THE IMPROVEMENT OF SUGAR DISTRIBUTION SYSTEM USING VALUE STREAM MAPPING (VSM) APPROACH A CASE STUDY: INDUSTRI GULA NUSANTARA, KENDAL, JAWA TENGAH

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ABSTRACT

This study was aimed to find kind of improvements of sugar distribution system using value stream mapping (VSM) when some inefficiencies in physical and service activities were encountered that will cause wasting time. The VSM was directed to reduce non value added time as the performace parameter. VSM was used to analyze thus inefficiencies because using VSM can simply mapping to trace whole activities both of material and service flow from beginning to the end of process. A case study of Industri Gula Nusantara showed that in its service operations, there were an inefficiency in the process of issueing the loading order. Move thus activity a day earlier, the improvement sounds a shorter service time over order and delivery schedule which in further make a better operation and service over the whole process of sugar distribution. At same time a policy of safety stock or inventory leveling could minimize stock out occasion by the increasing of service level from 25% to 38% that was close to standard deviation of demand during lead time.

Keywords: Sugar, VSM, inventory

INTRODUCTION

Sugar distribution in Indonesia involves various parties, started from sugar cane farmers, sugar factory, distributors, retailers, consumers and governments. Availability of sugar in market is the responsibility of distributor to serve various regions, hence it requires high service level in distribution process. On the other hand, distributors must also consider the production rate of sugar factory and demand fluctuations and volume in order to provide a quick response. Distributors also have to press down cost on sugar warehousing (Lee, 2006).

Because of the involvement of various parties, it might be increasing the occasion of inefficiencies in the distribution process. This inefficiency will reduce profit and service response. Therefore, it is important to minimize such wasting time were encountered in either physical and administration process, where in this study it was approached by applying value stream mapping or known as VSM.

VSM is a tool that can visualize the process orienting to lean manufacture (Lee and Snyder, 2007). This tool is very helpful to give an explanation to streamline work processes. VSM widely reflect the views of a process from external suppliers to external customers. The reason of using VSM because it can help to observe whole streamline processes that simply to analyze and trace the inefficiency process that occurred from the beginning to the end of process. Silva (2012) stated the benefits of using VSM are : helps to see linked chain of processes and to envision future lean value stream, provides a common language and understand so that everyone has the same vision, integrates material and information flow.

VSM has a lot of help in reducing inefficiencies in production processes, organizations, services, and logistics. McManus and Millard (2002) have tried to use VSM to accelerate product development. Vinodh et al (2010), have been combining VSM with various lean manufacturing tools like 5s, kanban, kaizen (Gurumurthy and Kodali, 2011), and total productive maintenance to reduce processing time that impact to production costs and product prices in a camshaft industry in India. Vanany (2005) conducted a study on the use of value stream mapping to reduce unnecessary processes, defects, and determine inventory level on each department.

At the service process, VSM has been used by Endsley et al (2006) to analyze the queuing process that occur in patient care in hospitals and the similar research was done by Lummus *et al.* (2006) on medical clinical services with

smaller size. In terms of improvement of the organizational structure, VSM can be used to measure leadership, behavior, and competencies (Emiliani and Stec, 2006).

VSM had helped in improving service levels in logistics service performance. The use of VSM can identify inefficient logistics processes that has complex supply chain Serano et al (2008). Another study conducted by Lehtinen and Torkko (2005) had succeeded in improving the performance of the food service industry towards lean production and lean supply by integrating suppliers and customers in terms of inventory, transportation, facilities, and information. The use of value stream mapping can be combined with other tools such as simulations, 5S and Kaizen which performed by Gurumurthy and Kodali (2011) that applied VSM to simulate and analyze inefficiency on jobshop production system in a furniture manufacture with some variation of the product where there was one dominant product.

This research is aimed to find kind of improvements of sugar distribution system using value stream mapping (VSM) when some inefficiencies occured for the case of sugar distribution process of a sugar company Industri Gula Nusantara, Kendal, Central Java Province, Indonesia. Value sounds in VSM analysis of its company distribution process is drawn by mapping each stage of the process leading to added value. Therefore, value is an activity or transformation of raw materials or information to meet consumers needs (Gasperz, 2007).

METHODS

Stages of values analysis of sugar distribution is adopted from Lee (2006) which had explored the VSM analysis into system observation, model mapping, determination of value added or non value added, identification of waste, and performing restoration effort. Efficiency can be measured by the ratio of value added time and non value added time. Output of VSM is used to make decision in inventory control policy to overcome the possible stockout.

System Observation

Distribution process began when a distributor put an order to the sugar factory and made payments. Five days after full payment, sugar factory would issue a delivery order (DO) letter. It indicated that distributor already had the sugar stored in the warehouse and ready for distribution. In this case, buyers are regionally served by distributor are Jakarta, Yogyakarta, Semarang, Kendal, Bandung, Surabaya, Salatiga, Ambarawa, Solo, Klaten, Purwokerto, Wonosobo, Cirebon, and Magelang.
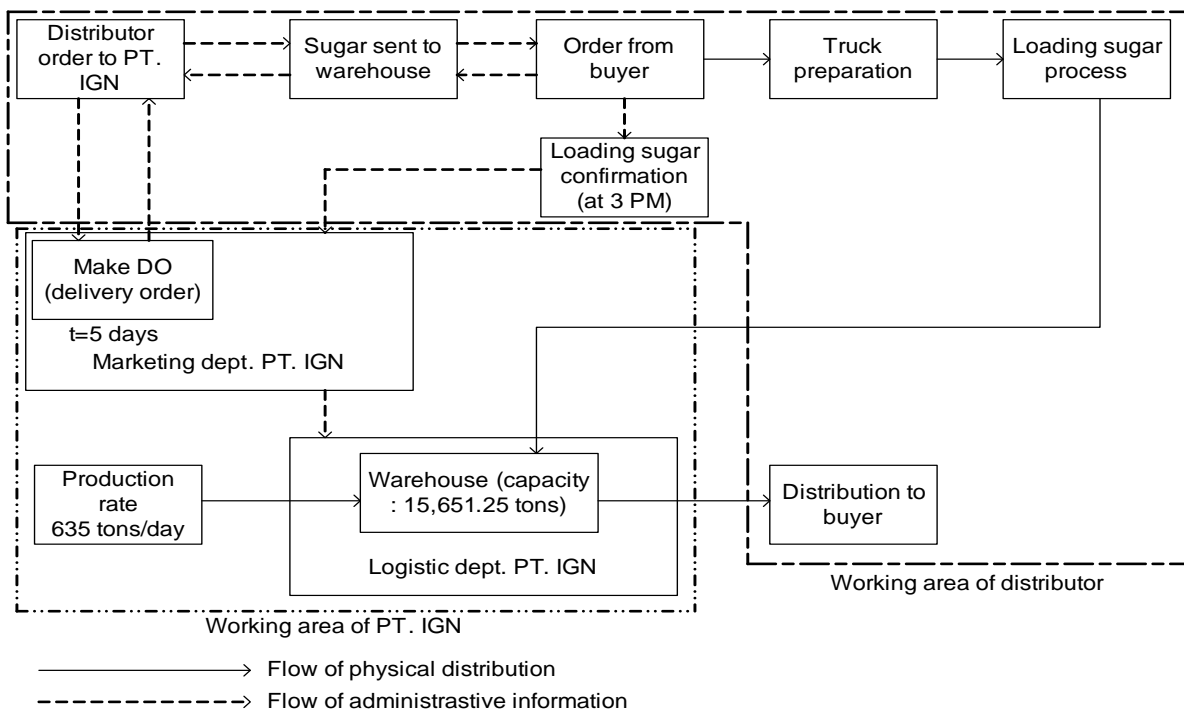

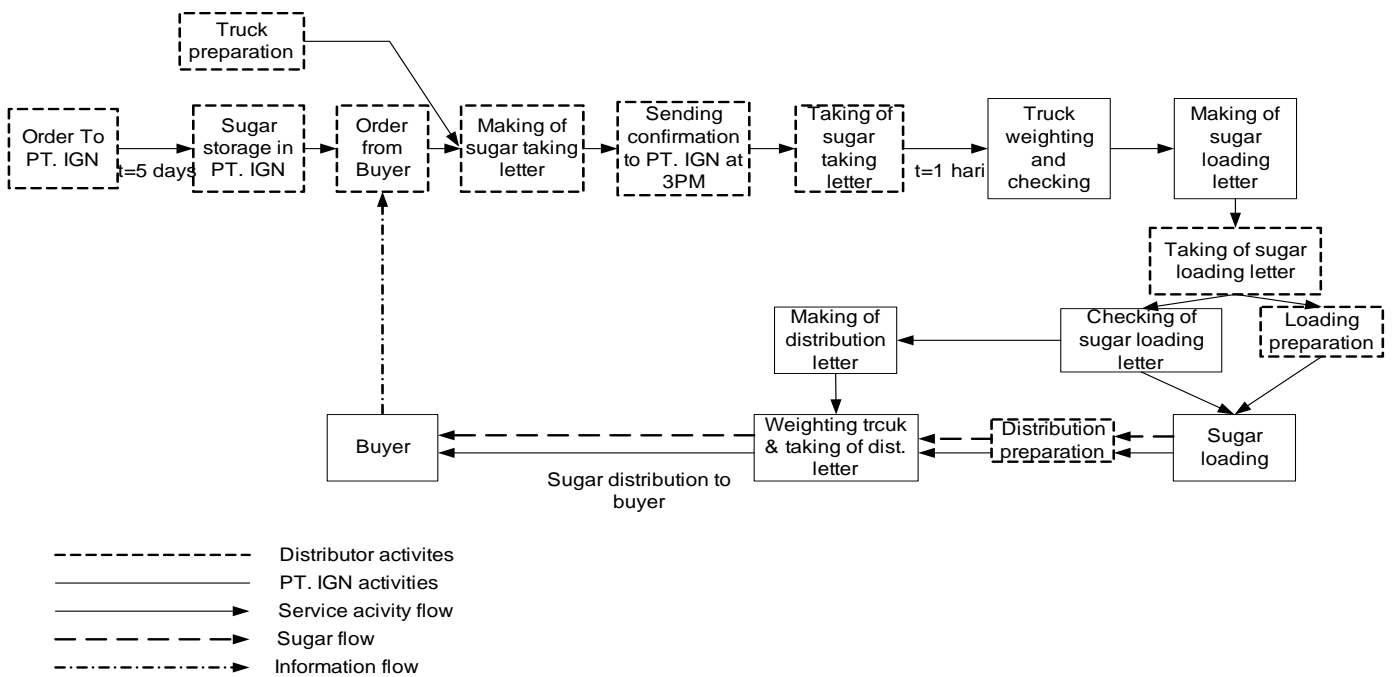
Figure 1. Sugar distribution process

Figure 2. Service activities flow

Delivery was made when a full payment was settled. Amount of buyers who will be served daily were confirmed by marketing department. A confirmation was carried out everyday at 15.00 pm. The following day, trucks would go to sugar warehouse or known as distribution center and showing "sugar withdrawal letter" for a loading. The complete processes are described in Figure 1 and Figure 2, where Table 1 shows cycle time of each processes.

Determination of Value Added and Non Value Added

Determination of value added and non value added was done by type of processes. Gazpers (2007) stated that there were three categories of activities, important and value-added activities, important activities but not value-added, and waste. Operation is value-added activity, inspection is important activity but not value-added, and waste for example product defect. Lee (2006) stated that all operation were value-added activities. Inspection, transportation, inventory, delay were not value-added activities. However, under particular conditions it could be different such as transportation could be a value-added activity when consumers were willing to pay for fast delivery.

Followed by a calculation of the percentage of value added time (% VAT) or known as process cycle efficiency (PCE) is a comparison between the value added time to the process lead time (lead time, value added time, and non-value added time).

Table 1. Cycle time of each processes

No	Activity	CT (minutes)
1	Cheking of sugar taking letter	3.82
2	Weighting truck in	2.73
	Checking truck	1.62
3	Making of loading order letter (SPM)	30.00
4	Taking of SPM	0.91
5	Loading preparation	7.02
	Checking SPM	1.19
6	Loading of sugar	37.78
	Making of distribution letter	10.00
7	Distribution preparation	11.54
8	Weighting truck in	2.81
	Checking of distribution letter	1.37

Identification of Waste

Identification of waste based on the seven types of waste which is known as seven waste that had been formulated by Singo (1989) namely overproduction, unnecessary motion, excessive transportation, inappropriate processing, waiting / delay, defects, unnecessary inventory and they were not analyzed all (Vanany, 2005). It was depended on the condition of the company. In this study, the analysis of waste was based on two tools e.g. process activity mapping (PAM) and

supply chain response matrix (SCRM). PAM gave a physical description and information flow, cycle of each processes, and distance among processes. It was used to show the process efficiency for the whole chain. While SCRM was used for an observation whether there was an increasing or decreasing process in lead time and level of inventory on each activity within the process. This methods was used by New (1993) and by Forza *et al.* (1993) in a textile supply chain setting. In a more wide-ranging work, Beesley (1994) applied it in a range of industrial sectors including automotive, aerospace and construction. A similar, this approach was adopted also by Jessop and Jones (1995) in the electronics, food, clothing and automotive industries.

Performing Restoration Effort

First, from PAM application, we knew the attribute of each processes such as process type, cycle time, worker, and distance. It gave a base for analyzing inefficient, inappropriate, and unnecessary process. The result also could be used to calculate process cycle efficiency.

Second, by using SCRM, it could be identified the inventory level of sugar stock against the demand level. It explained how responsive of the inventory usage. To determine the inventory level, it was started by measuring the capability of white sugar supply, and how much safety stock must be employed to anticipate demand fluctuations. According to Stratton and Warburton (2003), anticipation of fluctuations in demand was necessary to expedite the distribution process leading to a lean distribution.

There were several types of inventory control models as stated by Herjanto (1999). In this study, we used the Economic Order Quantity (EOQ) to determine optimal stock in accordance to preliminary analysis over the demand behavior. The formula was adopted from Muckstadt and Sapra (2010) as follows:

$$Q = \sqrt{\frac{2K\lambda}{IC}} \quad \text{..(1)}$$

Q   : Quantity order
K   : Ordering cost
λ : Demand in year
I   : Holding cost
C   : Purchase cost

A safety stock was determined to anticipate demand during lead time and determined by following formula:

$$SS = k \, x\sigma L \quad \text{..(2)}$$

SS : Safety stock
k   : safety factor
σL : Standard deviation of demand rate in lead time

Silver and Peterson (1985) revealed that the safety factor was determined by various policies. However, in this study used two policies were employed. First, it was a policy which prior in percentage demand that can be served (P2) for region which had general distribution demand pattern. Second, it which prior in probability of no stockout (P1) for region which had exponential distribution demand pattern.

Formula for calculating safety factor of P_2 is as follows:

$$Gu(k) = \frac{Q}{\sigma L} x(1 - P2) \quad \text{..(3)}$$

P2   : Expected service
Q   : Demand
σL   : Standart deviation of demand rate in lead time
Gu(k) : Probability of safety factor

Formula for calculating safety factor of P1 as follows:

$$Pu \geq (k) = 1 - P1 \quad \text{...(4)}$$

P_1 : Probability of no stock out
$Pu\geq$(k) : Probability of safety factor

RESULT AND DISCUSSION

Based on the above depiction of the sugar distribution process, it could be revealed that inbound logistics activity of the company is how to determine the ordering quantity of white sugar from sugar factory. The order system itself required distributors to make order as minimum as 1000 tons for a single order with indefinite span of time. This policy resulted an inventory rate of 461.54 tons per day.

Outbound logistics activity of the company was the scheduling of white sugar delivery to buyers. Amount of sugar loaded per day on average is 367.87 tons per day with a standard deviation of 147.15 tons, or near 40% of demand. This deviation proved that the sugar demand behave radically.

VSM was used for this case as constructed by two types of mapping e.g. operations and service process as shown at Figure 3 and Figure 4, respectively. Activities were classfied into value added and non value added categories. Operation, inspection, and transportation were kinds of activity that were categorized as the value added activities. Operation activity transformed order to delivery of sugar physically. Inspection expedited a good checking in truck loading permitting, loading letter, and delivery order letter issueing. Transportation created different value utility of place. Activities that were included to the non-value added activities were storage and delay. Storaging avoided the possibility of stock out. Delaying was aimed for security admission.
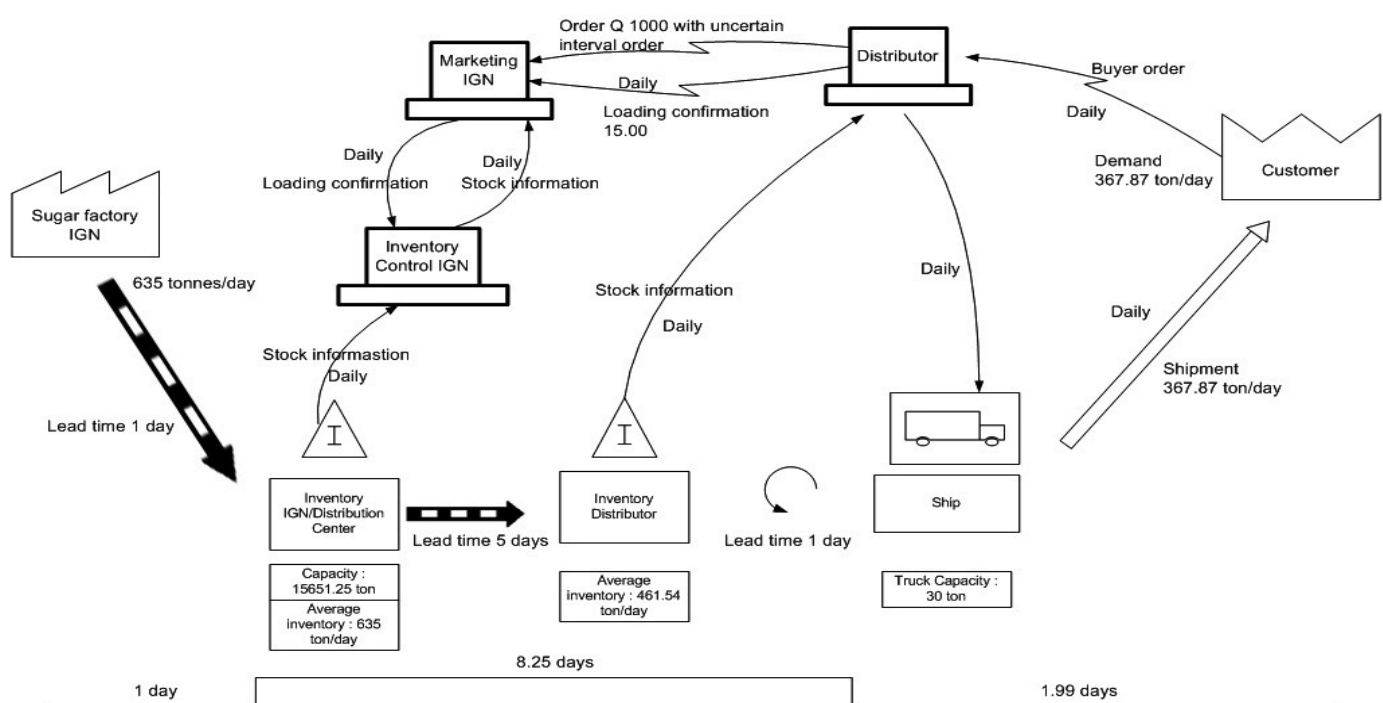
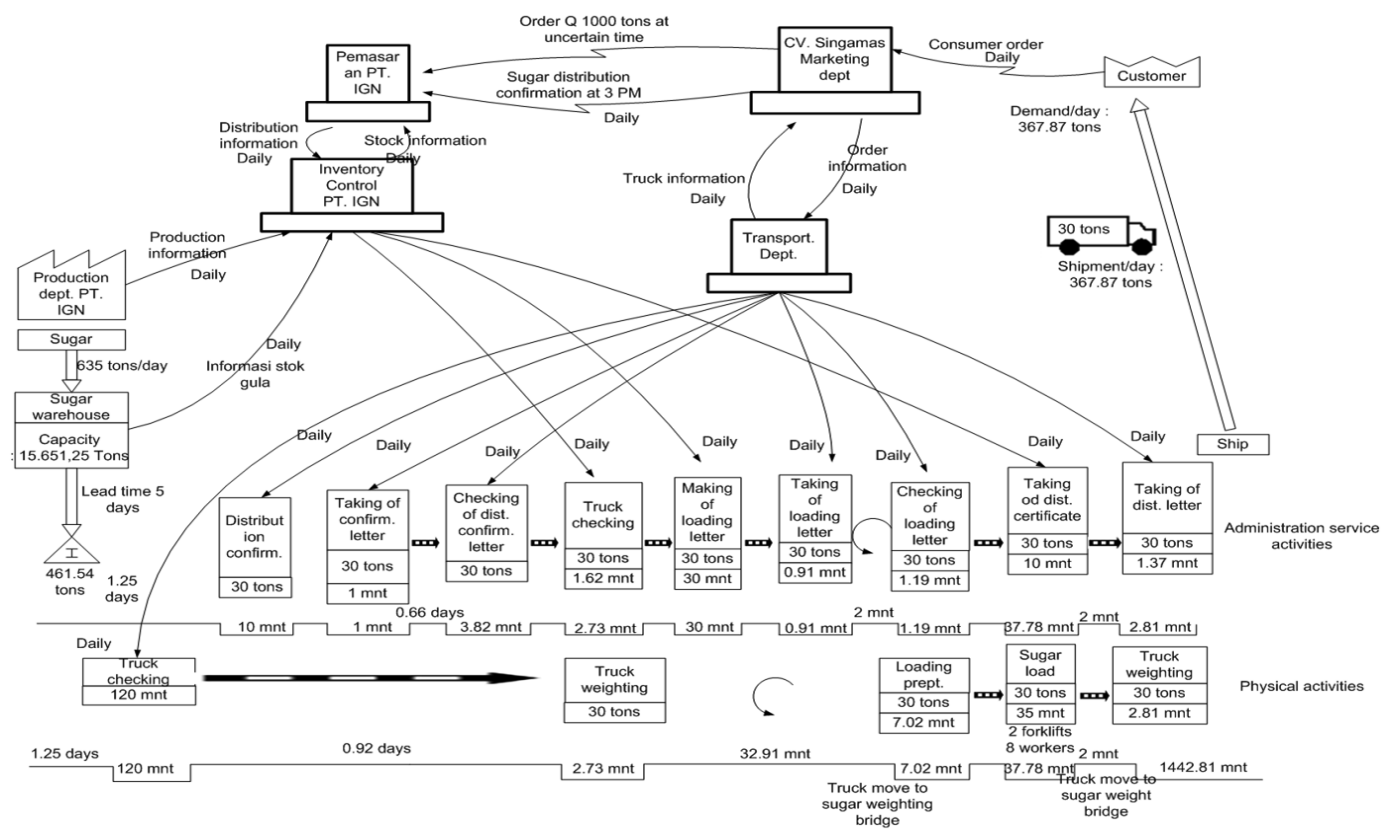Figure 3. Value stream mapping of sugar distribution

Figure 4. Value stream mapping of services flow

Based on PAM, the VSM of the process could be developed to show the process cycle efficiency, and by the same time we could notify kind of inefficient processes or activities. Cycle time of each activity was measured in comply with the value-added time (VAT) and non value added time (NVAT). Here, the mapping was applied for two types of service processes, administrative and physical service process as in detail shown in Figure 5, and Figure 6, respectively. It was found that both of administrative and physical service process have 4780.61 minutes in total. Also it could be identified that activity with the greatest value value added time is the transportation or approximately 30.31% of total process time.

No	Activity	Flow	Machine	Distance	Time (mnt)	Worker	○	⇨	□	△	D	Note
1	Inventory	S			2270.00					●		
2	Sugar carrying confirmation and make its letter of carrying permission	O	Computer and fax		10.00	1	●					
Taking of Letter of sugar carrying permission												
3	Checking of truck and driver	I	Manual		1.62	1			●			
4	Taking confirmation letter	O	Manual		1.37	1	●					
5	Waiting to carry sugar	D			957.01	1					●	
6	Checking of letter of carrying sugar permition	O			3.82	1	●					
7	Weighting truck in	I	Weighting scale		1.62	1			●			
8	Waiting to load sugar to truck	D			1.11	1					●	
9	Making of SPM	O	Computer		30.00	1	●					
10	Taking SPM	O	Manual		0.91	1	●					
11	Truck movement to warehouse	D		200 m	2.00	1					●	
Checking SPM in warehoure												
12	Checking SPM by warehouse laborer	I	Manual		1.19	1			●			
13	Waiting to load sugar to truck	D			5.83	1					●	
Making of letter of sugar distribution permission												
14	Making of letter of sugar distribution permission	O	Computer		10.00	1	●					
15	Waiting of loading process	D			27.78	1					●	
16	Waiting dist. Preparation	D			11.54	1					●	
17	Movement to weighting scale bridge	D		200 m	2.00	1					●	
18	Taking of letter of sugar distribution permission	O	Manual		1.37	1	●					
19	Weighting truck out	I	Weighting scale		1.44	1			●			
20	Distribution process to buyer	T			1440.00	2		●				
Total time					4780.61							
Value added time (VAT)					1501.39							
% VAT					31.41%							

Figure 5. Process activity mapping of administrative service

No	Activity	Flow	Machine	Distance	Time (mnt)	Worker	Type of Activity ○	⇨	□	△	D	Note
1	Inventory	S			1800.00					●		
2	Checking of truck equipment and administration	I	Manual		120.00	3			●			
3	Waiting to sugar carrying sugar process	D			1323.82	1				●		
4	Weighting of truck in	I	Weighting scale		2.73	1			●			
5	Waiting to load sugar to truck	D			30.91	1				●		
6	Truck movement to warehouse	D		200 m	2.00	1				●		
7	Loading preparation	O			7.02	2	●					
8	Loading sugar into truck	O	Forklift and manual		37.78	10	●					
9	Distribution preparation	O			11.54	1	●					
10	Movement to weighting scale bridge	D		200 m	2.00	1				●		
11	Weighting of truck out	I	Weighting scale		2.81	1			●			
12	Distribution process to buyer	T			1440.00	2		●				
	Total time				4780.61							
	Value added time (VAT)				1621.88							
	% VAT				33.92%							

Figure 6. Process activity mapping of physical service

There was an inefficient process which was relied on administrative activity in the processing of a loading order letter (SPM) that took 30 minutes. This letter was issued after receiving a confirmation from the buyers a day before. When the trucks arrive, it must waited about half an hour to get a permit to load sugar as legalized by the loading order letter. However, this finding had become a suggestion to the company to do an improvement, and it was confirmed that it can be implemented. By redesign the administrative activity of issuing SPM to be done after receiving a confirmation a day before, it would safe half an hour in loading process, or reducing waiting time.

Further, to know level of inventory of white sugar and how responsive of inventory rate we used supply chain response matrix (SCRM). In SCRM we calculate day physical stock that compared inventory rate to demand rate. From the calculation of existing days physical stock = 461.53/367.87 = 1.25 showed that there was 25% tolerance of inventory in facing demand fluctuations. However, with demand deviation 147.15 tons or 40% of average demand, hence there was high probability for stockout. Therefore we needed to calculate EOQ. To Calculate EOQ we needed data about ordering cost (K), annual demand (λ), holding cost (I), purchase order (C). Holding cost was 0,08% of purchase order per year and purchase order was 7,000,000 per ton. Ordering cost (K) and annual demand (λ) for each regions can be seen in Figure 7 and Figure 8, respectively.
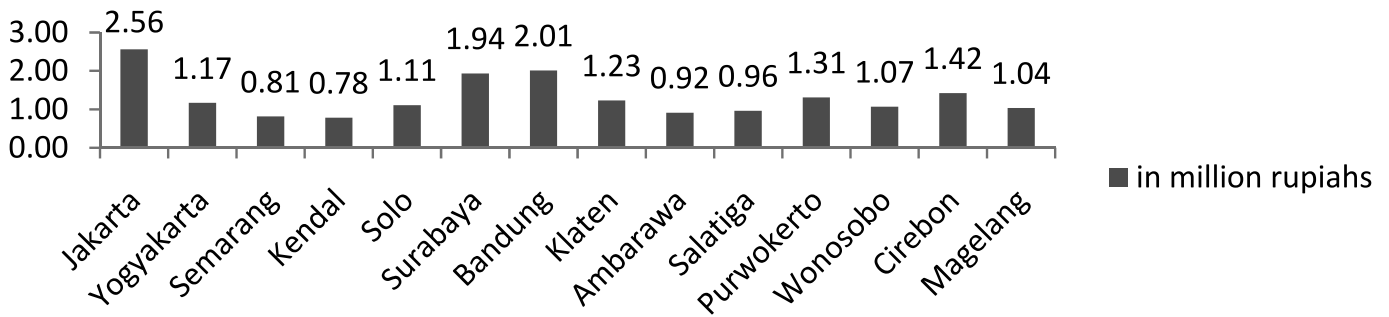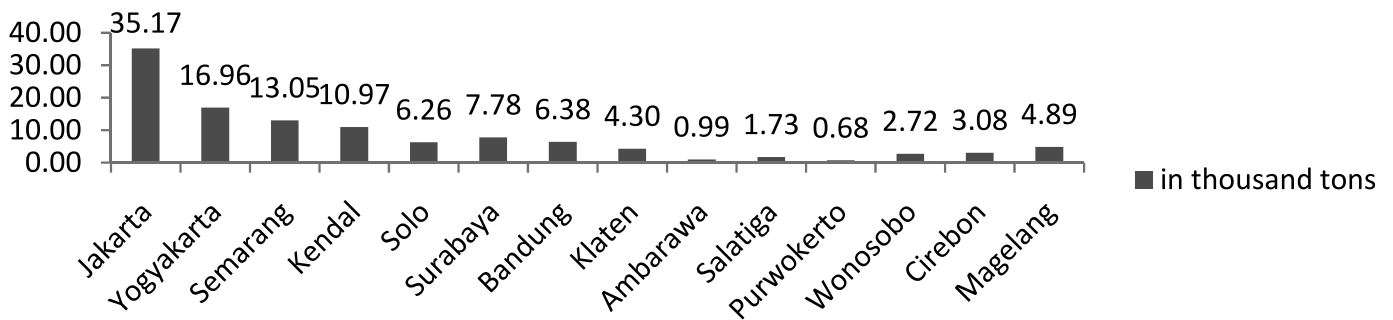
Figure 7. Ordering cost each regions (K)

Figure 8. Annual demand each regions (λ)

For instance the EOQ for the Jakarta buyer is:

$$Q = \sqrt{\frac{2K\lambda}{IC}} = \sqrt{\frac{2x2,564,000x35,172.8}{0.08\%x7,000,000}} = 5,571.72$$

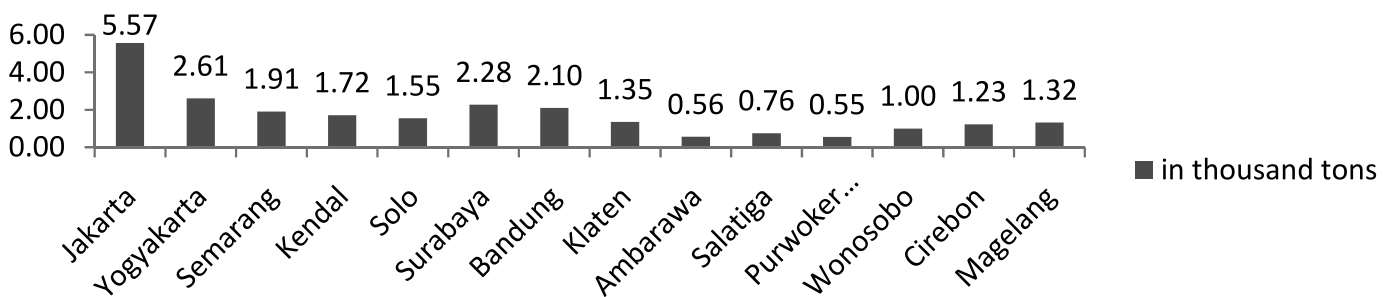(EOQ for other regions can be seen in Figure 9, respectively).

Figure 9. EOQ calculation result each regions

Safety stock was a company policy of consumer service. The amount of safety stock was determined by using different policies based on order distribution pattern. Buyer region might have different order distribution pattern. Those who had normal distribution for their order, safety factor was determined by service policy that focused on how much service could be served and expected (P2). Buyer with an order that exponentially distributed should be approached by a safety factor that had a probability of no shortage (P1). To determine order distribution pattern we used kolmogorov-smirnov test. We needed data about demand rate during lead time which can be seen in Figure 10 respectively and standard deviation of demand rate during lead time which can be seen in Figure 11 respectively.
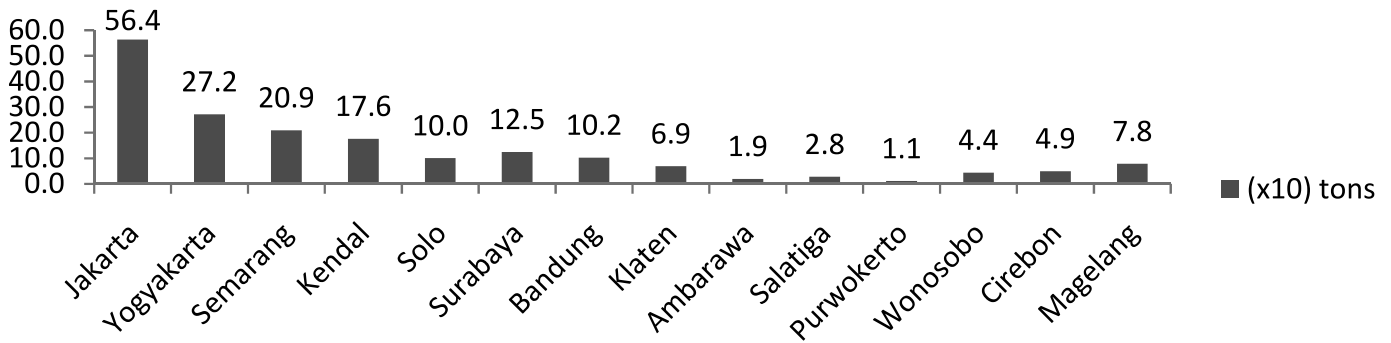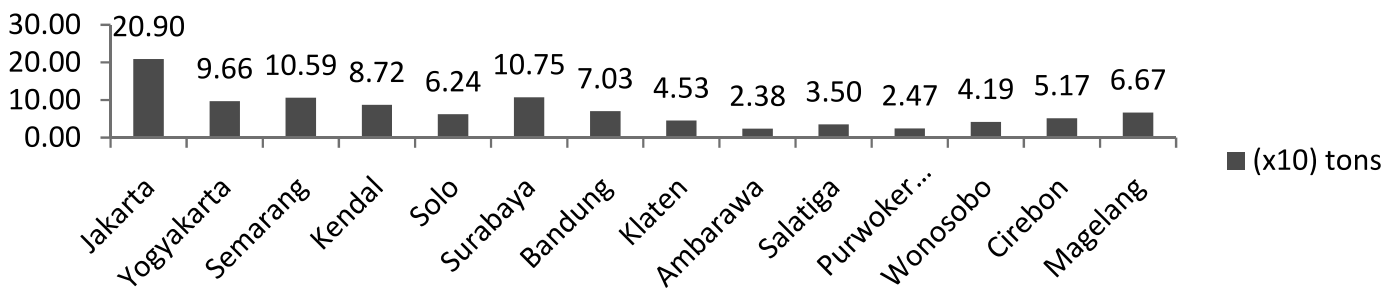
Figure 10. Demand rate during lead time

Figure 11. Standard deviation of demand rate during lead time

On this study, based on the Kolmogorov-Smirnov test regions who have general demand pattern are Jakarta, Yogyakarta, Semarang, Kendal, and Solo, and those who have exponential demand pattern are Surabaya, Klaten, Salatiga, Ambarawa, Wonosobo, Purwokerto, Bandung, Cirebon, and Magelang. By determining service level at 99%, safety stock of Jakarta for instance is:

$$Gu(k) = \frac{563.7}{209} x(1 - 0.99) = 0.027$$

then searched using some function of the unit normal distribution table (see Silver and Peterson, 1985), we got value of safety factor was 1.54 or safety stock 1.54 x 209 = 321.86 tons.

While, safety stock for the region with exponential distribution demand pattern, Surabaya for example is as follows:

$$Pu \geq (k) = 1.099 = 0.01$$

This obtained a safety factor 2.32 or equal to safety stock = 2.32 x 107.48 = 249.35 tons.

The complete calculation results of safety stock can be seen in Figure 12 respectively.
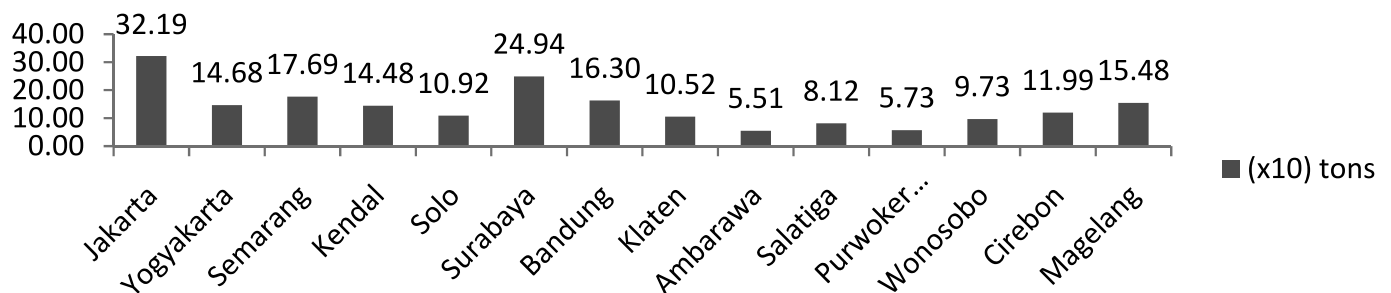

Figure 12. Safety stock calculation results

Yet, the average turn over inventory per day was 508.46 tons anticipating daily data on average 367.87 tons, or equivalent to:

This improvement (38%) represented the tolerance of inventory rate against demand rate, or it increased from 25% to 38% where it was close to demand standard deviation that was 40%.

CONCLUSION

The sugar distribution process was a operation and service process, both contained physical and administration activities. When this process was depicted by VSM it could be noticed that there were some inefficiency in term of its cycle time. A reducing or shortening cycle time was able to increase sevice performance or response and made a better inventory management which respect to the determination of safety stock as a policy for consumer order service. In this study it was found that administration activity of issuing the order loading letter had considerably taken waiting time. Therefore, this was strongly recommended to improve or reduce that waiting time by saving 30 minutes service time in order to increase service performance. At the same time, it could be notice that the current inventory policy unable to anticipate demand fluctuations due to standard deviation of demand. By applying EOQ could increase service level from 25% to 38% where close to demand fluctuation that was 40%. It was considerable more responsive to the erratic demand as proved by imposing two types of safety stock factor policy based on demand behavior whether they were normally or exponentially distributed.

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