SUSTAINABLE SUPPY CHAIN VALUE STREAM MAPPING (SSC-VSM)
The Application in Two Bottle Drinking Water Companies

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Abstract

High competitiveness level in manufacture industry has caused companies to compete not only to be efficient (lean) but also sustainable. In order to achieve sustainability, a company requires a thorough examination of the product design process, the manufacturing process, and the overall supply chain. Many studies have attempted to develop value stream mapping (VSM) that is integrated with environmental and social aspects to produce sustainable system, but they fail to describe the overall performance of sustainability throughout the product supply chain. To do so sustainable supply chain value stream mapping (SSC-VSM) has been developed. SSC-VSM aims to analyze sustainability performance throughout the product supply chain. In term of the product supply chain considered are pre manufacturing, manufacturing, and distribution. Aspects that are considered are economic, environment, and society in which each aspect has some indicators. This research aims to extend the previous research focusing on only manufacturing stage under the concept of Sustainability Valye Stream Mapping (Sus-VSM) to all stage in supply chain and to apply the modified Sus-VSM named SSC-VSM in two bottled drinking water companies. The application aims to assess and compare those companies and identify which indicator that less efficient and should be improved.

Keywords
Sustainable Supply Chain Value Stream Mapping (SSC-VSM), sustainability manufacturing, lean manufacturing, supply chain

1. Introduction

Activity in manufacturing industry produces a considerable impact on the environment that is through the use of excessive natural resources and waste generated. Natural resources are limited and non-renewable resources. Uncontrolled use of resources can lead to natural resource shortages and the future generations can not meet their resource needs. While the waste produced by manufacturing industry can cause environmental pollution such as air pollution due to emission of greenhouse gases (CO2, CH4, N2O, SF6) generated, water pollution caused by liquid waste containing chemicals, and soil contamination due to solid waste generated. Besides the importance industry on paying attention to environmental aspects, social aspects need to be considered. This is because humans have an important role in building sustainability.

In addition, the point of view environmental and social safeguards, increased public awareness of the importance of environmental and social safeguards for the better life of the future encourages companies today to compete not only to be lean but also sustainable. The concept of sustainable manufacturing becomes the main foundation for manufacturing industry practitioners to compete in global market. Sustainable manufacturing is important facts in competitive advantage for the company. Sustainable concepts are more able to compete globally considering they have been able to meet the standards of ISO 14000.

At the beginning of 1940 the concept of lean manufacturing become a new paradigm that is considered to have many benefits in its application. Lean manufacturing focuses on seing efficient in economic aspect that aims to improve the system continuously to eliminate waste in the manufacturing system, thus reducing production costs and accelerating products received by consumers. But nowadays the paradigm evolves towards the concept of sustainability that is focus on triple bottom line which not only focus on economy but also consider environmental and social aspects. This is due to the economic benefits that are not able to guarantee the sustainability of the next life, therefore the paradigm shifts towards sustainable manufacturing. Sustainable manufacturing is defined by the United Stated Department of commerce (2010)

"As the creation of manufactured products that use processes that minimize negative environmental impacts, conserves energy and natural resources, are safe for employee, communities, and consumer and are economically sound" (US DOC, 2010).

Faulkner & Badurdeen (2014) mention that sustainable manufacturing is important. It includes the use of sustainable processes and systems to produce more sustainable products. In addition, achievement of sustainable manufacturing requires a thorough examination of the product design process, manufacturing process, and overall supply chain (Faulkner & Badurdeen 2014; Brown et al. 2014). According to the explanation it can be seen that sustainable manufacturing becomes an important thing to note now in every process associated with the product.

2. Previous Research & Modifications

2.1 Sustainability Integration with Value Stream Mapping

Currently lean manufacturing has been widely used to develop a strategy towards green and sustainable manufacturing (Faulkner & Badurdeen 2014). One method of visualizing the production process with the lean principle is value stream mapping (VSM). VSM was introduced by Rother and Shook in 1999. VSM is a method that has been accepted and used by many practitioners to improve production systems using lean principles. VSM aims to identify and visualize waste in manufacturing processes where the main objective is to know lean oriented production practices and develop plans to improve future performance (Brown et al., 2014). VSM will describe all activities along the production line and will divide the activity as a value added or non value added activity. In its application the VSM focus on manufacturing stage and does not directly consider the performance of environmental. Many researchers have developed value stream mapping by considering environmental and social aspects.

Research conducted by Torres & Gati (2009) tried to develop environmental value stream mapping. That is developing methodology to map environmental aspect in VSM. The environmental aspect to consider is the use of water. Kuriger & Chen research (2010) develops energy and environmental value stream mapping methodologies. Aspects to be considered in this research are the time (waste) and environmental aspects which consist of measurement of energy and material consumption. Verma & Shrama (2016) develops green Energy VSM (EVSM), aspects considered in this study are time and energy consumption. Faulkner & Badurdeen (2014) developed a sustainable value stream mapping (Sus-VSM) methodology in the satellite dish industry. In this research social aspect started to be involved in VSM. Environmental aspects to consider are time (waste), energy, materials, and water. All of the mentioned studies have considered economic, environmental, and social aspects of VSM with a focus on the manufacturing stage. Whereas Marimin et al (2014) conducted a research on value chain analysis of natural rubber supply chain and the main focus is not only in the manufacturing stage but the pre-manufacturing stage. The processes considered by Marimin et al (2014) are natural rubber cultivation (pre manufactur) and ribbed smoke sheet production (manufactur). Indicators to consider are the consumption of energy, material, water, garbage, transportation distance, and emissions. In addition, Simons & Mason (2002) has introduced lean and green in the distribution stage, in this study CO2 emissions are considered thoroughly at the distribution stage starting from packaging manufacturing to retailers and home. Suarez-Barazza, et al (2016) has developed supply chain value stream mapping (SC-VSM) but focuses on volume and on time delivery (OTD) indicator from supplier to manufacturer and from manufacturer to consumer. Simons & Mason (2003) mentioned that it is necessary to understand further how the impact of the process of procurement and distribution of products on sustainability issues. Therefore, from various literatures it is found that there is an opportunity to develop the use of value stream mapping as a tool for mapping and analyzing the level of sustainability in the supply chain products from preparation stage (pre manufacturing), manufacturing, until product distribution process to consumers by considering economic, environmental, and social aspects.

2.2 Sustainable Supply Chain Value Stream Mapping (SSC-VSM)

Currently companies not only need to increase profit in the delivery process, but also necessary carry out business in good manner and think about the environmental and social impacts of all activities (Simons & Mason, 2003). To assist the company in evaluating all business activities on the environmental and social impacts SSC-VSM is developed. SSC-VSM integrates the conventional VSM that has been widely used by

users in identifying waste with triple bottom line. SSC-VSM aims to facilitate the user (company) in identifying all activities undertaken by the company starting from the preparation activities of raw materials (pre manufacturing), manufacturing process (manufacturing), and distribution by considering the triple bottom line (economic, environment, social). Pre manufacturing is preparation activity of raw materials starting from the process of ordering materials from suppliers to materials ready for use on the production floor. Manufacturing is a production activity that turns material into a product of value. Distribution is a product delivery activity from the production floor to the distributor / retailer / consumer. In each aspect have several indicators. This indicator is selected based on suggested indicators in references, a selection process through interview with water bottle companies were conducted and obtained the following indicators:

Table 1. Selected Indicator for SSC-VSM

Aspects	Indicator	Pre Manufactur	Manufactur	Distribution
Economic	Lead Time	Marimin et al (2014)	Rother & Shook (1999), Marimin et al (2014), Kuriger & Chen (2010) Li et al (2012)	-
	Quality	-	Haefner et al (2014)	-
	Volume and On Time Delivery (OTD)	Suarez-Barazza, et al (2016)	-	Suarez-Barazza, et al (2016)
Environmental	Material Consumption	Marimin et al (2014)	Faulkner & Badurdeen (2014), Marimin et al (2014), Kuriger & Chen (2010)	-
	Water Consumption	Marimin et al (2014)	Faulkner & Badurdeen (2014), Marimin et al (2014), Torres & Gati (2009),	-
	Energy Consumption	Marimin et al (2014)	Faulkner & Badurdeen (2014), Marimin et al (2014), Kuriger & Chen (2010)	-
	Emission	Marimin et al (2014)	Faulkner & Badurdeen (2014), Marimin et al (2014), Li et al (2012)	Simons Mason (2002)
	Waste Management	Marimin et al (2014)	Marimin et al (2014)	-
Society	Health	Jayal et al (2010)	Jayal et al (2010)	-
	Safety	Jayal et al (2010)	Jayal et al (2010)	-

Currently distribution is measured by emission (Simon & Mason, 2002). However since supply chain becomes important issue and identified as on of the main burdens for manufacturer, thus including economic aspect in the distribution measure is necessary. In this research distribution stage will be measured in some indicator in each aspect. The indicators considered in the economic aspects of the distribution stage are time and quality, on the environmental aspects are material consumption, water, energy, emissions, and waste management, on the social aspect are health and safety. The definitions and modified measurements of each indicator at each stage are as follows:

A. Economic Indicators

1. Lead Time: As described in the previous section, lean is a philosophy for minimizing resources including time spent on business activities, including minimization of non-value-added activities (Cox & Blasckstone, 1998). Therefore time calculation is needed on each process to identify time value added (value added activity) and non value added time (non value added activity). Lead time becomes the main reference in value stream mapping method. Here is a definition of value added and non value added time at each stage:
   a. Pre manufacturing
      1) Value added: the time required for the preparation of materials that starts from the ordering of materials on the supplier until the material is ready for use on the production floor and the activity adds value to the material
      2) Non value added: the time required for the preparation of materials that starts from the ordering of materials on the supplier until the material is ready for use on the production floor but the activity does not provide added value to the material
   b. Manufacturing
      1) Value added: Time needed for value-added activities (converting raw materials into valuable products)
      2) Non value added: time wasted for activities not worth adding.

c. Distribution

1) Value added: time spent on value-added activities when delivery products to consumers
2) Non value added: time wasted for activities when delivery products to consumers

Lead time is measure by the time it takes to prepare the product from the time the consumer orders until the product will be delivered to the consumer (Bharath & Prakash, 2014). To calculate the lead time it is necessary to measure the cycle time on each activity on the business process. One method that can be used is by using stopwatch time study (STS).

2. Quality: Quality is one of the most important things to note. Juran (1993) defines the quality as fitness for use of the product to the needs and customer satisfaction. Therefore quality is one of the indicators that need to be considered. Inventory is one of the waste that need to be eliminated.

a. Pre manufacturing

1) Value added: good quality material when purchased from supplier and can be used in good performance when it will be processed at manufacturing stage
2) Non value added: defect materials when purchased from suppliers or materials that do not have good performance when will be processed at the manufacturing stage.

b. Manufacturing

1) Value added: the product conform to the specified specification
2) Non value added: the product does not conform to the specified specification

c. Distribution

1) Value added: products delivered and received by the retailer or consumer in good condition
2) Non value added: products delivered and received by retailers or consumers in defect condition

Quality at each stage can be measured by counting the number of materials or products that are good and bad for a certain period

3. Volume and On time Delivery (OTD) Performance: on SSC-VSM will be used indicator which introduced by Suarez-Barazza, et al (2016) that is considering volume and OTD in SC-VSM

a. Pre manufacturing: Performance accuracy of the volume and on time delivery of the supplier
b. Manufacturing: the accuracy of volume and time of production in accordance with production targets
c. Distribution: the accuracy of the volume and delivery time of the manufacturer to consumer.

B Environmental Indicators

1. Material consumption: Processed material is a major source of cost for the finished product so that material consumption can become waste in the environment and economy (Torres & Gati 2009). This means that measuring the effectiveness of the materials used during the production process is important to do.

a. Pre manufacturing

1) Value added: Materials needed for material preparation process materials that starts from the ordering of materials on the supplier until the material is ready for use on the production floor and and the material consumption adds value to the raw material
2) Non value added: Material needed for material preparation process materials that starts from the ordering of materials on the supplier until the material is ready for use on the production floor, but the the material consumption does not provide value to the raw material or become waste after process

b. Manufacturing

1) Value added: Materials needed during the production process that can provide value added products
2) Non value added: Material required during production process but not providing value added product or become waste after the process

c. Distribution

1) Value added: Materials needed for product delivery process that can provide value added products
2) Non value added: The material required for the delivery process but can not provide value on the product or become waste after the process

Material consumption in maufacturing stage can be calculated by calculating the weight of components before and after a process (Vinodh, 2016). And in pre manufacturing and distribution stages it can be calculated by measuring the weigh of material supplied to the material or product.

2. Water Consumption: Measurement of water consumption aims to calculate the amount of water used during the manufacturing process and to illustrate the important aspects that should be evaluated for improvement from the standpoint of sustainability manufacturing (Faulkner & Badurdeen 2014). Wastewater or waste causes environmental and social harm (Torres & Gati 2009) therefore water consumption becomes one of the important indicators to be analyzed for sustainability.

a. Pre manufacturing
   1) Value added: Water required for material preparation process that starts from the ordering of materials on the supplier until the material is ready for use on the production floor and and the water consumption adds value to the raw material
   2) Non value added: Water required for the material preparation process that starts from the ordering of materials on the supplier until the material is ready for use on the production floor, but the the water consumption does not provide value to the raw material or become waste after the process

b. Manufacturing
   1) Value added: Water required during production process that can provide value added products
   2) Non value added: Water required during the production process but does not provide value added products or become waste after the process

c. Distribution
   1) Value added: Water required for the delivery of products that can provide value-added products
   2) Non value added: Water required for product delivery process but does not provide value to the product or become waste after the process

The water consumption of the product in manufacturing stage can be calculated by measuring the water supplied to a machine and water resulting from a process. While calculating the calculation process of water consumption per unit of product is as follows (Faulkner & Badurdeen 2014):

$$Water\ Consumption = \frac{\text{(the amount of water used in the process over a period of time)}}{\text{(number of units of goods produced over a period of time)}} \quad (1)$$

In pre manufacturing and distribution stages it can be calculated by measuring the water supplied to the material or product.

3. Energy consumption is directly related to the environment this is due to the use of non-renewable resources and emitted GHG emissions (Faulkner & Badurdeen 2014). Therefore, energy consumption metrics need to be measured to identify how much energy is consumed in each process or between processes such as in-plant transportation, and the energy needed in the storage process.

a. Pre manufacturing
   1) Value added energy: energy required for material preparation process that starts from the ordering of materials on the supplier until the material is ready for use on the production floor and and the energy consumption adds value to the raw material
   2) Non value added energy: energy required for the material preparation process that starts from the ordering of materials on the supplier until the material is ready for use on the production floor, but the the energy consumption does not provide value to the raw material

b. Manufacturing
   1) Value added energy: the energy needed during the production process that can provide value added products
   2) Non value added energy: energy needed during the production process but does not provide value added products

c. Distribution
   1) Value added energy: energy required for the process of delivering products that can provide value added products
   2) Non value added energy: energy required for the delivery of products but does not provide value on the product

Measurement of energy consumption at each stage using the following formula:

$$Q = \sum_{i=1}^{n} P_i x\, t_i \quad (2)$$

Where:
Q = Amount of energy consumed
P_i = Energy needed for device i
t_i = operating time of the i tool i

4. Emission

One of the sustainability concept is to reduce CO2 emissions associated with the products (Simons & Mason, 2003). Gaseous emissions gas to the earth is generally referred to as greenhouse gas (GHG). The GHG are CO2 (Carbon dioxide), CH4 (methane), N2O (Dinitro Oxide), and SF6 (sulfurhexafloride). CO2 emissions are generally associated with transportation, industry, and domestic energy use.

a.Pre manufacturing
   1) Value added emission: emission generated from the material preparation process that starts from the ordering of materials on the supplier until the material is ready for use on the production floor and and the activity adds value to the raw material

2) Non value added emission: required emission of the material preparation process that starts from the ordering of materials on the supplier until the material is ready for use on the production floor and but the material consumption does not provide value to the raw material

b. Manufacturing

1) Value added emission: emissions generated during the production process that add value to the product

2) Non value added emission: emissions generated during the production process but do not provide value added products

c. Distribution

1) Value added emission: emissions generated from the product delivery process that adds value to the product

2) Non value added emission: emission generated from the product delivery process but does not provide material value to the product

To calculate Greenhouse Gas emissions at each stage can be calculated using following formulation (wirahardikusumah & Sahana, 2012)

$$GRK\ Emission = \frac{Energy\ Concumption\ (MJ) x\ Emision\ Factor\ (kg\frac{CO_2}{MJ})}{Product\ Total} \quad (3)$$

5. Waste Management

a. Pre manufacturing

1) Value added: waste generated from the process of material preparation that starts from the ordering of materials on the supplier until the material is ready for use on the production floor and had been manage (6R)

2) Non value added: waste generated from material preparation process that starts from the ordering of materials on the supplier until the material is ready for use on the production floor, but the the material consumption does not provide value to the raw material, but had not been manage (6R)

b. Manufacturing

1) Value added: waste generated during the production process and had been manage (6R)

2) Non value added: waste generated during the production process but had not been manage (6R)

c. Distribution

1) Value added: waste generated from the process of product delivery and had been manage (6R)

2) Non value added: waste generated from the process of product delivery but had not been manage (6R)

Waste management can be calculated by measure weight the waste before and after managed.

C. Social Indicators

Health and Safety: Health and Safety is a matter that needs to be paid attention to. Well-organized working conditions can improve worker productivity. The ILO (2013) states that if the workplace is safe and healthy workers can do their work effectively and efficiently, whereas if the workplace is bad it can lead to accidents, absenteeism due to illness, loss of employee income, and decreased productivity for the company. Each year there are more than 250 million accidents happening in the workplace and over 160 million workers suffering from ill health due to poor work environment (ILO, 2013). From this, the health and safety of workers need to be considered in producing a sustainability system.

1. Health

a. Pre manufacturing

1) Value added: total number of days of attendance of workers capable of fulfilling material preparation activities that starts from the ordering of materials on the supplier until the material is ready for use on the production floor.

2) Non value added: total number of days of absenteeism so unable to fulfill material preparation activity that starts from the ordering of materials on the supplier until the material is ready for use on the production floor.

b. Manufacturing

1) Value added: total number of days attendance of workers who are able to fulfill production activities

2) Non value added: total number of days of absence of worker so unable to fulfill production activity

c. Distribution

1) Value added: total number of days of attendance of workers capable of fulfilling material preparation activities

2) Non value added: total number of days of worker absence so unable to fulfill product delivery activity

2. Safety
   a. Pre manufacturing
      1) Value added: total number of worker days capable of fulfilling material preparation activity well that starts from the ordering of materials on the supplier until the material is ready for use on the production floor.
      2) Non value added: the total number of worker days has a work accident so unable to fulfill the material preparation activity that starts from the ordering of materials on the supplier until the material is ready for use on the production floor.
   b. Manufacturing
      1) Value added: total number of worker days capable of fulfilling production activity well
      2) Non value added: the total number of worker days has a work accident so unable to fulfill the production activity
   c. Distribution
      1) Value added: total number of worker days capable of fulfilling product delivery activity well
      2) Non value added: total number of worker's day have job accidents so unable to fulfill product delivery activity

Worker health and safety can be calculated by counting the number of days of attendance of the number of workers during a certain period due to ill worker or accident.

3. Case Study

In this research, SSC-VSM method applied to two bottled drinking water companies located in Indonesia. The companies have differences in that the second company has a larger production capacity compared to the first company that is 30,000 units per month. While the company's first production capacity is 6000 units per month. In addition to the difference from production capacity, the two companies have the distinction of existing product advantages. The company first focused on producing gallon water with TDS <6 quality level while at second company focus on fulfill the quality standard specified by ISO. TDS is the amount of water content in water such as Al, Fe, Ca, etc. All aspects and indicators will be collected and processed into value-added information. The results of all indicators will be used as a basis for drawing SSC-VSM maps. The results of the SSC-VSM map will be analyzed in three aspects (economic, environmental, and social)

3.1 Case Study 1

The first case study was the application of SSC-VSM to a manufacturing company that produces gallon-packed drinking water (AMDK) gallons. The company is a new and growing company. The company is able to produce 6,000 units per month. The water offered has an advantage at TDS level <6 and has more oxygen content. The product is generally used by consumers such as for drinking, cooking, washing fruits and vegetables, etc. Product in this company has 3 stages: pre manufacturing, manufacturing, distribution, Activities in pre-manufacturing process are the process of purchasing all materials on suppliers, raw material inspection, and storage of raw materials at the warehouse. Activity at the manufacturing stage is filtration 1 (filtering using sand filters 1 and 2), back wash process, filtration 2, micro filter (bacterial filtering), UV irradiation and ozonization, gallon sterilization, filling, and storage of finished products in the warehouse. The process of gallon sterilization and filling on PT X is done manually. Activities at the distribution stage are distributing finished products to retailers and consumers as well as the process of storing finished products to retailers. PT X does the distribution process by using two pickup vehicles. The related data on each indicator and aspect required were collected by observation, secondary data, and interviews to related parties at every stage. The results of the data collection used to draw SSC-VSM. SSC-VSM for PT X can be seen in Figure 1.

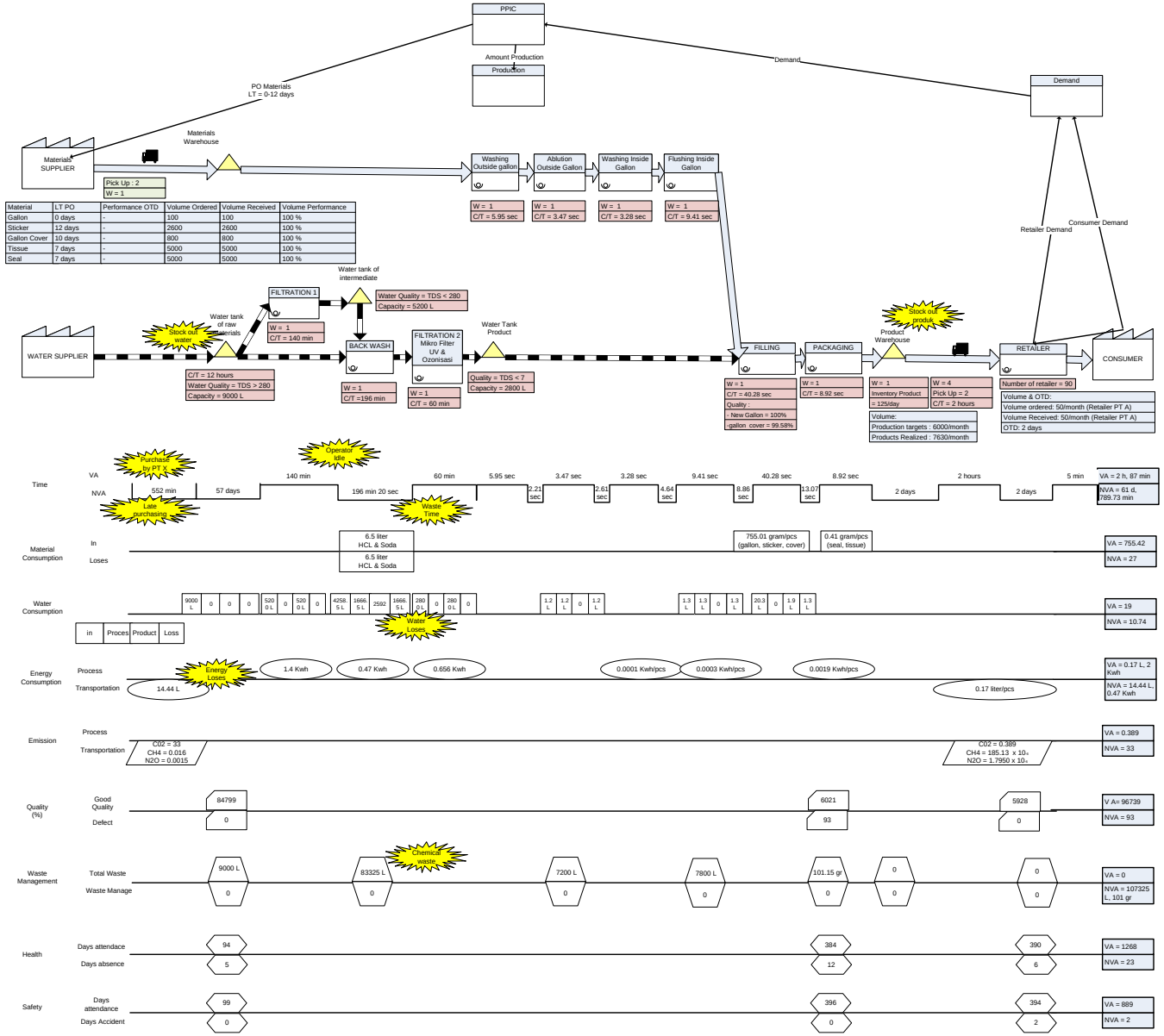

Figure 1 SSC-VSM PT X

The following is a result of the value added and non value added indicators on the SSC-VSM PT X map:

Table 2. Comparison Value Added and Non Value Added for PT X

Aspects	Indicators	Pre Manufactur		Manufactur		Distribution		TOTAL		units
		VA	NVA	VA	NVA	VA	NVA	VA	NVA	
Economic	Lead Time	-	57 d, 552 min	200.82 min	237.73 min	2 h 5 min	4 days	2 h, 87 min	61 d, 789.73 min	
	Quality	84790	0	6021	93	5928	0	96739	93	Pieces
Environment	Material Consumption	-	-	755.42	27	-	-	755.42	27	Gr
	Water consumption	-	-	19	10.74	-	-	19	10.74	L
Environment	Energy consumption	0 0	14.44 -	- 2.056	- 0.47	0.17 -	0 0	0.17 2.056	14.44 0.47	L Kwh
	Emission	0	33	-	-	0.389	-	0.389	33	Kg/CO_2
	Waste Management	0	9000 0	0 4518	98325 91.5	0	0	0 4518	107325 91.5	L Kg
Social	Health	94	5	384	12	390	6	1268	23	days
	Safety	99	0	396	0	394	2	889	2	days

Based on Figure 1 we can see the sustainability performance PT X:

a. Time Analysis: in pre manufacturing time is widely used for material purchasing process and for material storage. At the manufacturing stage the comparison between VA and NVA times is dominated by NVA time. This is caused by the process of washing machine done in a long time of about 3 hours. This process belongs to NNVA activity because this activity does not provide added value but needs to be done to ensure the water produced meets the TDS level <6. The low TDS is believed by consumers to be able to provide more health benefits. So this is superior to the product of PT X, but the TDS allowed by the environment ministry regarding the TDS level in drinking water is 500 mg. At distribution stage, time is widely used for storage of products on retailers
b. Quality Analysis: The quality of material and water produced in each stage is good when viewed from the number of defects identified. However, laboratory tests are still needed to ensure water quality meets the required drinking water standards.
c. Volume and On Time Delivery: at the pre manufacturing stage, material purchasing process is done by PT X company, this is caused by the amount of purchase does not meet the minimum order of supplier. So at the pre manufacturing stage there is no OTD and the quantity ordered can be fulfilled well by the supplier. While at the manufacturing stage the production targets can be met well every month. In the distribution stage the number of orders by distributors and consumers can be fulfilled well by the manufacturer.
d. Material Analysis: material consumption at PT X is only needed at the manufacturing stage. The materials consumption in this product are chemicals for machine washing process and package on product packaging.
e. Water Analysis: water consumption at PT X is only needed at the manufacturing stage. The largest water consumption is the washing machine activity described previously.
f. Energy and Emission Analysis: The biggest energy consumption is the process of purchasing raw materials using PT X vehicles. This causes a waste of energy and produces a large emission.
g. Waste Management Analysis: In PT X there is no waste management for liquid waste, the managed waste is a waste of gallon packaging, that is with the reuse of gallons to be refilled. However, gallons that can not be reused are not managed. Plastic waste from gallons that can not be reused directly throw away in landfill without recycle.
h. Social Analysis: Overall health and safety of workers is good because rarely worker absenteeism and workplace accidents.

3.2 Case Study 2

The second case study is the application of SSC-VSM to a manufacturing company producing AMDK gallons with a production capacity of 30,000 units per month. PT Y focus on fulfill the quality standard specified by ISO. The PT Y's product has three stages are pre manufacturing, manufacturing, and distribution. In general, activity at every stage of product PT Y is similar to activity of PT X. Product activity at pre manufacturing stage are the process of purchasing raw materials (water) on suppliers, the process of inspection of material coming, and material

storage process at warehouse. Activities at the manufacturing stage are filtration (filtration of water with sand filters 1 and 2), filtration with activated carbon (filtering water for odor removal), micro filter 10, 5, and 0.3 micro (for bacteria removal), UV and ozonization, gallon sterilization process, filling, and storage of finished products in the warehouse. The process of gallon sterilization and filling is done automatically using machine. Activities at the stage of distribution is similar to the activities undertaken at PT X. PT Y performs the distribution process using two truck vehicles and 4 pieces of pick ups. From the results of data collection and calculation, it used for draw the SSC-VSM map. SSC-VSM for PT Y can be seen in Figure 2. The following is a result of the value added and non value added indicators on SSC-VSM PT Y:

Table 3. Comparison Value Added and Non Value Added for PT Y

Aspects	Indicators	Pre Manufactur		Manufactur		Distribution		TOTAL		units
		VA	NVA	VA	NVA	VA	NVA	VA	NVA	
Economic	Lead Time	-	183 d, 6 h	3663.35 sec	737.94 sec	20 min	2 days	20 min 3663 sec	185 d, 6 h, 738 sec	-
	Quality	2429360	0	403731	8100	402446	1401	3235537	9501	unit
Environment	Material Consumption	-	-	755.42	0	-	-	755.42	0	Gr
	Water consumption	-	-	19	1.28	-	-	19	1.28	L
	Energy consumption	0 -	29.63 -	- 0.0337	- 0.0036	0.38 -	- -	0.38 0.0337	29.63 0.0036	L Kwh
	Emission	0	79.04	-	-	0.015	-	0.015	79.14	Kg/CO_2
	Waste Management	0	8040	0 299873	33480 0	0 0	2218.25 0.585	0 299873	43738.25 0.585	L Gr
Social	Health	2670	12	5052	14	5066	0	12788	26	days
	Safety	2682	0	5066	0	5055	1	12803	1	days

Based on figure 2 we can see the performance at PT Y:

a. Time analysis: Less effective time is the time of purchase of raw materials (water) with vehicle PT Y and long time store on material. Long shelf life leads to high costs and possible material damage due to high storage. The time on the production process has been good because the time for product delay is low. At manufacturing stage, time is dominated by VA activity (83%) but still needs to minimize the transportation time between processes. At distribution stage, time is widely used for storage of products on retailers.
b. Material Analysis: Material consumption at PT Y is only needed at the manufacturing stage. The materials consumption in this product is water packaging, this is caused by the main raw material of product is water.
c. Volume and On Time Delivery: at the pre manufacturing stage, the material is delivered by the supplier, but for raw water the company PT Y makes a purchase with the truck it has. It aims to reduce the delay of water arrivals on daily. So at the pre manufacturing stage, OTD on each material is 14 days and the volume ordered can be fulfilled well by the supplier. While at the manufacturing stage the production targets can be met well every month. In the distribution stage the number of orders can be fulfilled by the company.
d. Water Analysis: Water consumption at PT Y is in the manufacturing process. In the manufacturing process water use is quite good. But there are still some activities that cause the water loses too high. These activities are loses at the reservoir and the dumping process.
e. Energy Analysis: wasted energy and less value-added is the process of purchasing water using PT Y vehicles, this leads to additional costs of labor costs, truck maintenance costs, and fuel costs.
f. Emission Analysis: The resulting emissions are caused by the use of fuel in the process of purchasing raw water as well as the process of transporting the product delivery.
g. Waste analysis: PT Y has waste management for gallon packaging, empty gallon will be reused and gallons that can not be reused are managed by sending the gallon to the supplier for recycling. So that plastic waste from gallons is not thrown away directly on the landfill. On the other hand there is no waste management for for waste water.
h. Social analysis: Overall health and safety of workers is good because rarely worker absenteeism and workplace accidents.

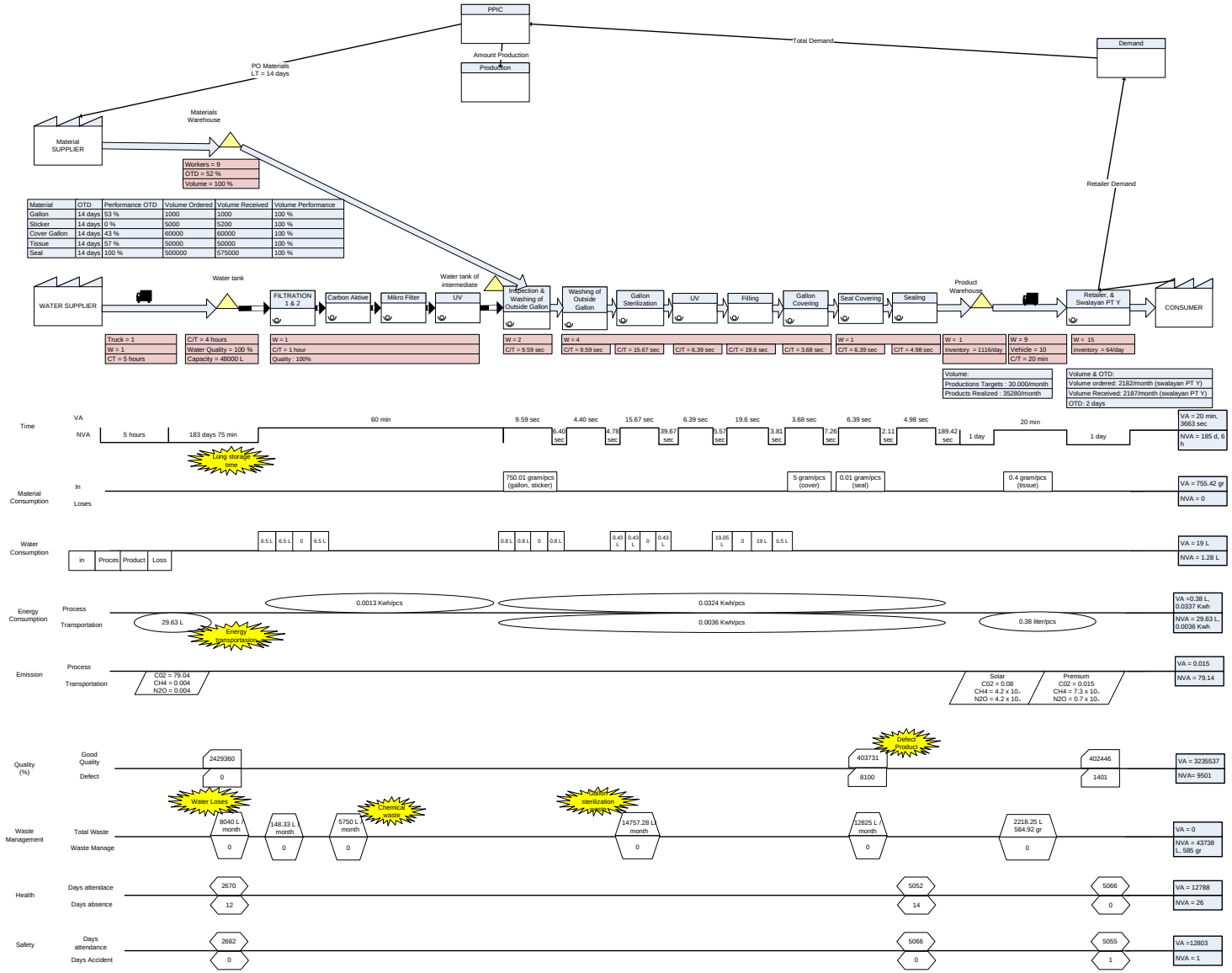

Figure 2 SSC-VSM PT Y

4. Discussion

According to the results of the application of SSC-VSM in both companies, it is found that PT Y tends to have better sustainability performance than PT X. Comparison of the performance of the two companies as follows:

A. Economic

PT X and PT Y have poor performance that is for PT X at manufacturing stage and PT Y at pre manufacturing stage. PT X has poor performance at the manufacturing stage due to the back wash filter process caused by the back wash filter activity done 2 times in one day. The back wash filter activity is classified as NVA because it aims to maintain low water TDS (<6), while the TDS standard allowed by the health ministry is less than 500 mg. Therefore, since drinking water standards do not require low TDS (<6) then back wash filter activity is classified as NVA. Likewise PT Y does not do back wash filter process every day because PT Y follow the standard set by the health ministry that is below 500 mg. Overall, both companies are able to produce products that fit to the quality specifications at each company and able to meet the consumers needs

B. Environments

In environmental aspect it can be seen in manufacturing stage that material, water, and energy consumption of PT Y is better than PT X. This is caused by PT X has back wash filter process, so there is material consumption for back wash filter process (HCL chemicals and caustic soda), In the indicator of energy consumption and emissions generated during pre manufacturing and distribution stage. The performance in the pre-manufacturing stage is low due to the fact that there is still a material purchase process under the minimum amount of purchases on suppliers so that the company needs to make manual purchases to suppliers. The last indicator is waste management. It is known that both companies for pre manufacturing stage until distribution process, do not apply waste management process. So that the waste generated will be immediately disposed of in the final landfill. But for gallon packaging has been well managed by both companies, especially by PT Y. This is because the gallon that has been used will be returned to the company for reuse to be refilled into new products. The difference between the two companies is that PT Y manages the defective gallon waste by resending it to the supplier for the recycling process in the gallon, whereas PT X does not recycle the unused gallon packaging.

C. Social

On the social aspect, it is found that both companies have good performance. However, workload of workers in the company especially in the manufacturing stage can be identified that the workload of workers in PT X greater than PT Y, this is seen from the method in the production floor. PT Y produces the product using machine while PT X manually produces. In addition the number of workers in PT X 14 people and PT Y more than 50 people. This further indicates that the workload of PT X is bigger than PT Y. Similarly in the pre manufacturing stage it can be seen that in PT X the workload is increased due to the requirement of purchasing all material manually to the supplier. Whereas in PT Y manual purchases made on water purchases, this is due to the need for high enough water and difficult to meet if only rely on delivery by the water supplier.

5. Conclusion and Future Work

It can be concluded that SSC-VSM can be used as a sustainability tool. SSC-VSM is able to identify economic, environmental, and social wastage throughout the product supply chain. Based on the results of SSC-VSM implementation, it is found that there are differences in sustainability performance between the two companies. This indicates that firm size has an effect on sustainability performance. Factors that cause performance differences are different quality specifications, production capacity and type of process used. PT X focuses on low TDS (<6) and the manual production process leads to the need for back wash filter process twice daily. The existence of this activity leads to the consumption of time, water, and energy that is high enough at the manufacturing stage. In contrast to PT Y back wash process carried out for 3 months so that the consumption of time, water, and energy for each unit produced is quite low. PT X is classified as a small company because it has 14 workers and has a production capacity of 6000 units per month. This causes the number of orders on suppliers are not able to meet the minimum order so that the company purchase material using the company vehicle. This causes the energy consumption and there are emissions generated. Similarly with PT X, PT Y does purchase by own vehicle to purchase water at mountain springs. But for other material sent by supplier because it meets the minimum order. This is considering that the production capacity of PT Y is quite high at 30,000 units per month and PT Y is included in medium companies because the workers above 50 people. In the overall distribution stage both companies have the same performance. The future work can develop several indicators that can generalize a variety of products in sustainability measurement.

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