Rich (1997) succeeded in formulating the seven value stream mapping tools to describe the seven wastes. The seven value stream mapping tools are Process Activity Mapping, Production Variety Funnel, Quality Filter Mapping, Demand Amplification Mapping, Decision Point Analysis, Supply Chain Response Matrix, Physical Structure Mapping.

Golf glove manufacturing industry has contributed significantly to the economy of Yogyakarta, amounting to 8.5 percent. Lately, the foreign tradeactivities of Kalasan Sleman citizens faces so many problems and fluctuation, as a result of the global financial crisis that began in mid- 2008. In addition, the decline in export value is also increasingly critical due to the customer's requirements associated with environmental issues, and due to strong competition from new competitors from such as Taiwan and Thailand (Reuters, 2009). According Triratnafuri (2009), Adi Satria Abadi limited company is one of the industries that produce export quality golf gloves under very strong competition conditions. Many similar industries are out of business because they cannot compete in terms of both quality and quantity. Therefore, Adi Satria Abadi limited company has to figure out how to survive in the competition and even outperform its competitors.

In order to meet its production targets and to fulfil customer's needs, the company needs to put more attention on the production transformation process from raw materials into finished products. Emphasis on the production transformation process can be conducted by reducing and even eliminating wastes that occurred during the production activities so that production runs more efficiently and smoothly. According to Gaspersz (2007), one of the concepts appropriate to reduce waste is the implementation of lean manufacturing. Lean Manufacturing is a systemic and systematic approach that is used to identify and eliminate wastes or activities that are not value-added (non-value-adding activities) through radical continuous improvement by arranging products (materials, work in process, outputs) and information to flow forwards based on the internal and external customers' needs (using pull production systems) to pursue the excellence and perfection of production transformation process. The existence of many kinds of wastes that occurred during the production process of Callaway Diablo golf glove at Adi Satria Abadi limited company, such as too many transportations, delays, inventories, and product defects, reinforces the importance of the application of Lean Manufacturing in the industry. Thus, reduction of wastes is expected to be able to improve the existing value stream of the Callaway Diablo golf glove production systems.

By understanding the existing value stream using Current State Value Stream Mapping, Adi Satria Abadi limited company can also determine the value of the process cycle efficiency (PCE) of Callaway Diablo golf gloves production systems and compare it with those of other companies to achieve a lean production system. To increase the performance of these production systems in terms of PCE value, the proposed improvements are required. Those improvements are described in the proposed value stream mapping (Future State Value Stream Mapping). Therefore, this study aims to provide suggestions for improvement of the value stream, which is illustrated using value stream mapping, through the reduction of waste so as to improve the efficiency of the process (Process Cycle Efficiency) of the Callaway Diablo golf gloves production systems.

2. RESEARCH METHODOLOGY

2.1. Object of Research.

The object of research under this study was the Callaway Diablo golf glove production systems at Adi Satria Abadi limited company. Instruments used in the data collection were stopwatch and visual records, while the analysis of data used Microsoft Excel and Visio software.

2.2. Stages of Research

The study was conducted through several stages. The first stage of field observations was to determine the initial value stream of the object under study. The second stage was to identify and formulate the problems that occured in the field, which were associated with wastes along the flow of value in the company. The next stage was to create

the Current Condition Value Stream Mapping for determining the company's flow of value. The fourth stage was to identify the wastes that existed in terms of Shigeo Singo's classification. The fifth stage was to measure the amount of waste that occured using VALSAT. The sixth stage was to determine the formulation of improvement so as to reduce waste and improve the company's value stream improvement in terms of PCE values. The final stage wasto draw conclusions based on tools that were used for identifying wastes and improvements.

3. RESULTS AND DISCUSSION

3.1. Business Process of Adi Satria Abadi Limited Company

At the stage of field observations, it is known that the business activity of Adi Satria Abadi limited company begins when marketing division receives an order in the form of Purchase Order (PO). Furthermore, the marketing division makes an order sheet and submitsit to supervisor of materials division. The supervisor of materials division is responsible for planning the use of raw materials and it is referred to as a Production Material Request (PMR) based on purchase order from customers. The planning of material use is then submitted to the purchasing division for making further bookingsand negotiation with the supplier.

At the moment the synthetic raw materials being ordered come, the warehousing division will receive and match their condition with the purchase order whether or not the quality and quantity are in accordance with the requirement. If the goods that have already come comply with the order requirements then the warehousing division will release an Inbound Material Notice (BBM), showing the amount of raw materials already received. The use of synthetic raw materials is justified with the production planning by the Production Planning and Control (PPC) division. PPC sets the amount of golf gloves that should be produced everyday at each work station by considering the production capacity (availability of machinery and labours).

The use of synthetic raw materials is initiated by the cutting work station. When the cutting work station is going to process these sysnthetic raw materials, the material warehouse releases an Outbound Material Notice(BBK) to record the number of synthetic raw materials that are delivered to the cutting work station. After releasing BBK, then the material warehouse immediately sendsthese synthetic raw materials to the cutting work station for cutting process. These materials are then further processed in sewing 1, 2, and 3, and ironing work stations, and ends up at the packaging process as finished products of Callaway Diablo golf gloves.
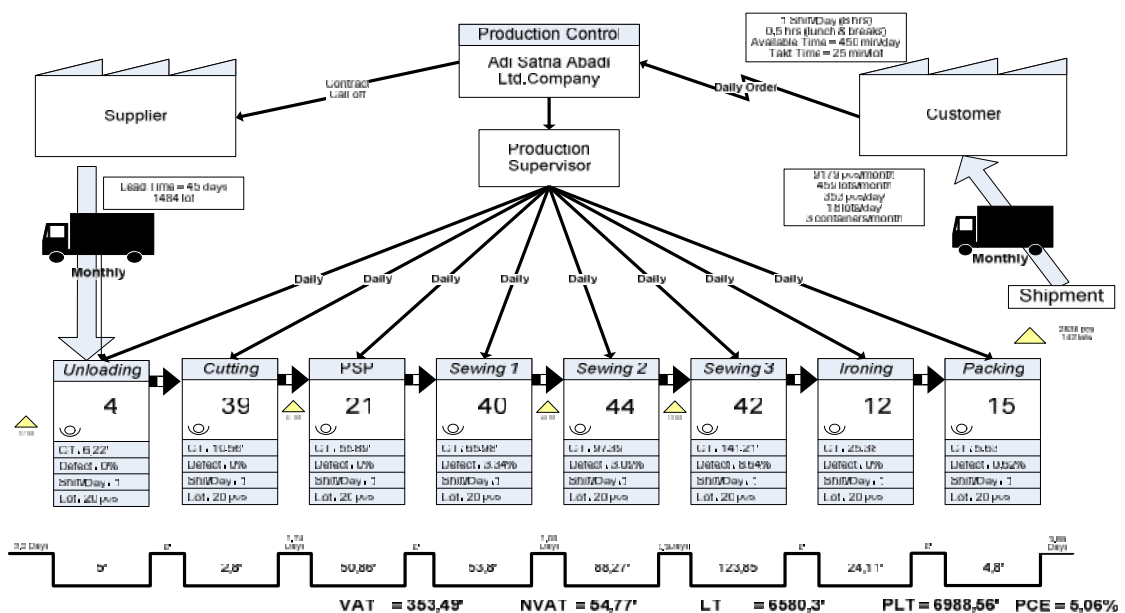

Figure1.   CurrentStateValue   StreamMappingof   AdiSatriaAbadi   Ltd.Company

At the stage of problem formulation, it was found that there existed some kinds of wastes throughout the business process of Adi Satria Abadi limited company. Most of them were inventories, delays, transports, and defects. Therefore, a visual mapping was required to describe this condition.

3.2. Current State Value Stream Mapping

From the observations, it was known that the current state value stream mapping of Adi Satria Abadi limited company looked as in Figure 1.From Figure1 it can be seen that the Process Cycle Efficiency (PCE) of the golf glove production process was 5.06%. This showed that there was only about 5.06% of the production time actually used for activities that added value. The remaining time was used for many other activities that did not add value. In addition, the production process was carried out to meet the demand for a month so that it required a lot of workers.

3.3. Waste Analysis Using Value Stream Analysis Tool (VALSAT)

3.3.1. Process Activity Mapping

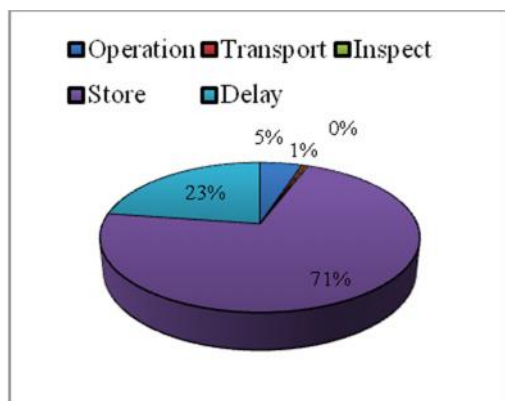This tool was used to map delays and transportation activities.

Figure 2. Process Activity Mapping

From the process activity mapping depicted in Figure2, most of the production activities that did not add value to Adi Satria Abadi Limited company were dominated by inventory activities that accounted for 71.41%, followed by delays, transports and inspections with the percentages of 22.75%, 0.45%and0.33% respectively.

3.3.2. Supply Chain Response Matrix

This tool was used to map the delay and inventory activities. Based on Supply Chain Response Matrix, it can be seen that the amount of time confiscated for delay activities (lead time) was dominated by waiting activities at the work stationsof PSP, Sewing 2 and Sewing 3 whereas inventory activities occured in the areas for receiving raw materials and delivering finished products as shown in Figure 3.

3.3.3. Quality Filter Mapping

This tool was used to map the defects. Overall, the percentage of defect products were mostly found Sewing station 3, followed by sewing stations 1 and 2. The amount of defects that occuredat Adi Satria Abadi Limited company can be mapped in Quality Filter Mapping in Figure 4.

3.3.4.Demand Amplification Mapping

Demand Amplification Mapping was used to map the inventory activities. Based on Figure 5, there was a considerable difference between the supply of raw materials and the inventory of finished products. This difference resulted from the company's policy that set the purchasing of raw materials much higherthan what required, considering the long lead time of raw materials for about 1.5 months so that necessary inventories were sufficient to anticipate the possible delays in the arrival of raw materials.
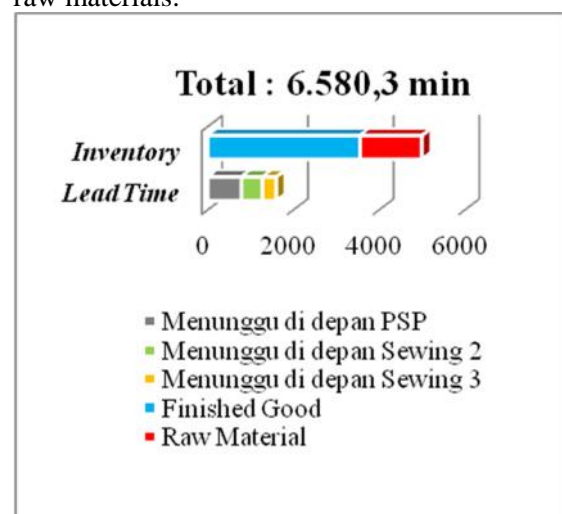

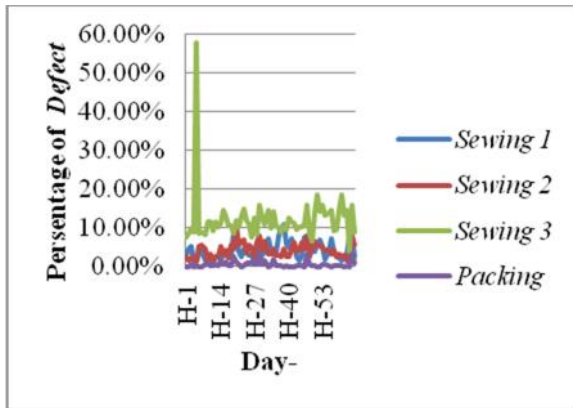Figure 3. Supply Chain Response Matrix

Figure 4. Quality Filter Mapping

3.4. Improvement Formulation to Reduce Waste.

From the value stream map it can also be seen that the takt time of the business process at Adi Satria Abadi Limited company was 25 min/lot. Therefore, the ideal condition required each work station to have a cycle time approaching the value of the takt time. In this situation, the substantial differences in cycle timesof work stations from its takt time caused inventory buildupsat some work stations during the production process (WIP). Comparison of cycle time and takt time at Adi Satria Abadi Limited company can be seen in Figure 6.
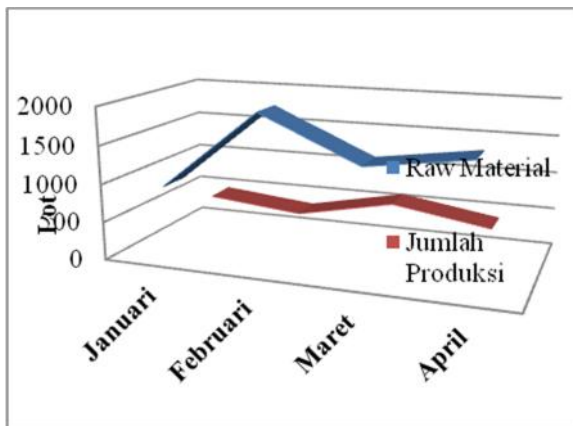

Figure 5. Demand Amplification Mapping

Based on Figure 6, it is clear that the work stations of unloading, cutting and packing have a cycle time of much smaller than the takt time while those of five other work stations exceeded the takt time. Therefore, each of those five work stations must employ labours more than 1 person. To adjust the cycle time of each work stations for not exceeding the takt

time so as to reduce the value of WIP, those cycle times should be improved through the elimination of unnecessary time and the determination of optimal number of workers.
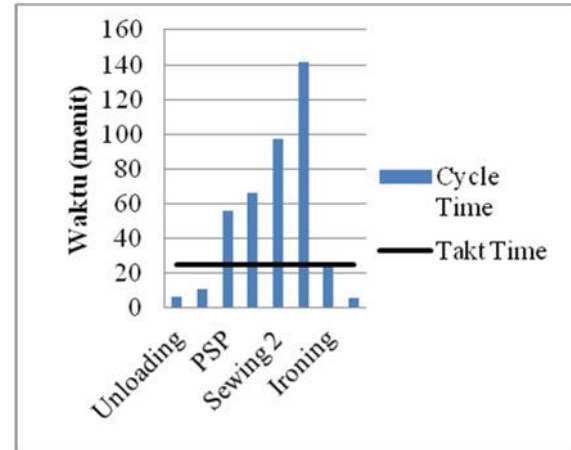

Figure 6. Cycle Time vs Takt Time (Now)

Optimal number of workers (optimal crew size) can be calculated using the following crew sizing formula (Pereira , 2008):

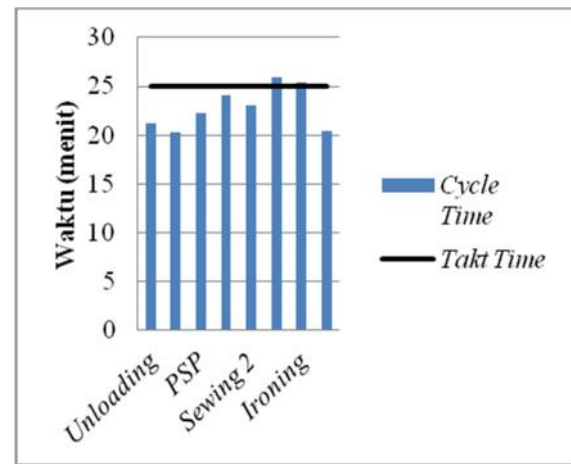$$Optimal\ Crew\ Size\ (N) = \frac{Cycle\ Time}{Takt\ Time}$$

Figure 7. Cycle Time vs. Takt Time (improved)

Optimal cycle times were obtained by dividing the improved cycle times with the optimal crew size. The results of improvement showed that the majority of work stations could be reduced to be smaller and approaching the takt time as shown in Figure 7. Problem on sewing work station 3 with its cycle time slightly exceeding the takt time

could be solved with the help of workers from sewing work station 2.

3.5. Designing Future State Value Stream Mapping,

In the Future State Value Stream Mapping, some suggestions for improvement are given as follows

kanban for procurement of raw materials and kanban for finished product delivery. On the kanban for procurement of Raw Materials, due to long geographical distance between the supplier and the company, the retrieval system is designed to be fixed cycle with flexible quantity. To support the effectiveness of this systems, the company needs to order raw materials with a fairly large lot size and safety
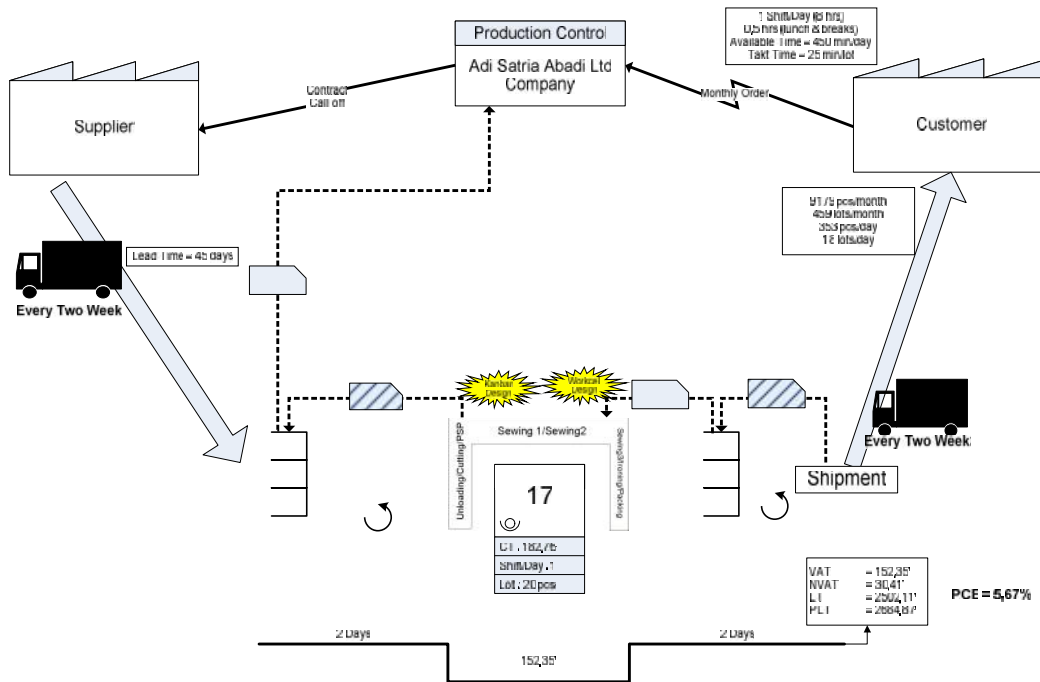

Figure 8. Future State Value Stream Mapping PT Adi Satria Abadi

3.5.1. Workcell Design

The workcell design proposed is a U-shaped layout, the entrance and exit points are in the same position. By applying this layout, the work station of unloading, cutting and packing can be handled by the same worker. Material flows at the proposed layout become smoother than the company's initial layout. In addition,the work cell size is smaller than the initial condition, since the number of lots that flows in every stage of the process is smaller (i.e. every one lot at a time) and the number of workers employed is fewer when compared to the that of initial condition. In this proposed layout, the multi-skilled workers who are well trained and versatile are urgently required.

3.5.2. Implementation of Kanban

The kanban types suggested to be used in the Future State Value Stream Mapping are

stocks. In this study, the targeted safety stock is equal to 18 lots, and the amount of raw materials waiting to be processed within one day is also 18 lots, totaling the number of stocks of raw materials before unloading of 36 lots.

For the kanban of finished product delivery, the shipping process is conducted using smaller number of lots, targeting that the average number of stocks of finished products awaiting for delivery is only 36 lots. The delivery cycle is designed to be once every two weeks (twice per month). Because the proposed kanban system uses fixed delivery cycle with flexible quantity, then the number of products to be shipped will vary. The future state value stream mapping of Adi Satria Abadi Limited company is illustrated in Figure 8.

3.5.3. Opportunity for VMI Application

Since the demand for callaway diablo products was fairly stable and dominant when compared to those of golf glove products, the application of vendor managed inventory method (VMI) that relies on electronic data interchange (EDI) or the Internet is possible to do so. From the technology point of view, it can be said that there are no real obstacles for such application since the use of electronic data interchange (EDI) and internet is prevalent and it can be accessed properly within the area of production. Delivery of raw materials with smaller amounts with frequency of twice a week can be done with the milk - run method, given in Yogyakarta there are many companies located in Bantul and Sleman producing golf gloves as well.

To avoid situations where suppliers establish orders for raw materials that the company does not require and to prevent over and under allocations scenarios, agreements on inventory turns, fill rates, frequency of replenishment should be predetermined. In this case, VMI models must be tailored to the systems that both parties can follow.

Some of the advantages to be gained if VMI can be implemented are a decrease in the amount of inventory, decrease the possibility of shortages, as well as reduction in materials purchasing activities and forecasting of raw material needs.

Based on the proposed improvements of value streams involving improved cycle time, reduction in transportation time, the application of kanban systems and u-shaped work cell with the use of multi skill workers, it can be estimated that the process cycle efficiency can be increased by 12.6 %, from 5.06 % to 5.67 %.

4. CONCLUSION

From the research that has been done, it can be concluded that the company's initial value stream still had many kinds of wates in the forms of delays, transports, and defects.The value of company's Process Cycle Efficiency was 5.06 %. After analysing the condition and analytically proposing some of the possible improvement through determining the optimum crew size, the design of u-shaped workcell and Kanban, and the idea

autonomation, the wastes could be reduced, increasing the value of company'sprocess cycle eficiency by 12.06 %.

REFERENCES

Gaspersz, V. 2007. *Lean Six Sigma For Manufacturing and Service Industries*. Gramedia Pustaka Utama . Jakarta.

Hines, P. and Rich, N., 1997. *The Seven Value Stream Mapping Tools*. International Journal of Operations & Productions Management , Vol . 17 . No . 1 , 1997 , pp . 46-64.

Kumar, Phani and Muthu Kumar, 2003. *Vendor Managed Inventory in Retail Industry.* White paper . Tata Consultant Services.

Republika.,2009. *Global Crisis, Export Sleman Down1 Million Dollars.* http://koran.republika.co.id. Accessed on October 12, 2010.

Ridwan , A., and R. Ekawati. *The design of the Production System Using Value Stream Analysis Tools (VALSAT)*. Department of Industrial Engineering . University Sultan Ageng Tirtayasa . Banten

Shingo, S., 1989. *A Study of the Toyota Production System from an Industrial Engineering*. Viewpoint, Productivity Press, Cambridge, MA.

Triratnafuri, E., 2009. Thesis.*Implementation of Lean Manufacturing Using Value Stream Mapping Tool with Process Cycle Efficiency Indicators at Adi Satria Abadi Limited Company*. Department of Agroindustrial Technology. Gadjah Mada University,Yogyakarta.

Womack, J.P., and D.T.Jones,, 1994. *From Lean Production to the Lean Enterprise*. Harvard Business Review.March-April 1994. PP. 93-130.