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PRODUCTION SYSTEM IMPROVEMENT THROUGH KANBAN APPLICATION IN LABOR INTENSIVE COMPANY

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Abstract -- *Delivery performance is essential for a manufacturer to meet customer requirement. The only manufacturer with fast, accurate and on time delivery could survive in global competition as a sports shoe manufacturer with the labor-intensive production process, PT. XYZ faced a problem with massive work in process inventory that impacted low delivery performance. This research aims to support the shoe manufacturer company to reduce work in process inventory by applying Kanban System. The manufacturer company can decrease work in process in the production line and cut the lead time of production. Kanban System can be utilized from receiving material process, production process, until the packaging process. By implementing a kanban system correctly and consistently, the company can control material supply, production material usage, and customer order delivery inaccurate process. With controlled those items, the company could monitor and manage material and process from beginning to end of the process, even to monitor distribution to a customer. The result of analysis proves that by applying kanban system can achieve the specified daily production target without work in process inventory.*

Keywords: *Just in Time; Kanban Method; Inventory Control*

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INTRODUCTION

The company has a tough challenge today in the face of increasingly competitive business competition and technological advances that affect the production process. To be able to survive in this competition, one of the solutions is to develop more productive and more efficient production system. The ability of companies to compete with more competitive prices can be done by reducing operational costs or production costs by applying Just in Time or known as JIT (Poojary & Kumar, 2015).

Kanban is a Japanese word that means "signboard." This word has developed into identical with "Demand Scheduling' or "Just in Time (JIT) Manufacturing. Its pedigree is traced to the near the beginning days of Toyota's pioneering production system of the late 1940s and early 1950s. Kanban was developed to manage production between the processes and to apply Just in Time Manufacturing. The facts of Kanban became well known during the global recession of the 1970s when it was vital for companies to reduce waste and hack costs to be successful (Rahmana, Sharifb, & Esac, 2013).

Kanban is a Lean and Just in Time (JIT) technique, which was created to control inventory levels and the production and supply of components (Junior & Filho, 2010). According to Papalexi et al. (2014), kanban is defined as a Material Flow Control mechanism (MFC), which controls the proper quantity and proper time of the production and delivery of required products and services (Phumchusri & Panyavai, 2015). It ensures the supply of the right product, at the right time, in the right quantity and at the right place. Kanban system becomes practical; it synchronizes all manufacturing activities entire manufacturing with customer needs. Every process on the floor is controlled by the Kanban system which is designed to respond to actual needs.

Application of kanban production system is a means of making the necessary kanban cards and counting the number of kanbans, as well as planning the efficient and effective kanban flow by utilizing the means of supporting the kanban system. Kanban system planning needs to be done optimally to be able to control inventory and production process can be achieved by the production plan then the company can produce the required product following the amount needed at the time specified.

According to Naik, Kumar & Goud (2013), the principle of Kanban is to generate Visual Indicator's to permit the operators to be the ones who decide how much of goods to run and at what time to stop or change over. Kanban system also tells the operators what steps to take as soon as they have trouble and whom to go to when the problem occurs. Based on the actual usage the operators then start production, rather than forecasted usage. The products that are consumed by the customer (Naik, Kumar & Goud, 2013).

With kanban system which is a tool to achieve just in time process, it is desirable to suppress the current problems by making kanban control system starting from raw material supply, inventory reduction, unnecessary inventory eliminating so as to eradicate inventory cost. Kanban is a card that serves as a control tool for Just in Time production. Just In Time is a philosophy of embodiment of concepts that result in different ways of doing business for most organizations (Fogarty, Blackstone, & Hoffman, 1991).

Based on above description, formulation of the problem in this research is how to suppress accumulation of goods or inventory through a good kanban system in the production process of stock-fitting and to assemble in the company of PT. XYZ., how to make a kanban system so that no extra order will occur and overproduction and measuring the performance of the kanban system in the production process of stock-fitting and assembling. This research is assumed the department's layout site is still in its current state, all requests are considered to be able to meet, and the machine condition is deemed to be under normal circumstances.

MATERIAL AND METHOD

Material

Lean manufacturing has emerged as a solution to decrease waste in production processes implementing the concepts originated at the Toyota Production System (TPS) developed by Eiji Toyoda, Taiichi Ohno, and Shigeo Shingo at the beginnings of the 1940s. The applicability to discrete industries, i.e., assembly industries, has been straightforward. However, applicability in process industries, i.e., continuous industries, remains behind.

Recently scholars, for example, Abdulmalek et al. (2006), King (2009), Lyons et al. (2013), Papalexi et al. (2014), and Pool et al. (2011) have been studying and implementing some of these lean concepts at process industries reaching remarkable results.

Semi-process industries are somewhere between process and discrete industries due to their process and product hybridity. The discretization point (DP) is known as the point where object type changes from continuous to discrete (Abdulmalek et al., 2006, p. 21). In this case, the fact of being a mixed process, semi-process industries benefit from the previous experiences and favorable results on discrete sectors, but still lacking understanding of the scope and impact on the non-discrete part.

Lean manufacturing aims to reduce waste in every stage of the production process. It is based on five principles:

- Identifying value from the perspective of the customer
- Value stream mapping to detect value-added and non-value-added activities
- Make production flow by eliminating non-value-added activities
- Pull production from customer demand
- Continuously eliminate all waste to reach process perfection.

Lean production planning and control (PPC) tools are these tools dealing with the alignment of production and demand (Lyons et al., 2013). Applicability of these tools can help industries to smooth the production process, reaching high service levels and reducing production and lead times. Scholars as King (2009), Powell, Alfnes, and Semini (2010) and Pool et al. (2011) have lately applied these concepts at a process and semi-process environments.

According to Pool et al. (2011) lean PPC tools are analyzed and proposed to be applied in the environment:

- Cellular Manufacturing is a lean PPC tool capable of reaching high levels of production flexibility and reducing production times by producing products in families.
- Takt time is a lean PPC tool which establishes a familiar production rhythm or "takt" to reduce spare times.
- Kanban is a signaling replenishment methodology to produce under actual customer demand, thus reducing work in progress (WIP).
- Cyclic planning is a repeated methodology of planning that aims to mitigate the volume variation in demand with optimized sequences of production runs. Beneath cyclic planning methodologies, two main distinctions are made. Heijunka or leveled production, which is a scheduling concept to balance production volume and product mix. And cyclic wheels, which are an evolution of Heijunka planning methodology where a repeated sequence of products is produced in a cyclic way

As mentioned above, the Kanban method is a tool in the Just In Time (JIT) system. Simply described that JIT only requires the required units to be available in the required quantities and when needed. The underlying logic of JIT thinking is "Nothing will be produced until it is needed." Producing an extra unit is as bad as

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providing less than one unit. Completing the rest of the day products faster is also as bad as providing a day slower.

JIT's view is not to waste time sorting the good parts from the ugly, or the available parts of the unqualified, but use that time to prevent producing ugly or unqualified parts. In other words; Do It Right From The Beginning (Do It Right The First Time).

The source of waste identified by Toyota and first introduced by Taiichi Ohno, known as Toyota's Seven Wastes, is:

1. Wastes from producing defects (producing defects)
2. Wastage in transportation and material handling (transportation and material handling)
3. Waste of inventory (inventory)
4. Waste of overproduction (overproduction)
5. Waste of waiting time (waiting time)
6. Wastage in a process (processing).
7. Waste of movement (motion)

Kanban is used in the production system that is kanban card is a crucial component of kanban implementation which is used as a signal of the need for material in a production facility, or transfer material from supplier to production facility (Ramnath, Elanchezhian, & Kesavan, 2010). Kanban is a tool used to realize the JIT production system. Kanban in Japanese means "visual record or signal." JIT production system uses the flow of information in the form of kanban in the way of cards or other equipment such as flags, lights, and others (Susatyo & Triana, 2016).

Kanban system is an information system that harmoniously controls the production of necessary products in the required quantities at the time required in each manufacturing process and also among companies.

The most commonly used form is a piece of paper contained in a rectangular vinyl envelope. Kanban carries information vertically and horizontally within Toyota's plant as well as Toyota with partner companies. The sheet of paper moves information consisting of 3 categories: information collection, information of displacement, and production information.

The kanban system is supported by the following: smooth production, standardization of work, reduction of setup time, repair activity, machine layout design, and autonomation.

According to Taiichi Ohno, "Kanban is a tool to control production." Natural use controls material flows through a JIT production system using a card to instruct a work center to move and produce certain elements or components.

Kanban is a tool to run a mechanism that provides specific work center signals that require certain components of the previous work center. The signs provide information to the last center work, so the number of elements that the next work center needs can be directly assigned. Furthermore, the number of components that have been taken work center can be produced or reproduced by the previous work center.

The idea of kanban thinking arises from the mechanism of supermarket work. The goods purchased by the customer are checked and recorded by the cashier. Information on the type and quantity of items purchased is then delivered to the purchasing department. With this information, the items purchased were quickly replaced by the purchasing department of the type and type the amount. If the kanban is applied to the supermarket, the information provided to the purchasing department will be delivered with the card, and the card is by the picking kanban in the tax return. In supermarkets, goods on display at stores are similar to inventory in the manufacturing industry.

Kanban has two general functions, namely as a controlling of production and as a means of increasing production. Its role as a controller in output is obtained by uniting the process together and developing a suitable system so that the raw materials, components, or products needed will come when needed in an amount appropriate to the needs of all work center on the production floor, even extending to the supplier associated with the company. While the function as a means of increasing production can be obtained if applying it by using the inventory level reduction approach. The level of inventory can be reduced in a controlled manner through the reduction of the number of kanban in circulation.

There are two production system well known, the pull system and push system (Push system). The push system is a production system that drives the product to the consumer. The company is not paying attention to demand or not. The downside of the system is when the product continues to be produced without seeing its actual demand, and then there will be an accumulation of goods in the warehouse so eat the factory space. In the pull system, production activities will run based on actual demand. Companies act as producers do not a production, by the way, push the product to the consumer, but rework. The amount will remain but the reservation time is uncertain (Abhale & Masurkar, 2015).

According to Yasuhiro Monden, in detail the kanban system is used to perform the following functions:

1. **Command**, kanban applies as a command tool between production and delivery. When

the component needs to be taken or ordered to be transported, an address is written on the kanban. The address informs the process before the storage area of the processed component and reports the process after the place of the required components.
2. **Self-control to prevent overproduction**, each process shall be autonomously controlled, to ensure that each process only processes sellable products in a salable amount, at a time that can be sold following its cycle time. This autonomous control provides that production does not take place in excessive production speeds. The kanban system is also a self-control mechanism to allow each process to make small adjustments to its monthly production schedule due to monthly demand fluctuations.
3. **Visual control**, each kanban serves as a visual control tool because it provides not only numerical information but also physical information in the form of kanban cards.
4. **Improved process and manual operation, t**he use of a kanban system to help improve operations is needed because increased productivity leads to financial improvements, thus improving the company as a whole.

According to Ohno, in short, the kanban serves to:
1. Provide retrieval and transport information.
2. Provide production information
3. Prevent overproduction or excess freight
4. Applicable as a work order affixed directly to the component
5. Prevent defective products by recognizing processes that create defects
6. Disclose existing problems and maintain the stock.

Calculation of Kanban Cards

In a manufacturing industry company, material planning is the person responsible for issuing kanban cards. The plan also determines the lot sizes of the kanban to be interesting material. Sometimes real planning will issue additional material cards to increase production levels for a particular part. Instead of material planning also pulls out Kanban cards from circulation to reduce production schedules. Some kanban issued to certain parts based on:
1. Daily Request
2. Lot size or capacity per box
3. Cycle issue
4. Security coefficients

Kanban system is a pull system, where the process after ordering the required units from the previous process in the right amount at the right time and then the process before producing the unit as much as taken. As a result, a Kanban system can be viewed from the point of an inventory control system, which consists of two types: System fixed order quantity (Q-system) and System set order cycles (P-system).

The success of this system lies in the strict adherence to the kanban quantity specified in the card. The suppliers are strictly asked to adhere to the amount mentioned in the card. The kanban quantity has been determined so as to be in multiples of the bin quantity of the corresponding raw material sheet (Ravichandran & Kumar, 2015).

Method

This study aims to design a system that can control production flow, especially in stock-fitting and assembling department using kanban tools. So, it is expected that the flow of the production process is running promptly by the Work Orders (WO) in stock-fitting and assembling department and does not create an accumulation of certain materials in the workstation. The Assembly Department produces its goods according to the demand of the consumers. With this system, inventory would be reduced as an advantage.

This research begins by collecting data on the production floor of the assembling department. Data collection includes query data, data routing, process time data and setup time. The created material flows and information on the production floor at the beginning of the production process. Research methodology could be seen in Fig. 1.

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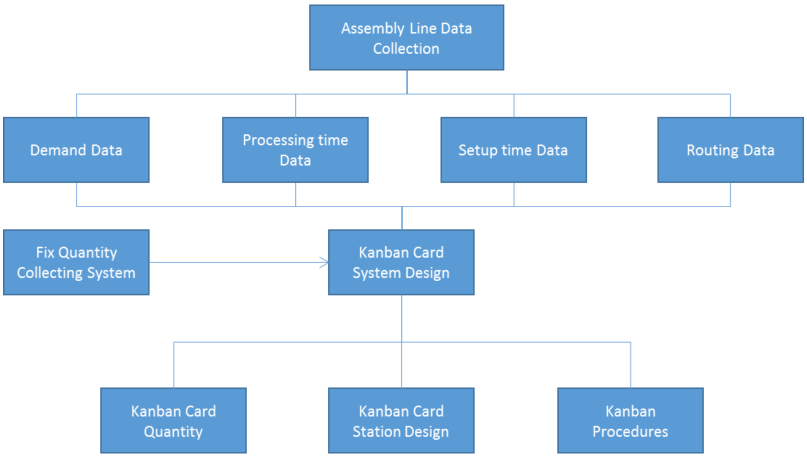

Figure. 1 Research methodology

Systematic problem-solving in this study is divided into three stages: the collection stage and data processing, analysis and phase conclusion.

1. Data Collection and Processing Phase
   - Data collection is done by direct observation. Required data are order demand data, data routing, setup time data, and process time data.
   - Data Processing After collecting the necessary data, then the next step is the stage of data processing.
2. Designing the Kanban System
   - The design of the flow of kanban materials. The flow of kanban material is made as a guide in implementing the system kanban.
   - Kanban Station Design. Kanban station as a stopover kanban card.
   - Calculation of the number of kanban cards
3. Stage Analysis and Conclusions
   At this stage analysis of the advantages and disadvantages of the system using a kanban card by not using kanban cards from research that has been done. From the investigation will be concluded.

RESULTS AND DISCUSSION

Production Process Information Flow

PT XYZ does the material order process with a supplier where the ordered goods are following the purchase order than received in a raw material warehouse. Then create a work order for each department starting from a raw material warehouse, upper process, and outsole process.

Preparation of material is done in the raw material warehouse, starting from checking material whether available or not, how much and how many taken. Upon completion, the raw material parts operator prepares the materials and components collected in the temporary area before being taken to the production unit. The information required for a production work order system is including a master production schedule and production plans provided to each department. In general, the flow of this information can be seen in the picture below.

Master Production Schedule directly controls each process on the pull system. Each department is given a list of work schedules to be carried out and transportation made between departments. Master production schedule diagram can be seen in Fig. 2.

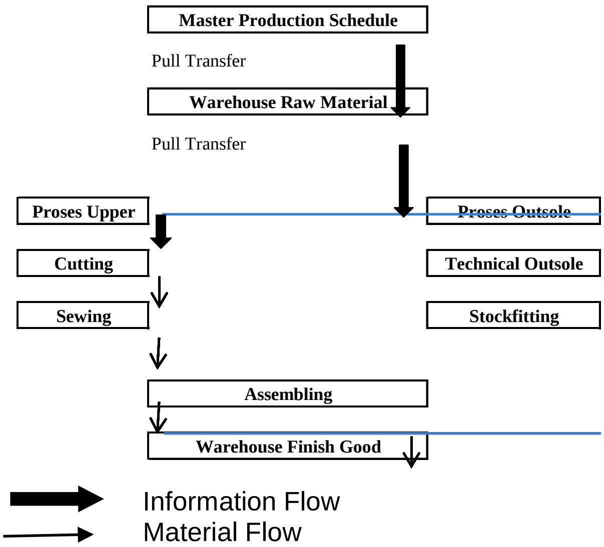

Figure 2. Master Production Schedule

Kanban Material Flow

Material flow of the proposed production system using kanban is a pull system that is the production process that runs from behind to the previous procedure. Here will be described the flow of kanban circulation in the upper production process and outsole production. There is a little change where the temporary shelters are removed. So, the products are brought directly to their respective process sections. There are two kanban system would be proposed in this proposal, kanban production orders and kanban picking. Kanban in Outsole Process Line uses kanban production orders according to work order that has been made by the Production Planning and Inventory Control department (PPIC). Using kanban material intake between departments on a raw material warehouse. In the process, there is an inefficient and slow process of transporting the material to the temporary shelter unit, and this process should be removed, so the components taken in the warehouse directly taken to their respective workstations. Rubber processing part receives pickup kanban from the material warehouse if the desired rubber component can be satisfied by the part warehouse, the kanban production orders attached to the product are placed at the receiving post of kanban, and replaced by kanban retrieval. Kanban along with the outcome will be taken to the shelter before entering the assembling department/shoe assembly. Kanban material flow can be seen in Fig. 3.

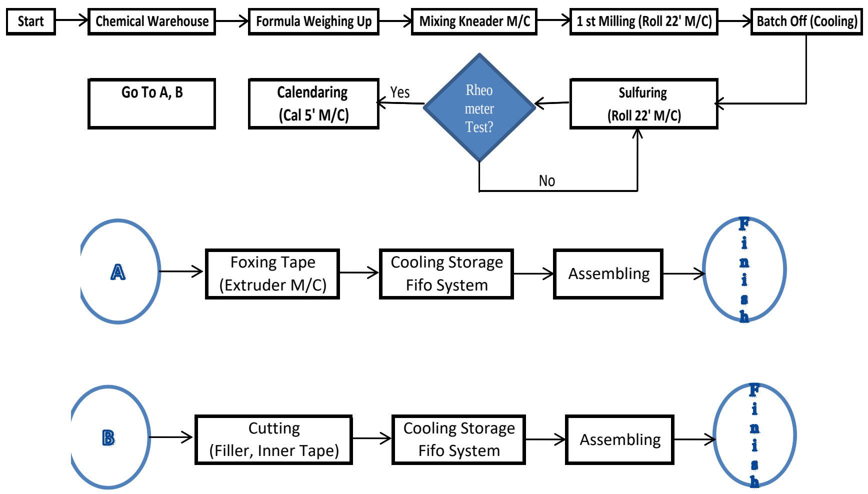

Figure 3. Kanban Material Flow

Determining Number of Kanban Cards

In implementing the kanban system, please note the number of kanban cards needed on the production floor to run smoothly. The amount the outstanding kanban should be limited. Because more and more kanban in circulation will be a higher number of existing parts on the production floor. Also vice versa, the less kanban card then, the smaller number of current parts. If the number of parts on the production floor is large, it can cause buildup. Whereas if the number of parts is small, it can cause the cessation of the production process. The number of kanban cards currently circulated only between departments. Card shifting by the time of an hour. Therefore, it is seen from the amount based on total working hours that is eight kanban card for 8 hours working time.

Kanban Card Poster Design Assembling Dept

Kanban station serves as a place to stop kanban card. Kanban post also serves as a display for operators on the production floor to know the hourly time in and out goods in the department and know the production activities. If there is a red, yellow, and blue production card in the kanban post, then the production operator must make the product according to the information on the card. Incoming postcards must be three cards:

1. Red card: Upper
2. Yellow card: Outsole
3. Blue card: Insole

Some parts must match the ones listed on the back of the card. Nothing more or more has been sold on the card. The operator may not perform production if there is no production card at the kanban post. The design of a kanban station on the sample production floor of the assembly department can be seen in Fig. 4.

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Figure 4. Assembly Department Kanban Station

Kanban Procedure

Kanban process starts from the process upper and outsole processes where kanban production orders and kanban taking the material are done in the cutting department and hot press department using a pull system. By the work order from PPIC dept then the work process is done based on the flow of kanban materials. The upper making after the cutting department is continued to the sewing department and collected temporary shelters before entering the Assembling department.

Outsole from the hotpress department continued the production process to the stock-fitting department is then sent to the goods shelter in front of the assembling department. After complete upper material, outsole and insole then kanban card input at kanban post. For takt time, the target per hour/pair and its output day can be seen in Table 1.

Table 1. Takt Time Data by Department

Category	Department	Takt Time	Target/ Hour/ Pairs	Output/ Day
Outsole	Hotpress	12,86"	300 prs	2400 prs
	Stock Fitting	12,9 "	280 prs	2240 prs
Upper	Cutting	12,86"	280 prs	2240 prs
	Sewing	22,70"	140 prs	1120 prs
	Assembly	11,52"	280 prs	2240 prs

It performed a standard WIP per department that can be seen in the picture below based on the length of quality with unit hours. The material that goes into the warehouse is done two times a day according to work order from PPIC department. Each department has calculated the time required work process in the work order based. With the use of kanban cards, there is no more accumulation of goods at every department's work station. Standard WIP diagram is shown in Fig. 5.

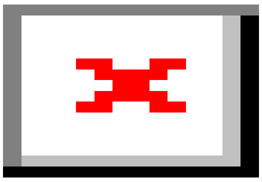

Figure 5. Standard WIP

Production Result

Production planning is a process of determining the overall level of manufacturing output to meet planned sales levels and desired inventory. The production plan defines the manufacturing level, usually expressed as the monthly rate for one year or more, for each product group.

Viewed from the production does not significantly affect the use of kanban cards using whether or not a used kanban card of production continues to reach the production target. Production result from January to April 2018 can be seen in Table 2.

Table 2. Production Result Data

Month	January	February	March	April
Prod. Result	523,129 prs	492,570 prs	451,123 prs	514,560 prs

Advantages and Weakness of Using Kanban Cards

The weaknesses and advantages of each use of kanban cards can be seen in Table 3.

Table 3. Comparison of Kanban Card Use

Without Kanban Card		With Kanban Card	
Advantage	**Weakness**	**Advantage**	**Weakness**
Re-Scheduling is not often (monthly)	Coordination between department is not good	Minimum inventory	Re-Scheduling Often (Daily/ Weekly)
Better material service to prod department	There are material accumulation in work station	No accumulation material/ WIP. Better communication between departments	Material transportation frequency higher.

CONCLUSION

Based on the result of research, it can be concluded that the production target can still be achieved by the assembling department 2240 pairs/day with the number of working days ranged from 22-24 days in a month. So total monthly production can reach the production target from PPIC dept. Kanban cards enter per hour simultaneously the upper kanban card, kanban insole card, and outsole kanban card. Using a kanban card can prevent the accumulation of goods on the workstation and materials worked following the MPS. No overproduction and quickly tracked if there is a working procedure error.

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