure 2 The SCOR 11.0 Framework (SCC, 2012)

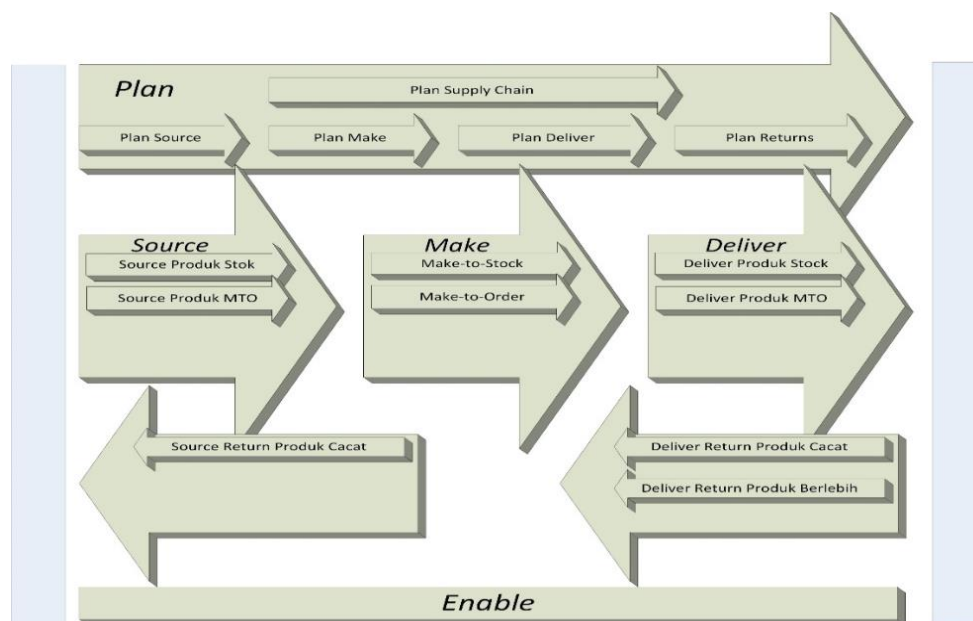


Figure 3 The Process of SCOR 11.0 (SCC, 2012)

The previous research about SCOR 11.0 is still limited. Chardine-baumann & Botta-genoulaz (2014) was conducting a research about a framework for sustainable performance characterization and an analytical model for sustainable performance assessment of SCM practices. The framework is used to characterize a company's sustainable performance in the economic, environmental and social fields. The result answers the initial question of how to assess the sustainable performance of SCM practices that can easily be applied to any SCM practice that is considered as a best practice at a given time in a company, or that a company intends to implement. The proposed framework can also be applied by a company in order to highlight those SCM practices that impact its sustainable performance more positively.

Palma-mendoza (2012) elaborated a literature review to result a solution by using the SCOR model, then to use Analytical Hierarchy Process (AHP) analysis for target process selection. AHP can aid in deciding which supply chain processes are better candidates to re-design in light of predefined criteria. The results provided by the AHP analysis go beyond target process selection. From the AHP analysis, it can calculate a priority rank for the metric criteria used.

Marimin, Darmawan MA, Machfud, Putra, Wiguna, stated that the systems approach was accomplished by identifying all of the factors contained in the system to obtain a good solution for resolving the problem, and then creating a model of AHP to help rational decisions. AHP model is used to calculate the weight of criteria, both quantitative and qualitative in one research.

Graphically, AHP decision problem can be constructed as a multilevel diagram (hierarchy). AHP begins with the focus or goal past the first level criteria, sub criteria, and finally alternative.

Xiao, Cai, & Zhang (2009) built a network-topology structure of cycle quality chain operations reference (CQCOR) model, which realizes the cycle operation by an added quality process of reverse manufacturing. The optimization model can avoid the traditional mercantilism idea. Fuzzy evaluation is applied and it decreases the distortion of unrigorous factors in modeling and improves searching efficiency in the optimizing of cycle quality chain. The model helps to map out a rough framework for supply chain manager to put the sustainable development strategy and resources recycle into practice.

2.1.2. Liquid Waste Management

The assessment for environmental aspect is conducted by measuring the Liquid Waste Assessment which is resulted by the company. There are so many parameters to measure the substances of the liquid waste. Samples for BOD, chloride, sulfite, nitrite, nitrate and alkalinity were not filtered and were kept in 50 ml PE bottles. These parameters were analyzed according to standard methods (APHA, 1998).

Mangimbulude (2009) elaborated that BOD, COD, N-organic matter, ammonia, sulfate and calcium can be used as the parameters of the liquid waste standard assessment applied in the leach ate area. The regulation of the local government of Central Java Province also arranges about the standard parameters of liquid waste by using COD, BOD, TSS, pH, and temperature that can be delivered to the surrounding environment (Environment Ministry No. 32, 2010). Temperature is a measurement of the average kinetic energy of the molecules in an object or system and pH measures how acid the substance is. While Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. In addition, Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter.

2.1.3. Employee's Welfare Assessment

Due to the social and environmental impacts of industrial activities in supply chains, corporate social responsibility (CSR) has become critical for many international companies. Social factor is one of the main factors of SSCM, as well with the economic and environment factors. Therefore, sustainability has become an important issue in both managers and researches, since managers will increasingly play a major role in writing and instituting CSR policies and code of conduct (Hsueh, 2014).

Freeman's (1984) stakeholder perspective suggests that firms need to meet the needs of the stakeholders in addition to the shareholders. According to this perspective, stakeholders are critical for the existence of the firm. The basic idea of the stakeholder perspective is that a firm's success depends on how it is able to manage relationships with key groups, such as customers, employees, suppliers, communities, politicians, and owners, each of which can affect its ability to reach its goals (Ihlen, 2008). Srinivas (2013) elaborated a research about an attempt to identify welfare facilities and employee's satisfaction level about welfare facilities. Employee welfare facilities in the organization affects on the behavior of the employees as well as on the productivity of the organization. While getting work done through employees the management must provide required good facilities to all employees. The management should provide required good facilities to all employees in such way that employees become satisfied and they work harder and more efficiently and more effectively.

2.2. Customer Order Decoupling Point (CODP)

The operations management research majorly characterizes production system as either make-to-order (MTO)

or make-to-stock (MTS). Most of them particularly apply pure MTO type of production system, and also pure MTS production system. Understanding customer requirements and their implications has for a long time been an important issue in forming a manufacturing strategy. Therefore, since the 1960s, many studies have dealt with the problem of deciding whether to make-to-order (MTO) or make-to-stock (MTS). Making to stock is typically more cost-efficient, but with making to order a wider variety of more customized products can be offered (Kerkka, 2007).

According to Rabbani et al. (2014), in MTO system, demands are responded when orders enter the system. MTO system is tailored for more expensive products which are highly customized. MTO is known to have short delivery lead-time, capacity planning, order acceptance/rejection, and high due-date adherence. While, in MTS system, demand is responded through finished products inventories. MTS systems have lower variety of customization and usually less expensive products. MTS systems are claimed to have high fill rate, planning for inventory, defining lot size and forecasting of demand.

As the development of the knowledge, the integration between MTO and MTS type of production are conducted on the previous researchers. The combined MTO/MTS problem has been relatively neglected in literature and only a handful of papers have been explicitly dealing with this combined problem. The research was conducted in the food industry that the integration is needed because of the huge increase in product variety and shorter lead-time requirements of the customers, the company is forced to shift a part of its production system from make-to-stock (MTS) to make-to-order (MTO) and has to operate under a hybrid MTO–MTS strategy (Soman *et al.*, 2007).

Sun *et al.* (2008) was also conducting research about the integration between MTO and MTS types of production for positioning multiple decoupling points of a product in a complicated supply network. It was measured by considering the bill of materials (BOM) of a product, then a mathematical model is developed in order to find the multi-decoupling points in the supply network through MTO and MTS integration, with the objective of minimizing the overall cost subject to satisfying customer delivery time, and the results show that the hybrid strategy is better than a pure MTO or MTS strategy in a dynamic supply network and tight delivery deadline environment.

The model of CODP has been developed by Olhager (2013) in Figure 12. It discusses the impact of having the decoupling point at different positions, and the distinguishing features for value chain operations upstream the decoupling point. The journal develops model of CODP which is the point in the material flow where the product is tied to a specific customer order; the basic choices being MTS, MTO, ETO, and ATO (Assembly to Order). As a rule, the CODP coincides with the most important stock point, from where the customer order process starts.

3. RESEARCH METHOD

3.1. Location and Object of Research

The object of this study is to conduct assessment of the SSC performance using the proposed model by the tools of SCOR 11.0, Liquid Waste Assessment, and Social Welfare Assessment. As it has been elaborated in Chapter 1, SSC is one of updating issues to be developed in the industrial field. The measurement on this aspect will benefit to comprehend the extent of SSC performance in the real industry. In this research, the focus will be on the Batik industry. Batik as one of industries which rapidly grows in Indonesia. The market is wider as the habit of society that likely to use this product because of its art values as the inheritance of Indonesia's culture. However, the business processes in Batik industry is resulting the economic, environmental, and social impact to the company's circumstances. Following to those reasons, the research will measure the SSC performance by using the proposed assessment model in the Batik industries which have MTS – MTO type of production which is identified by the clustering process. The industries are clustered from 200 industries of Batik which will specifically be located at Solo, Central Java as one of the Batik iconic cities.

Specifically, the research was conducted at PT Danar Hadi which applies production type of MTO – MTS. The company has given the awareness to the third parameter of SSCM which are based on economical aspect, environmental, as well as social. Thus, the proposed model for the SSCM performance assessment can be executed in this company.

The results will be processed by analytical process with the tools SCOR 11 for the financial and managerial aspect, Liquid Waste Assessment for the environmental aspect, and Social Welfare Assessment for the social aspect. The performance parameters are then defined to be six aspects that are Plan, Source, Make, Deliver, Enable, and Return. All of those parameters will be the focusing of the research in order to obtain the optimal performance measurement of SSC. Each of the Performance Parameters has its own Design Parameters.

3.2. Position of Research

The general topic that will be discussed in this research is the SSCM performance assessment and improvement. For the SSC performance assessment, the type of manufacture to be identified is Batik Industry with the type of production MTS and MTO. The aspect which will be analyzed is economic aspect, environmental aspect, and social aspect. The environmental aspect will be assessed by using SCOR version 11.0 with the parameters of Reliability, Responsiveness, Agility, Cost, and Assets Management. The designed parameters for this methodology are Perfect Order Fulfillment, Order Fulfillment Cycle Time, Total Cost to Serve, Cash to Cash Cycle Time, and Upside Supply Chain Flexibility. In Figure 5, both of aspects for the environmental aspect, liquid waste management will be the methodology to be applied in this research. The liquid waste will be tested related to the parameters of COD, BOD, TSS, pH, and also temperature. The result will be compared with the standard regulation defined by the local government. The social aspect will use the sampling method of the employees for measuring the parameters of the employees' welfare level that has been applied by the company. The designed parameters will be appropriate allowance, insurance, reward, and work hour appropriateness. Those all will result the performance assessment for the whole chain process of SSC.

In addition, the sub issue of the attribute of SCOR that will be improved is responsiveness. The industrial system that is selected is production, and the subsystem is scheduling. The method which will be applied is CODP. The SCOR recalculation then will be conducted and the comparison between the initial assessment with the improved performance. The whole process of the knowledge based development has been elaborated in the K-Chart development at Figure 4. The synthesis of environmental aspect and social aspect described at Figure 5. The elaboration between CODP and SCOR can be seen at Figure 6.

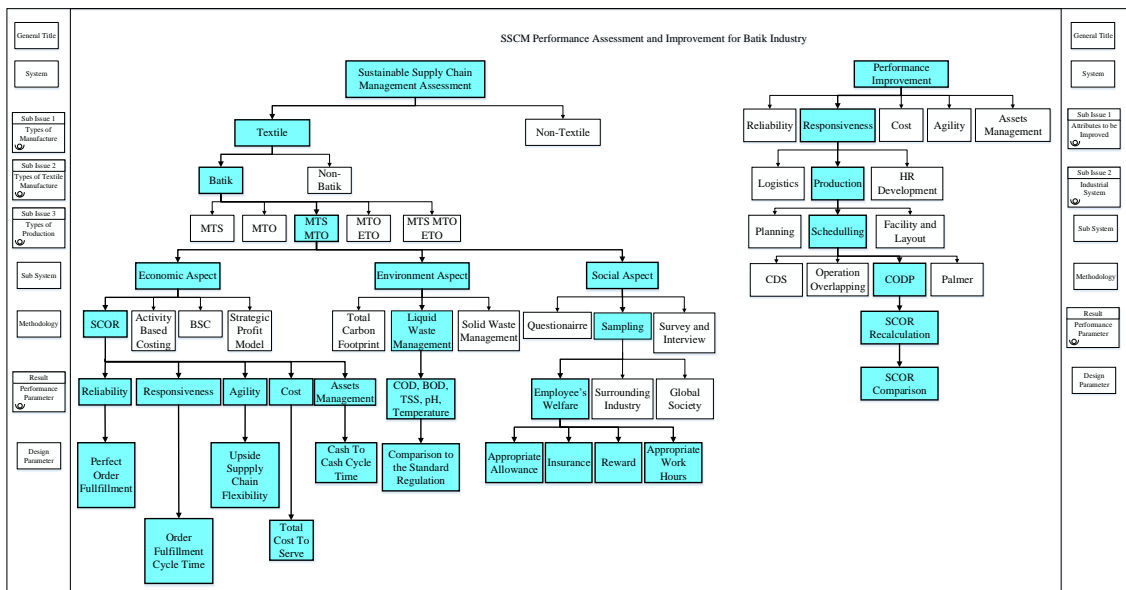


Figure 4 Research Position

Aspect of Assessment	Tools of Assessment	Parameter
Environmental Aspect	Liquid Waste Assessment	COD
		BOD
		TSS
		pH
		Temperature

Aspect of Assessment	Tools of Assessment	Parameter
Social Aspect	Employee's Welfare	Health Insurance
		Safety Tools
		Basic Allowance
		Annual Allowance
		Appropriate Work Hours
		Reward

Figure 5 Environmental & Social Aspect

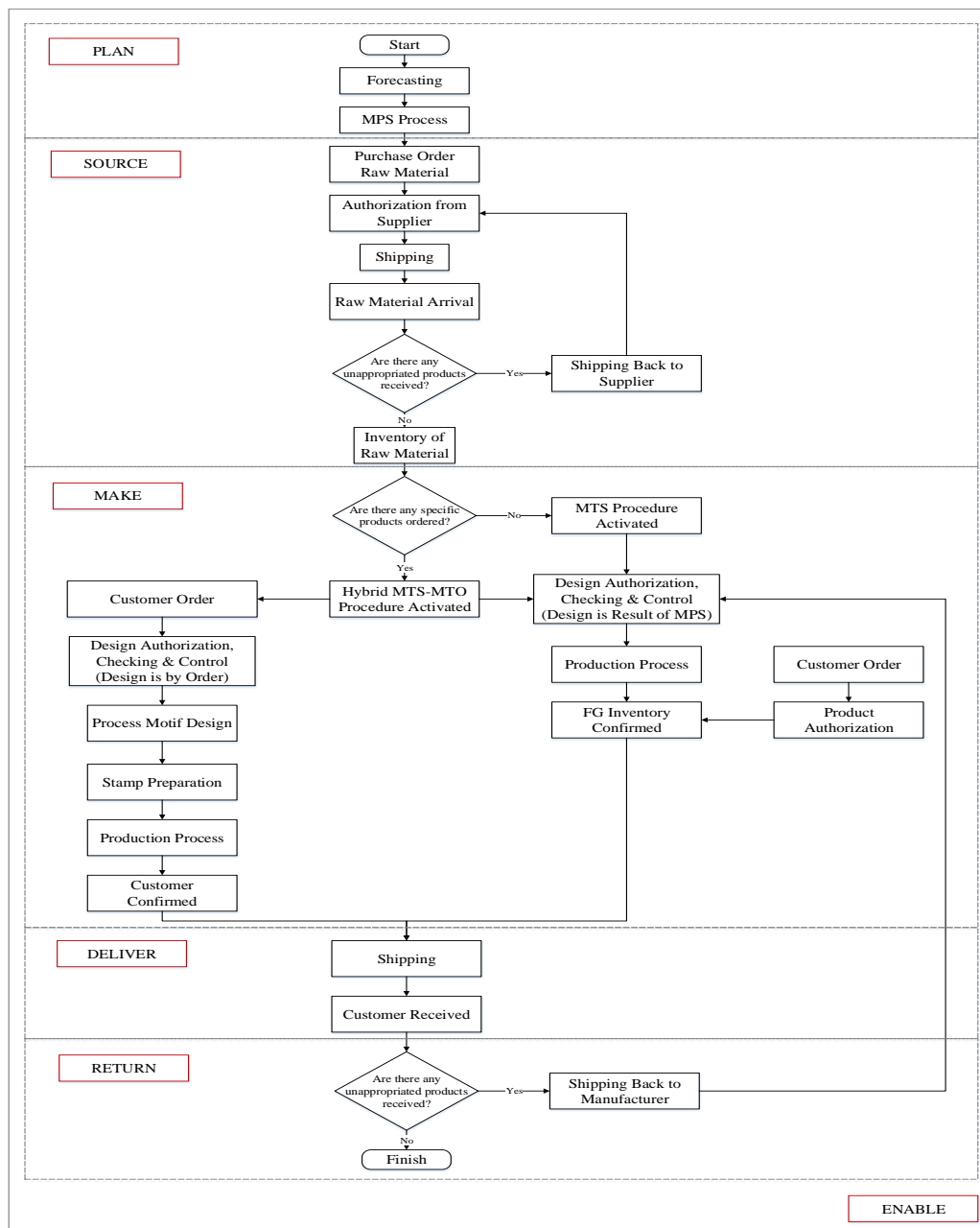


Figure 6 The Elaboration of CODP

4. RESULT AND DISCUSSION

4.1. Sustainability Analysis

The research was conducted at PT Danar Hadi which applies production type of MTO – MTS. Production flow make to stock type can be seen in Figure 7 and Production flow make to order in Figure 8. The company has given the awareness to the third parameter of SSC which are based on economical aspect, environmental, as well as social. Thus, the proposed model for the SSC performance assessment can be executed in this company. To obtain the performance assessment the following observation is conducted. This is kind of the initial step to get the data which is needed to be processed based on the methodology that has been developed. Based on the observation, several data are obtained. Those data are divided into primary data and also the secondary data. The primary data is acquired by the questionnaire and also the interview. Then, the secondary data has been provided by the company. These data are in the form of historical data that furthermore will be processed for the assessment as well as the performance improvement.

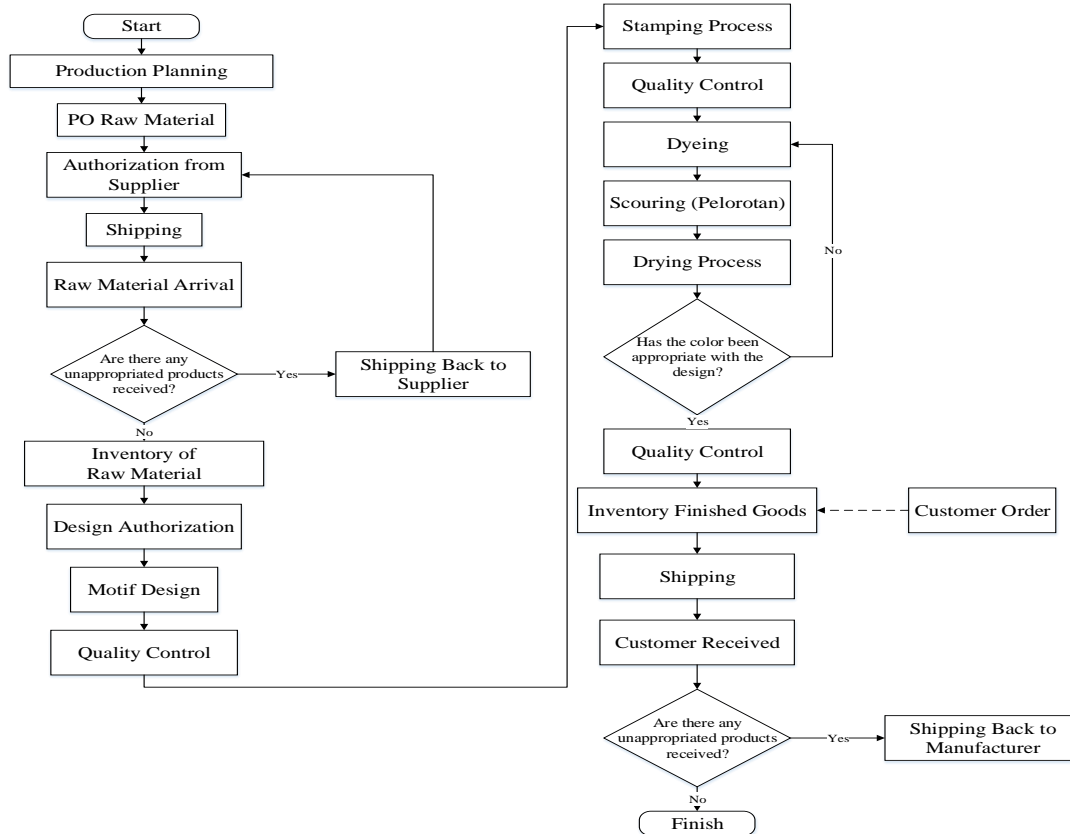


Figure 7 Production Flow for the MTS Type of Production (PT Danar Hadi, 2015)

The result of SCOR measurement can be seen in Table 1, then the resume of the SCOR measurement in Table 2 has to normalization to evaluate the gap between real result and target in Table 3. After normalize the the resume SCOR result, the radar chart can be drawn in Figure 9.

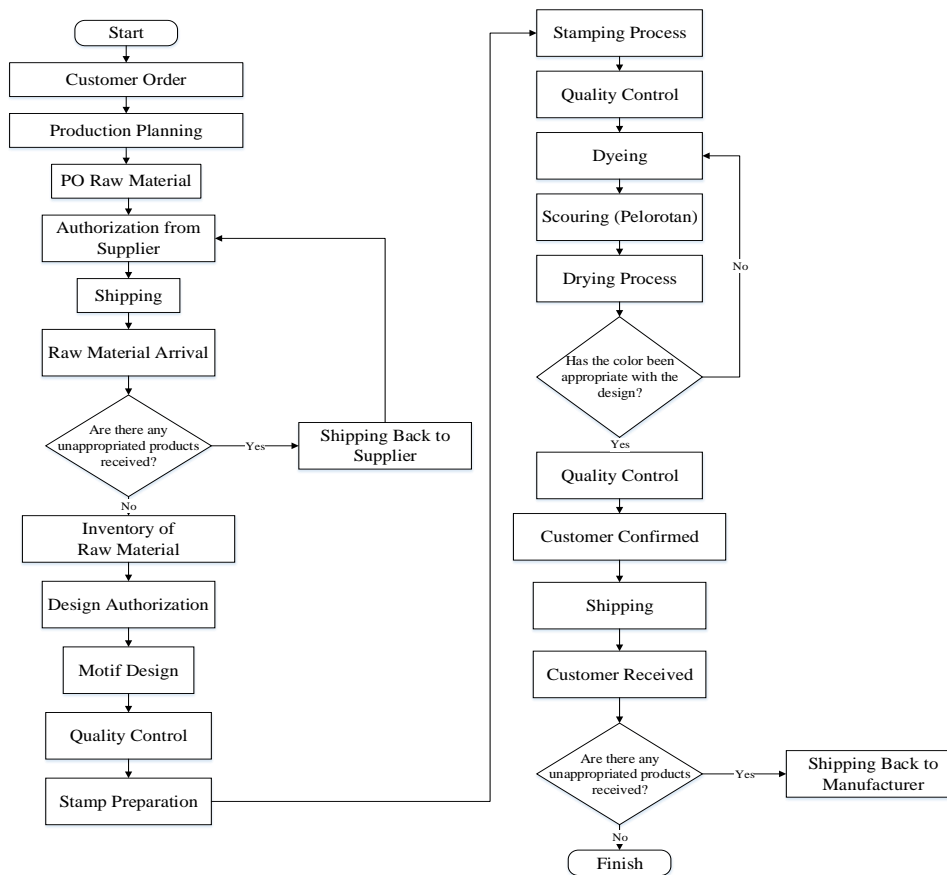


Figure 8 Production Flow for the MTO Type of Production (PT Danar Hadi, 2015)

Table 1 SCOR Measurement

Reliability	Plan	85.78%	85.58%
	Source	99.38%	
	Make	80.90%	
	Deliver	76.26%	
Responsiveness	Source	4.66	91.02
	Make	79.99	
	Deliver	2.76	
	Return	2.61	
	Enable	1.00	
Cost	Plan	IDR 1,482,637,610	
	Source		
	Make		
	Deliver		
	Return		
Agility	Source	100%	100%
	Make	100%	
Assets Management	Make	150.7	

Table 2 Resume The SCOR measurement

Attribute	Assessment	Target
Reliability	85.58%	100%
Responsiveness	91.02 days	80 days
Cost	IDR 1,482,637,610	IDR 1,400,000,000.00
Agility	100%	100%
Assets Management	150.7	120

Table 3 Normalization of SCOR Measurement

Attribute	Assessment	Target
Reliability	85.58%	100%
Responsiveness	86.22%	100%
Cost	94.09%	100%
Agility	100%	100%
Assets Management	74.41%	100%

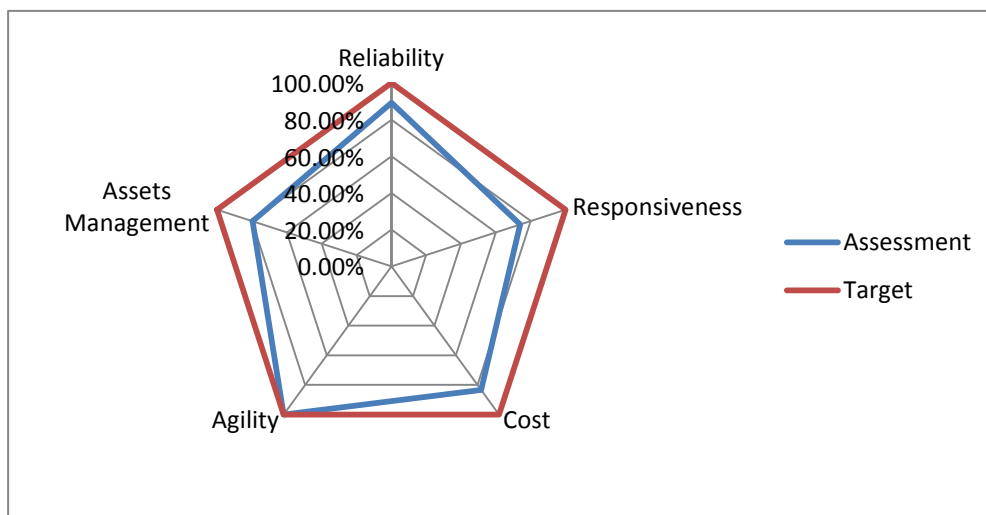


Figure 9 Radar chart SCOR model gap between assessment and target

By the same method, social aspect result can be seen in Table 4 and Figure 10 for radar chart to evaluate the gap.

Table 4 Normalization of Social Measurement

Attribute	Assessment	Target
Health Insurance	100%	100%
Safety Tools	100%	100%
Basic Allowance	70%	100%
Annual Allowance	100%	100%
Work Hours	67%	100%
Reward	70%	100%

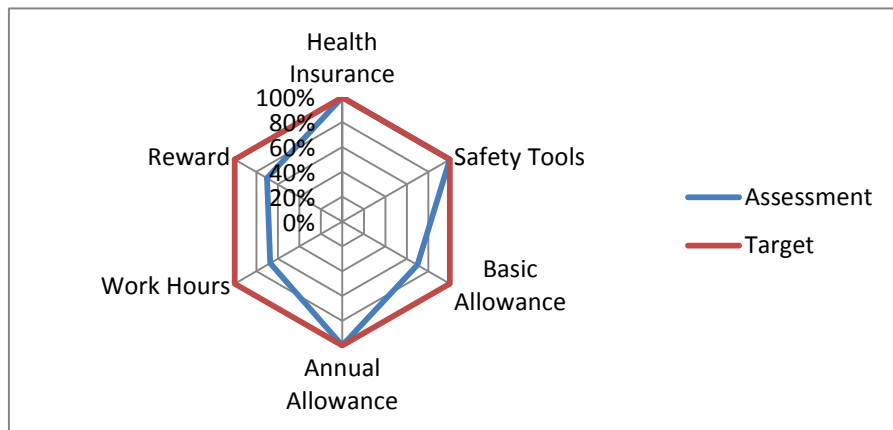


Figure10 Radar chart social aspect gap between assessment and target

For the environment aspect, Table 5 shows the result of environment measurement and Figure 11 shows the radar chart to evaluate the gap between the result from laboratory assessment and the target.

Table 5 Result of Environment Measurement

Parameter	Actual Condition	Target	Unit
Temperature	25.4	≤ 38	°C
pH	3.74	6 - 9	
BOD	18.34	≤ 60	mg/L
COD	231.52	≤ 150	mg/L
TSS	674	≤ 50	mg/L

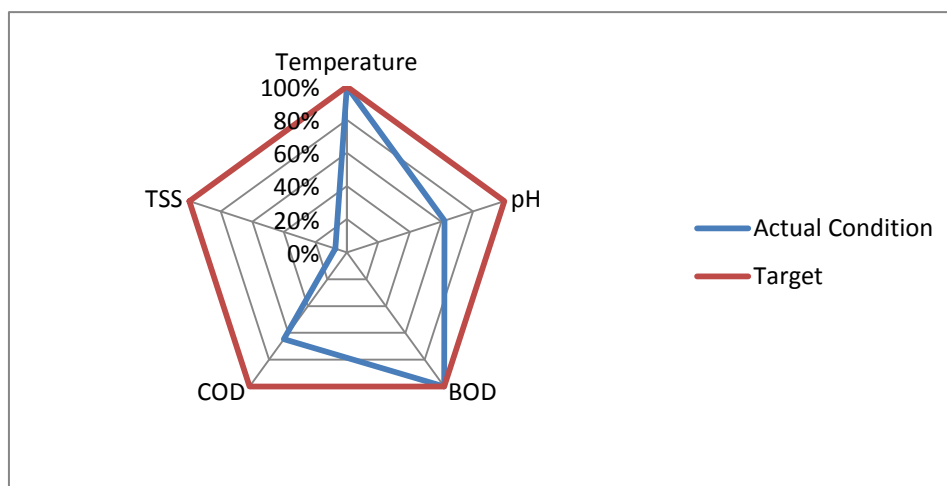


Figure11 Radar chart environment aspect gap between actual condition with target

4.2. Proposed Performance Improvement by CODP

The proposed performance improvement is applying the CODP. The CODP is traditionally defined as the point in the value chain for a product, where the product is linked to a specific customer order. Sometimes the CODP is called as the order penetration point, Olhager (2003). In this research, the process improvement is conducted by creating the decoupling point by arranging the process of MTO which can be switched to the process of MTS so the process of production can run faster. The figure of the placing point of the process that can be substituted is illustrated by Figure 12.

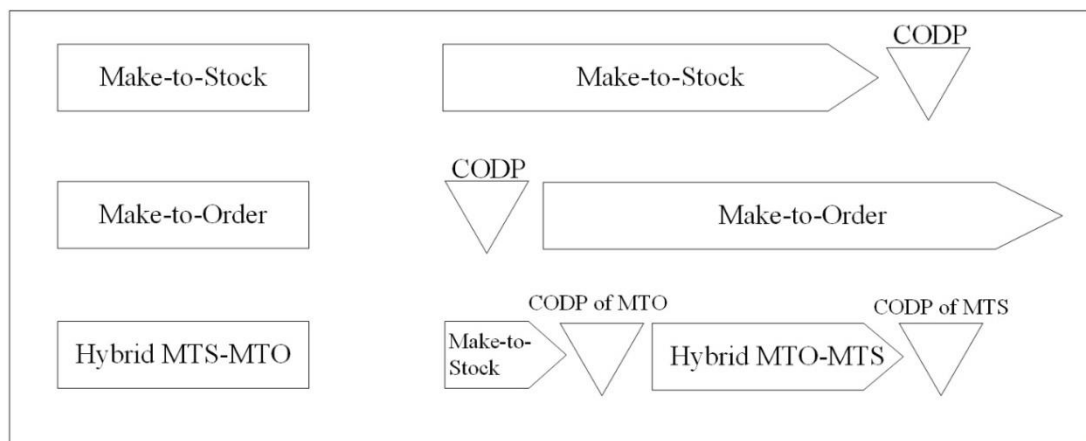


Figure 12 Position of CODP

The model of CODP that has been developed in this research is proposed to repositioning the order material process, so the process can be started earlier. MTS refers to the faster process than to MTO. Since the company applies Hybrid MTS and MTO, the process of MTO that can be conducted using MTS process will be switched to the MTS process. The illustration of the repositioning process itself is shown in Figure 12.

The repositioning process is in the Source processes which are at purchase order material, shipping, until the arrival of the raw material. In the MTO process, the raw material order is started when there is an order of the customer. While, MTS process conducts the raw material planning process and purchases the raw material based on those planning processes. The initial MTO can join the MTS in those processes. The raw material requirements will be added with the raw material for the MTO process by adding the numerous numbers of safety stocks. Therefore, when there is order from customer, there will be no lead time to wait the raw material purchasing process because the process has been conducted previously.

Based on the SCOR assessment in the attribute of Responsiveness, it can be obtained that the sum of process time for MTS process and MTO Process is resulted by the total of OFCT that are generated from the sum of Source CT, Make CT, Deliver CT, Return CT, and Enable CT. For the MTS Process it results 46.2 days, while for the MTO process it results 56.33 days. If the production refers to the CODP concept, for the customer perspective in the MTO process, the production will not need to wait the raw material purchasing because those have been available. Therefore, the Order Fulfillment Cycle Time for the customer perspective will be shorter to be the sum of Make CT, Deliver CT, Return CT, and Enable CT. It results 52.67 days that the improvement for the MTO process will be reduced as the raw material preparation which is 3.66 days.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The proposed framework to assess the SSCM applied in Batik Industry is by using SCOR for the economical aspect, liquid waste measurement for the environmental aspect, and the employee's welfare assessment for the social aspect. The attributes that are implemented in SCOR process are Reliability with Perfect Order Fulfillment as the Level 1, Responsiveness with the Order Fulfillment Cycle Time as the Level 1, Cost with the Total Cost to Serve as the Level 1, Agility with Upside Chain Flexibility as the Level 1, and Assets Management with Cash to Cash Cycle Time as the Level 1.

The economical aspect for SSCM performance assessment resulted score as Reliability is 85.58%, Responsiveness is 67.49%, Cost is 80%, Agility is 100%, and the Assets Management is 74.42%. For the social aspect, the sampling method is applied by considering the factors of Health Insurance, Safety Tools, Appropriate Basic Allowance, Annual Allowance, Appropriate Work Hours, and the Reward. The results show that the score of Health Insurance is 100%, Safety Tools is 100%, Basic Allowance is 70%, Annual Allowance is 100%, Appropriate Work Hours is 67%, and the Reward is 70%. For the environmental assessment, the converted percentage will be temperature is 100%, pH 62.0%, BOD 100%, COD 64.7%, and TSS 7.4%

The lowest score obtained is the Responsiveness at the economic aspects with the current value is 47.35 days. Thus, for improvement, the proposed framework is applied by using CODP to set the decoupling point, to which process of MTO can be substituted by the MTS process. After the CODP is implemented, it can reduce the OFCT to 3.66 days of production which is 7.73%.

5.2. Recommendations

The whole assessment and improvement processes have been conducted. Based on the process of research, it can be suggested several things that might become the contribution for the future research. Firstly, related to the proposed assessment and improvement framework, the knowledge still can be developed to obtain the future condition by using system dynamics to consider the direct and indirect factors that are able to influence the performance. Secondly, a software for supporting the attributes and levels calculation for the SCOR can also be developed, so the process of assessment can be easier to be conducted. Thirdly, related to the improvement framework, there are still numerous numbers of improvement tools for increasing the performance score, for instance the application of lean manufacturing, six sigma implementation, or mathematical modeling development. Lastly, the tools for obtaining the integrated score that has been including all parameters can be developed, so the score for the whole process of chain is able to be acquired.

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