IMPROVEMENT OF KANBAN SYSTEM USING CONSTANT QUANTITY WITHDRAWAL SYSTEM TO FULFILL BUFFER STOCK REPLENISHMENT ON SINGLE AISLE PROJECT AT PT. XX

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ABSTRACT

PT. XX, is a state-owned company that engage in aircraft manufacturing. Nowadays, this company facing a problem in Single Aisle Project, which is to fulfill demand with appropriate time. Problem occur because of line stop take place in assembly. Line stop happen because lack of parts that needed in component assembly which make assembly process not running properly. Main cause that create lack of parts problem is amount of buffer stock are not comply with amount that needed and replenishment schedule for buffer stock not well-timed. According to that reason, a system that comply with buffer stock replenishment schedule is required.

In this research will be design an idea about Kanban System that consist of Kanban card calculation, Kanban Post, mechanism of using Kanban System and calculation amount of Kanban card that used in fulfilling schedule for buffer stock replenishment.

Result of this research is a Kanban System that has buffer stock amount more than amount of units that needed during replenishment and buffer stock replenishment that well-timed when buffer stock almost complete consumed, thus the amount of buffer stock is not less or over than needed.

Keywords: Kanban, Buffer Stock Replenishment, Constant – Quantity Withdrawal System, Pull System.

1. INTRODUCTION

1.1. Background

Indonesian Aerospace or IAe is a state-owned company that engage in aircraft manufacturing. One of business unit in Indonesian Aerospace is Aerostructure. Business unit Aerostructure engage in design, component manufacture, and subassembly airframe with high quality and competitive price.

Figure 1 Illustration of Components Dnose, Pylon and Skin

In Single Aisle Project consist of 3 component that manufacture in Indonesian Aerospace company which is Dnose, Pylon and Skin as illustrate on figure 1.

Figure 2 Average Delivery per Week from Total Delivery per Year

Now, Indonesian Aerospace Company facing problem in Single Aisle Project, IAe can not fulfill the demand timely. Based on data on Figure 2, average amount of 3 aircraft component that have been delivered still not fulfill the demand. In 2012 Indonesian Aerospace only deliver around 9
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1.2. Problem Formulation
How to design improvement of Kanban System to fulfill buffer stock replenishment on Single Aisle Project in assembly?

1.3. Research Benefit
1. Because of this research, cost from Single Aisle Program on Indonesian Aerospace Company can be reduce especially reducing penalty cost because of delay when component being deliver.
2. Become idea for Indonesian Company in implementing Kanban System which is in order to decide time and amount of production order and amount of inventory.
3. Production System and flow of information in assembly will work harmonically in every process.
4. Easy to find problem on production floor when needed.

2. THEORETICAL BACKGROUND

BASIC THEORY
2.1. Just In Time
Basic concept production system Just In Time (JIT) is producing the product that needed, when needed by customer, with appropriate amount based on customer needs, with excellent quality, from every process in production system, with most economically or most efficient way using waste elimination and continuous process improvement.[1]

2.2. Pull System
On Pull System, production process will running based on actual demand. “Pull” means a company that doing production process not push the product to customer, but produce the product based on demand from customer. Benefit from this method is low amount of inventory.[2]

2.3. Type of Waste
There are seven waste that do not have added value in business process or manufacture, it is include unnecessary work.
Although the factory produce different product, but type of waste in industrial environment relatively the same all the seven type of waste are:
1. Overproduction
2. Waiting time / delay
3. Unnecessary transportation
4. Unnecessary Process
5. Over stock
6. Unnecessary movement
7. Reject product

2.4. Value Stream Mapping
Value Stream Mapping is a tools that used to represent flow of production process. Value Stream Mapping is a tool that have been develop to simplify the understanding of value stream, facilitate to make improvement about waste. Value Stream Mapping also an approach using weighting waste, then use that weighting to choose tools with matrix.

2.4.1. Kanban System
1. Kanban Type
Two type of Kanban that usually used are Withdrawal Kanban and Production – Ordering Kanban.

2. Kanban Rule
Ideal tools is one way to accomplish effective purpose. If used appropriately, Kanban sytem can be an effective work hour surveillnace. To accomplish Just In Time (JIT) purpose, This rules should be follow:

a. Following process should take the product that needed from previous process with appropriate amount and appropriate time based on needs.

b. Previous process should produce the product comply with amount of product that taken from following process.

c. Rejected product should not hand over to following process.

d. Amount of Kanban should be a little as possible.

e. Kanban should use to adapt with little fluctuation in demand (production control with Kanban).

3. Deciding number of Kanban
a. Constant – Cycle Withdrawal System

Necessary number of parts during the lead time of withdrawal Kanban = Lead time of withdrawal Kanban × Hourly average quantity of parts needed for subsequent process

Remark:
Lead time of withdrawal Kanban = Withdrawal interval + Production lead time
Withdrawal interval = Time between pulling/taking at time t and pulling/taking at time t+1 in constant – cycle withdrawal system
Production lead time = Time between Withdrawal Kanban released into next process then produce number of part that comply with amount of part that must be produced which written in released Kanban and time for next process already have the same parts and ready to use.
Safety inventory = Usually 10% from necessary number of parts during lead time of withdrawal Kanban

b. Constant – Quantity Withdrawal System

Necessary number of parts during the lead time of withdrawal Kanban = Lead time of withdrawal Kanban × Hourly average quantity of parts needed for subsequent process

Capacity of one box

Remark:
Lead time of withdrawal Kanban = Production lead time
c. Computation of Reorder Point

Necessary number of parts during the lead time of Signal Kanban = Lead time of Signal Kanban × Hourly average quantity of parts needed for subsequent process

Capacity of parts box

Lot – Size

Lot – Size = (Daily average usage of parts / Times of setup per day) + Safety inventory per day

2.4.2. TaktTime
Takt in Deutsch language means rhythm or meter. Takt Time is amount of time that allocated to produced one unit or a part based on allocated operational time compare to amount of product that needed.
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3. RESEARCH METHOD
3.1. Conceptual Model

4. RESULT AND DISCUSSION
4.1. Designing Kanban System
4.1.1. Creating Value Stream
In Single Aisle project, there are 3 aspects that are not related, thus Value stream mapping (current state) will divided into 3, which is VSM for Dnose, Pylon and Skin.
In this three VSM there are total lead time and time process that has value added. Based on VSM current state, total lead time for making 1 set Dnose component is 29 days with value added 44.212 hour. Same with Pylon, total lead time for creating 1 set component is 35.5 days with value added 40.501 hour dan Skin component have total lead time is 18.5 days with value added 8.031 hour.

4.1.2. Kanban Card Calculation
a. First step – Calculation lead time of withdrawal Kanban.
b. Second step – Calculation amount of part or unit that needed by next process
c. Third step - Calculation of number of parts or units required for the lead time of withdrawal Kanban.
d. Fourth step – calculation amount of Kanban card.

4.1.3. Designing Kanban Card
There are two type of Kanban Card, Signal Kanban Card and Production Kanban Card as shown by Figure 4 and Figure 5.

4.1.4. Designing Kanban Post
a. Kanban Post Whiteboard
b. Kanban Post Hanger

4.1.5. Design of Mechanism Using Kanban System
Based on the results of Kanban card design post and the results of the calculation of the number of Kanban cards, the following needs to be designed as a guide in performing the procedure or Kanban system is a mechanism the use of Kanban System that contains Kanban flow and proposed a
prototype application that is useful as a tool in use of Kanban System.

4.1.5.1. Prototype Modeling Applications
Electronical Kanban
a. Designing Context Diagram
This section describes the model of the overall system. Context diagram shows an entity involved, namely the PPIC (production planning and inventory control).

![Figure 8 Context Diagram](image)

b. Designing Data Flow Diagram
This section describes the flow of data in electronic Kanban application prototype. Data flow diagrams Level 1 is composed of data input process part number and Kanban number, file creation (.PDF) Kanban cards containing a new Kanban ID, and the data input process Kanban ID.

![Figure 9 Data Flow Diagram level 1](image)

4.1.5.2. Interface Design and Prototype Application Usage.
a. Kanban Database
Kanban database is a data set that contains a variety of information required in the Kanban card as well as the results of the calculation of the number of Kanban cards that have been done before. From figure 10, data that exist in Kanban database is part number, component, part name, process, quantity per set, batch size, total cycle time per batch, total preparation time, total move/transportation time, lead time / replenishment time, hourly demand, necessary number of units during lead time, kanban type, capacity of bin or box, number of kanban, total buffer stock, dan reorder point / trigger point. All data will be used in the decision or calling the data needed on a prototype application of electronic Kanban.

![Figure 10 Kanban Database](image)

b. Kanban Form
Kanban order form is a form or a form that will be filled with the aid of the barcode scanner. There are two functions of the Kanban this order form which make / print a new Kanban cards when Kanban card has been removed from its place and makes recording data or recording the data in the Kanban record database.

![Figure 11 Kanban Order Form](image)
c. Kanban Record Database
Kanban database record is a record of the data stored automatically when Kanban form has been filled. The usefulness of this form Kanban record is as a tool to monitor the performance of the Kanban system as a reference for adjusting the number of Kanban cards and have shown indications of a problem by looking at the ratio of the standard lead time with the actual lead time. In other words, Kanban database record is used as historical data that will be useful as continuous improvement or continual improvement of the Kanban system.

d. Kanban Card template
Kanban card template is a template of the Kanban card designs that have been designed previously that is still empty as shown in Figure 15. All of the information that will be loaded on the Kanban card template will be filled automatically according to the part number that is filled when filling in the form Kanban obtained or invoked from the database Kanban.

4.1.5.3. Designing Kanban Flow

4.2. Discussion
4.2.1. Analysis of Advantages and Disadvantages Results Kanban System Design
Table 1 Advantages And Disadvantages Analysis of Design Kanban System

<table>
<thead>
<tr>
<th>Element of Kanban System</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desain Kanban Card</td>
<td>1. All information displayed on Kanban card is complete and clear as required.</td>
<td>The possibility of damage to the Kanban cards such as bent or torn because of the materials used are paper.</td>
</tr>
<tr>
<td></td>
<td>2. Has the information in the form of a barcode that is useful in facilitating the data input.</td>
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<tr>
<td></td>
<td>3. It has been integrated with a prototype application of electronic Kanban.</td>
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<tr>
<td></td>
<td>4. Using the visual aspect of the colors that are distinguished by the intended process or department.</td>
<td></td>
</tr>
<tr>
<td>Mechanisam Using Kanban System</td>
<td>1. Useful as procedures or guidelines in the use of Kanban cards, Kanban post, and trigger point or reorder point.</td>
<td>It takes adaptation to apply Kanban system to workers, because of differences in the procedures of the new system and the old system.</td>
</tr>
<tr>
<td></td>
<td>2. Shows the flow of Kanban are all activities that must be performed by the parties involved in the use of Kanban System.</td>
<td></td>
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<tr>
<td></td>
<td>3. Using a prototype application that is useful in recording the orders placed on the Kanban system and also in the manufacture or Kanban card printing.</td>
<td></td>
</tr>
<tr>
<td>Amount of Kanban Card</td>
<td>1. The number of Kanban cards are in accordance with the capability of the production process at PT. Indonesian Aerospace.</td>
<td>The need for adjustment or setting the layout of a buffer stock in a storage area for the number of Kanban cards.</td>
</tr>
<tr>
<td></td>
<td>2. There is a trigger point or reorder point corresponding to the lead time in making a part number or replenishment time.</td>
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<tr>
<td></td>
<td>3. There will be no shortage amount of buffer stock due to the amount of buffer stock is in conformity with the required amount of buffer stock at the time of replenishment or the buffer stock replenishment time.</td>
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</tr>
<tr>
<td></td>
<td>4. There can be no excessive amount of buffer stock for Kanban card number that counts is the boundary or limit the amount of buffer stock may be saved.</td>
<td></td>
</tr>
<tr>
<td>Design of Kanban Post (Whiteboard)</td>
<td>1. Function as a stopover place Post Kanban Kanban cards can be achieved.</td>
<td>Require additional activity by operators in arranging the order of Kanban cards.</td>
</tr>
<tr>
<td></td>
<td>2. Easy to be made, all the necessary materials in the manufacture of Kanban Post can be purchased.</td>
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<tr>
<td></td>
<td>3. Costs incurred in making Kanban Post was not too expensive.</td>
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</tbody>
</table>

Table 1 Advantages And Disadvantages Analysis of Design Kanban System

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</tr>
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<tbody>
<tr>
<td>of Kanban Post (Hanger)</td>
<td>2. that as a stopover place Kanban cards can be achieved. With a downward sloping hanging, Kanban card sequence settings will regularly without operator assistance or eliminate the activity of the sequence settings Kanban Cards.</td>
<td>the Kanban cards are used due to the clamp.</td>
</tr>
</tbody>
</table>

4.2.2. Schedule Analysis of Buffer Stock Replenishment On Kanban System

In addition to adjusting the amount of buffer stock to the amount needed, Kanban system also works in scheduling replenishment time or replenishment the buffer stock for each part number. Based on the results of the calculation of the number of Kanban cards are performed on data processing, there are two types of Kanban is used, namely signal Kanban and production Kanban. Both of these have different types of Kanban replenishment schedule for buffer stock. In Kanban signal types used in the part number that has a number of units required for replenishment time is smaller than the number of units in a single replenishment (batch size). While the part number that has a number of units required for replenishment time is greater than the number of units in a single replenishment (batch size), the type that will be used is Kanban production.

Figure 17 Buffer Stock Replenishment Schedule for Signal Kanban

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machining process, and red for the assembly process.

3. Amount of Kanban Card
In the calculation of the number of Kanban cards that are performed in this study, obtained necessary number of units during the lead time, the number of Kanban cards, the total buffer stock and buffer stock replenishment schedule. In the Kanban system designed, found the number of buffer stock that is greater than the number of units required for replenishment time, so there will be no shortage of buffer stock when replenishment is done. Here is a sample Table 4 that displays the results of the calculation of the number of Kanban cards and a comparison between the total buffer stock on the Kanban system with the number of units required for replenishment time.

Table 4 Sample of Results Calculation Kanban Card Number and Comparison Total Buffer Stock with Necessary Number of Units During Lead Time

Moreover, according to the analysis of the buffer stock replenishment schedule on Kanban Systems designed, replenishment will be done just as a buffer stock will be depleted, so there will be no shortage or excess amount of buffer stock owned. Buffer stock replenishment schedule distinguished by type of Kanban that used. In Kanban signal types, buffer stock will begin to be replenished again when the reorder point began to be consumed. While on the type of production Kanban, buffer stock will be
replenished at each Kanban that has been used or when the Kanban is empty.

4. Mechanisms use of Kanban System
Mechanism designed using Kanban system is in the form of a Kanban Flow that describes the overall process is done in running Kanban System. In general, there is the Kanban process flow is divided into two phases, namely Kanban order phase and Kanban received phase. In Kanban order phase will be shown all the processes performed in an order for replenishment of the Kanban system start from Kanban card removed until Kanban card with the new Kanban ID printed and hung on the Kanban post. While the Kanban received phase, will be shown all the processes carried out in the reception back Kanban replenishment has been completed which include Kanban card making Kanban is hung on a post and made a number of parts or components that are listed on the Kanban card until the process of recording the time when Kanban back in the storage area.

In the mechanism of the use of Kanban systems there is an electronic Kanban application prototype modeled using visual basic that exist in Microsoft Excel are useful as supporting applications in doing recording orders placed on Kanban system and also in the Kanban card manufacture or Kanban card printing.

6. REFERENCES

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