

Sustainable Performance Measurement Using Sustainable Value Stream Mapping: A Case Study On One Of Palm Oil Companies In Indonesia

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Abstract

The palm oil industry is an important industry for the Indonesian economy. However many problems faced by the palm oil industry in Indonesia, especially related to the environment and social in various levels of production and consumption in the supply chain. This has resulted in poor performance and a lot of attention for improvement. This paper proposes methods for improving the performance of the palm oil industry using Sustainable Value Stream mapping (Sus-VSM). Sus-VSM is a methodology developed from traditional VSMs by adding three metrics to evaluate environmental sustainability and two metrics to evaluate social sustainability on production lines. In this study, sustainability index is measured using 29 metric indicator which been obtained from the previous research. A case study on one of palm oil companies in Indonesia was conducted and resulted in a sustainability index score of 59.34 (in range 1-100) or highly fair, with the highest index in the economy (72.23) followed by Social 54.56 and Environmental Index 20 , 64. Suggestions for improvement are given to improve the index sustainability, especially the Environment index.

Keywords

Sustainability, Value Stream Mapping, Economy index, Social index, Environment index

1. Introduction

Palm oil is a very important commodity and became the leading commodity exports for Indonesia. Palm oil and its derivatives products contributed to the export of 75 percent of the non-oil and gas sectors. Therefore palm oil became one of the largest contributors to the country's income (Gapki,2017). The challenge of the palm oil industry is getting bigger. In the late 90s the palm oil sector began to face criticism about some environmental and social practices at various levels of production and consumption in its supply chain. Forest fires in oil palm-run areas in Indonesia in recent years have put more pressure on the palm oil industry in Indonesia.

Today, people prefer to buy environmentally friendly products. attention to "ethical and green credentials products", including manufacturing and distribution processes as well as corporate and brand reputation are the focus of today's European consumers. Looking at this green trend, in the future, it is not just European consumers who will demand a hundred percent sustainable supply chain for various products, but began to expand to consumers of other countries. Therefore it is necessary for the palm oil industry in Indonesia to improve performance, especially its sustainability performance. This study focuses on performance measurement using Sustainability Value Stream Mapping (Sus-VSM) approach. A case study on one of the major palm oil companies in Indonesia will be done by measuring index sustainability in three sizes, namely economic metrics, environmental metrics and Social metrics. This research is a continuation of previous research, where in previous research found 29 metric and its weight (Kusrini & Primadasa, 2017). This metric will be used in measuring index sustainability. By using this Sus-VSM method, the company can know the performance comprehensively, especially from the point of view of sustainability. The company can

formulate policies and decision-making to reduce activities that do not have added value while improving its sustainability.

2. Literature Review

Value Stream Mapping is a tool developed within the Toyota Production System which, according to Rother and Shook (1999) describes the "door-to-door" production flow within a production floor, from the delivery of parts and materials to production to the final delivery to the consumer. VSM was first used to identify waste in the value stream and then developed as a future state map of improvements which was then implemented, then repeated processes for continuous improvements. Meanwhile, according to Daniel T. Sparks (2014) traditional VSMS have a weakness of metrics to assess performance in terms of environmental and societal sustainability. In an effort to build and develop traditional VSM and other lean techniques to consider more than economic aspects, the Environmental Protection Agency (EPA) in the United States developed two toolkits: a lean and environmental toolkit (EPA 2007) and a lean and energy toolkit (EPA 2007)(<https://www.epa.gov/>).

Faulkner and Badurdeen (2012) show methods for visualizing sustainability in a production line called Sustainable Value Stream (Sus-VSM). Sus-VSM still uses traditional VSM but by adding a matrix that measures environmental and social aspects. Further Faulkner and Badurdeen use Sus-VSM in various industries. Sus-VSM is a methodology that extends traditional VSMS by adding three metrics to evaluate environmental sustainability and two metrics to evaluate societal sustainability at the production line level (Faulkner and Badurdeen, 2012). The addition of this metric allows three aspects of sustainability to be evaluated from its production line, while also allowing potential improvements to be identified.

A literature study conducted in previous research to determine the indicators that are typically used in the measurement of sustainability, especially for palm oil industry. The indicators used are base on study conducted by Veleva, et al (2001), Faulkner, et al (2016), Sparks.D.T (2014), Bai & Sarkis (2014), Hall, et al (2012). The study resulted in 29 metric to measures sustainability performance (Kusrini & Primadasa,2017) which is used to measures sustainability index in this subsequent research.

3. Methodology

In this study, the measurement of sustainability performance is done through 4 stages, namely the selection of sustainability indicators, performance measurement, VSM mapping and calculating sustainability index. Sustainability indicators for the oil palm industry using previous research results (Kusrini and Primadasa, 2017) consisting of 29 valid indicators and their weights as illustrated in Figure 1.

4. Result and Discussion

The Sustainability VSM map on one of the palm oil companies in Indonesia is conducted and the result is illustrated in Figure 2. In order to obtain sustainability index, the measured data is normalized within range 1-100 using SNORM method. The process of normalization (SNORM) De Boer (Trienekens and Hvolby, 2000) employed scale of 0 to 100 to get the value of each metric with the following formula:

Larger is better

$$S_{norm} = ((S_i - S_{Min}) / (S_{max} - S_{Min})) \times 100 \quad (1)$$

Lower is better

$$S_{norm} = ((S_{Max} - S_i) / (S_{Max} - S_{min})) \times 100 \quad (2)$$

where,

S_i = average value

S_{max} = the value of achieving the best performance indicators

S_{min} = the value of achieving the worst performance indicators

The calculation of sustainability index is shown in Table 1.



Figure 1. Sustainability Indicators and its weight (Kusrini & Primadasa, 2017)

Table 1. The Calculation of Sustainability index

Metric	Code	Result	Standard	Min-Max	S Norm	Weight	S-Norm * Weight
OER (Rendemen)	EC-1	23,4 %	24,63 %	Min 0 %	95	0.36	34.2
Oil Losses	EC-2	1,578 %	max 1,7 %	Min 0 %	71.76	0.16	11.48
FFA	EC-3	3,26 %	max 5 %	Min 0 %	34,8	0.15	5.22
Moisture	EC-4	0,27 %	Max 0,3 %	Min 0 %	10	0.05	0.5

Metric	Code	Result	Standard	Min-Max	S Norm	Weight	S-Norm * Weight
% Breakdown	EC-5	0.0001 4 %	0 %	Max 100 %	99.9	0.10	1
Lead Time/Plant Time	EC-6	4,359 days	5 days	Min 0 day	12.82	0.05	0.64
Value Added Time	EC-7	316,5 min	320 min	Min 0 min	98,9	0.05	4.94
Work In Process	EC-8	62,25 ton/jam	-	Min 11 ton/jam Max 150 ton/jam	63.13	0.03	1.9
Cost Associated with EHS	EC-9	83 jt/year	-	Min 37 jt/year Max 327 jt/year	84.14	0.04	3.36
Economy Index							72.23
Water Usage	ENV-1	23.7 ton/jam	Max 30 ton/jam	Min 0 ton/jam	21	0.16	3.36
Energy Usage	ENV-2	1009 kw	Max 1200 kw	Min 0 kw	15.9	0.19	3.02
Waste Generated Before Recycled	ENV-3	1101ton/day	Max 1200 ton/day	Min 0 ton/day	8.25	0.09	0.74
Global Warming Potential	ENV-4	19582 ton/year	-	Min: 122 ton/y Max: 70732 ton/y	71.93	0.11	7.91
BOD	ENV-5	11	Max 6 mg/L	Min 0 6 mg/L	0	0.15	0
COD	ENV-6	47	Max 50 mg/L	Min 0 mg/L	6	0.05	0.3
% Waste Reused	ENV-7	20.8 %	100 %	Min 0 %	20.8	0.06	1.25
% CPO Certified	ENV-8	0 %	100 %	Min 0 %	0	0.11	0
Material Usage	ENV-9	69,3%	-	Min 23 % Max 100 %	60.13	0.03	1.80
Acidification Potential	ENV-10	134,5 ton/year	-	Min: 0 Max 538: ton/year	75	0.03	2.25

Metric	Code	Result	Standard	Min-Max	S Norm	Weight	S-Norm * Weight
Percent Product with Take-Back Policies	ENV-11	0 %	100 %	Min 0 %	0	0.02	0
Environment Index							20.64
Lost Workday and Injury Illness	Soc-1	1.3 hari/year	0	Min: 0 Max: 7 days/year	81.42	0.26	21.17
Hour of Employee Training	Soc-2	3.4 hour/year	-	Min: 0 max: 24 hour/year	14.167	0.07	1
Worker Job satisfaction	Soc-3	51 %	-	Min 0 % max 100 %	51	0.11	5.61
Local Community Hiring	Soc-4	38 %	-	Min 0 % max 100 %	38	0.15	5.7
Physical Load Index	Soc-5	1,3	-	Min :1.21±0.05 Max:1.41±0.20	68.89	0.13	8.95
1. Electrical System Hazard	Soc-6	41,4 (M)	-	Min: 25(L) Max 50 (M)	34.4	0.08	2.75
2. Noise Hazard	Soc-7	85,72 dB	-	Max : 96,62 dB Min : 80,01	65.74	0.08	5.26
3. Average Length of Service of Employees	Soc-8	8,6 years	-	Min 7,2 years Max 11,5 years	32.56	0.05	1.63
4. High-Speed Component Hazard	Soc-9	37,5 (M)	-	Min: L (25) Max: M (50)	50	0.05	2.5
Social Index							54.56

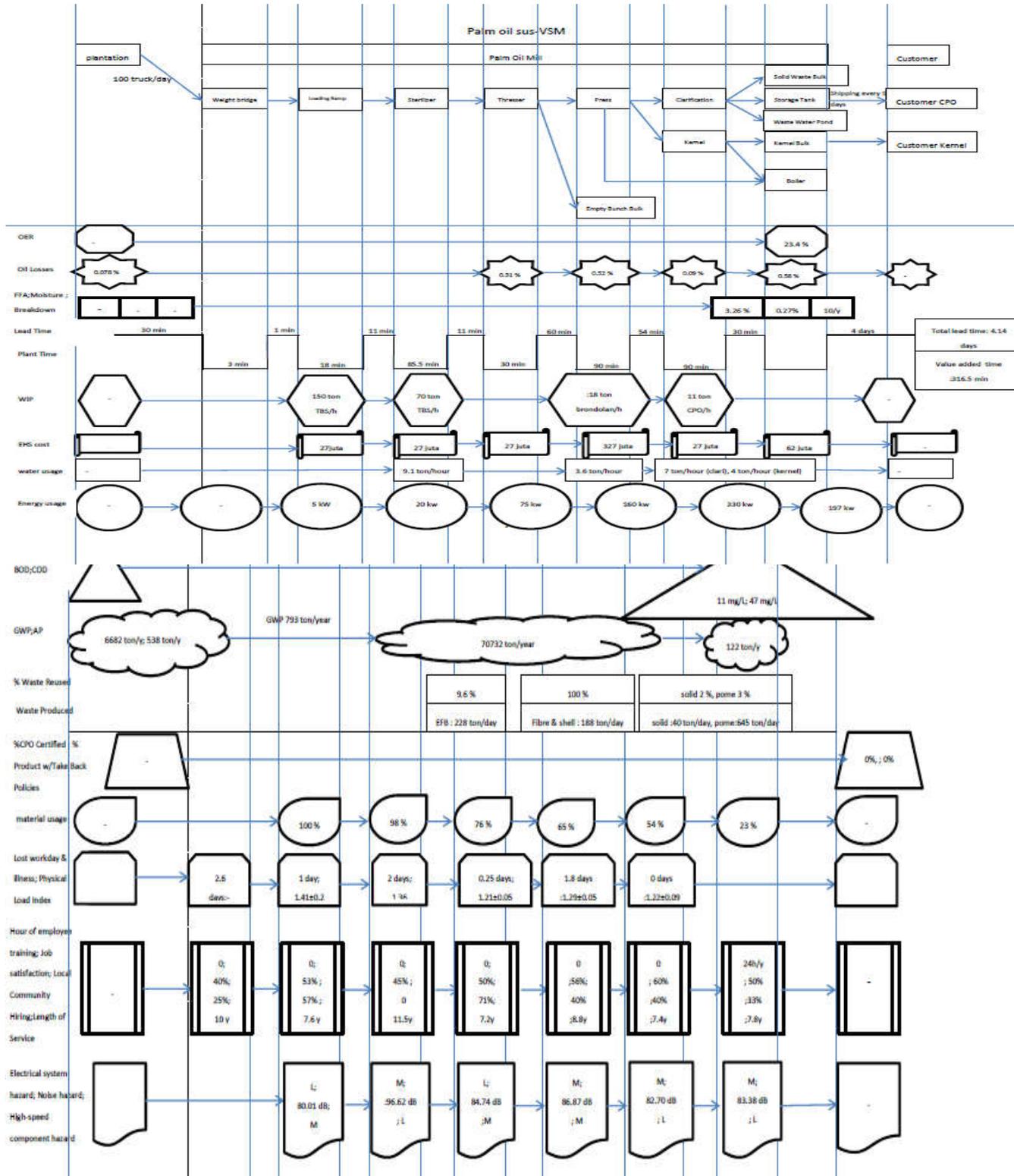


Figure 2. Sustainability VSM

The results of this study indicate that the economic sustainability index total of 59.34, where the index is in the category of Highly Fair. The categorization of sustainability index results is based on Cheng EWL (2006) as presented in Table 2. This index is generated from the economic index of 72.23 (Moderately good), environmental index of 20.64 (Moderately poor), and social index of 54.56 (Highly fair). Sustainability supply chain performance in this palm oil company need improvement especially on environmental issues. The company needs a thorough evaluation of environmental indicators because it is still not sustainable. Improvements can be focused on increasing BOD, COD, % CPO Certified and Percent Products with Take-Back Policies. Companies should attempt to obtain Sustainable Indonesian Palm Oil (ISPO) certificates, both on plantation and factory sections. The efforts to increase CPO% gradually should also be the focus of improvement. Improved worker satisfaction could be done by providing training and development. To increase OER, it is necessary to suppress its oil losses especially in final effluent to waste water pond. % Waste Reused can also be increased especially for POME (liquid waste) by utilizing liquid waste for example as irrigation and liquid fertilizer. Furthermore, companies can use these metric results as a basis for prioritizing improvements.

Table 2. Sustainability Index Category

Score	Description	Action plan	Score	Description	Action Plan
0-10	Highly poor	The company has not been sustainable yet. a thorough improvement in every supply chain process is required.	51-60	Highly fair	It needs 10-20 percent improvement on the supply chain process that has not been sustainable
21-20	Moderately poor		61-70	Lowly good	
21-30	Lowly poor		71-80	Moderately good	
31-40	Lowly fair		81-90	Highly good	
41-50	Moderately fair	It needs 30 percent improvement on the supply chain process that has not been sustainable	91-100	Excellent	Maintaining a sustainable supply chain process

5. Conclusion

The sustainability VSM metrics are used to measure the performance of oil palm companies by using 29 metrics grouped into 3 types of metrics, namely economy, social and environment metrics. The use of VSM along with index sustainability measurement can help company in enhancing performance in each process more easily because it is visually displayed. Index sustainability is the multiplication index between the value of performance with the indicator weight. The performance measurement results can be used to determine corrective actions to improve sustainability performance.

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