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 stockare 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 designan 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.

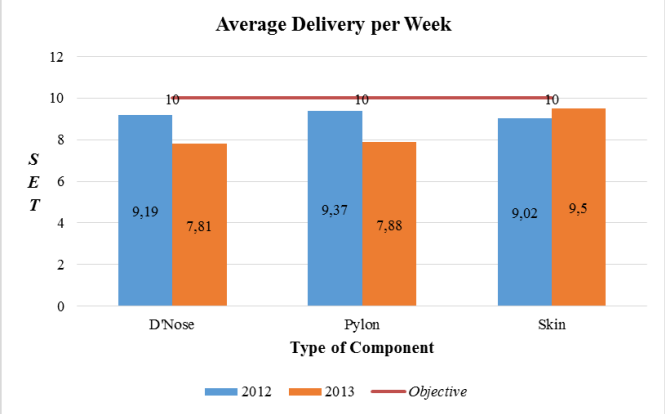


Figure 2 Average Delivery per Week from Total Delivery per Year

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

set per week for three component, and in 2013 there is significant reduction from 2012 especially for D'Nose component and Pylon component until 7 set per week. The data show that Single Aisle Project can not fulfill the demand from costumer which is 10 set per week for each component. According to supervisor and logistic in assembly, this problem occur because of line stop in assembly line. Line stop occur by reason of assembly line not running properly because of lack of parts that needed in component assembly. Main cause that create lack of parts problem because some rejected parts are still continue to next process so that rework is needed, this means there is waiting activity until parts come, also amount of buffer stock are not comply with amount that needed and replenishment schedule are not well-timed.

From all the factors above, the dominant factor that cause line stop is amount of buffer stock are not comply with the amount that needed and replenishment schedule for buffer stock are not well-timed. In overcoming that problem there is a system that can be implemented which is Kanban System. Kanban System is a system running as a pull system that use Kanban card as a tool for information flow to control production process so amount of product that produce corresponding with demandand appropriate time when customer needed. Therefore, pulling information about amount of product that will be produce and amount of parts that needed start from ending process based on demand from customer until beginning process in production process. Hence, this reason become background why in this research only in assembly line because ending of production process before delivery on Single Aisle Project is assembly process. Kanban System use to coordinate every process in the production system by controlling work in process (WIP) for every process with appropriate amountand maintain communication and flow of information to make it running properly.

In order to fulfill the replenishment schedule on time and create a good communication and good flow of information, Indonesian Aerospace has to plan and design new Kanban System with planning amount of Kanban card, designing Kanban post, designing Kanban card and implementation mechanism of Kanban Sysytem on Single Aisle Project.

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 compononent 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 pduction 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 excelent 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[3] all the seven type of waste are :

1. Overproduction
2. Waiting time / delay
3. Unnecessary transportation
4. Unnecessary Process
5. Over stock
6. Unnecesary 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[4]

2.4.1. Kanban System

1. Kanban Type

Two type of Kanban that usually used are Withdrawal Kanban and Production – Ordering Kanban.[5]

2. Kanban Rule

Ideal tools is one way to accompilsh effective purpose. If used approriately, Kanban sytem can be an effective work hour surveillaince.[5]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 proccess.
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[5]

$$\begin{aligned}&\textit{Necessary number of parts during the lead time of withdrawal Kanban}\\&=\textit{Lead time of withdrawal Kanban}\\&\times\textit{Hourly average quantity of parts needed for subsequent process}\end{aligned}$$

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[5]

$$\begin{aligned}&\textit{Necessary number of parts during the lead time of withdrawal Kanban}\\&=\textit{Lead time of withdrawal Kanban}\\&\times\textit{Hourly average quantity of parts needed for subsequent process}\end{aligned}$$

$$\textit{Number of Withdrawal Kanban}=\frac{\textit{Necessary number of parts during the lead time of withdrawal Kanban}+\textit{Safety inventory}}{\textit{Capacity of one box}}$$

Remark :

Lead time of withdrawal Kanban = Production lead time

c. Computation of Reorder Point[5]

$$\begin{aligned}&\text{Necessary number of parts during the lead time of Signal Kanban}\\&=\text{Lead time of Signal Kanban}\\&\times\text{Hourly average quantity of parts needed for subsequent process}\end{aligned}$$

$$\text{Number of Signal Kanban}=\frac{\text{Necessary number of parts during the lead time of Signal Kanban}+\text{Safety inventory}}{\text{Capacity of parts box}}$$

d. Determination of Lot – Size[5]

$$\begin{aligned}&\text{Lot}-\text{Size}\\&=(\text{Daily average usage of parts}\ /\ \text{Times of setup per day})\\&+\text{Safety inventory per day}\end{aligned}$$

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..[5]

$$Takt\ Time = \frac{Effective\ Operational\ Time}{Daily\ Demand}$$

3. RESEARCH METHOD

3.1. Conceptual Model

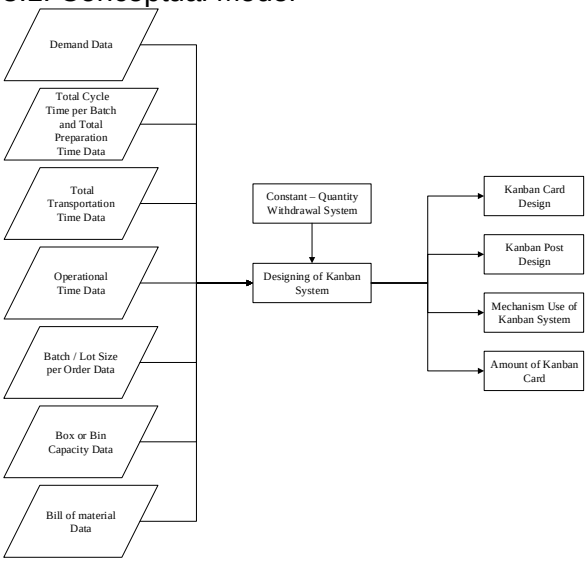


Figure 3 Conceptual Model

4. RESULT AND DISCUSSION

4.1. Designing Kanban System

4.1.1. Creating Value Stream

In Single Aisle project, there are 3 aspects that 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.

SIGNAL KANBAN CARD				
D57250330208	PART NUMBER	D57250330208	PROCESS	*100006*
	PART NAME	BRACKET	SHEET METAL FORMING	
	BATCH SIZE	72 UNIT		
	STANDARD LEAD TIME	122 HOUR		
	REORDER POINT	2 \ 4 NUMBER OF KANBAN		

Figure 4 Signal Kanban Card

PRODUCTION KANBAN CARD				
D57250800204A	PART NUMBER	D57250800204A	PROCESS	*100007*
	PART NAME	DOOR F-S ROOT	MACHINING	
	BATCH SIZE	15 UNIT		
	STANDARD LEAD TIME	183 HOUR		
	KANBAN NO.	1 \ 4 NUMBER OF KANBAN		

Figure 5 Production Kanban Card

4.1.4. Designing Kanban Post

a. Kanban Post Whiteboard

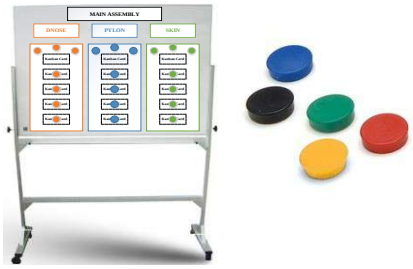


Figure 6 Whiteboard and Magnetic Pin

b. Kanban Post Hanger

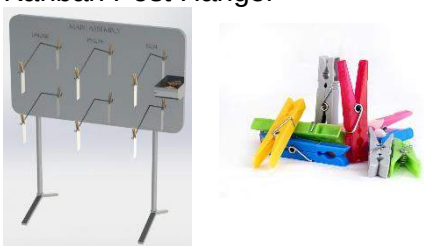


Figure 7 Hanger and Plastic/Wood Clamp

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 Electronic 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).

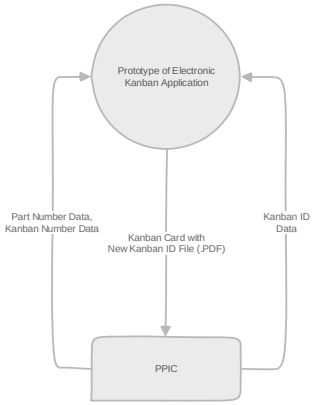


Figure 8 Context Diagram

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.

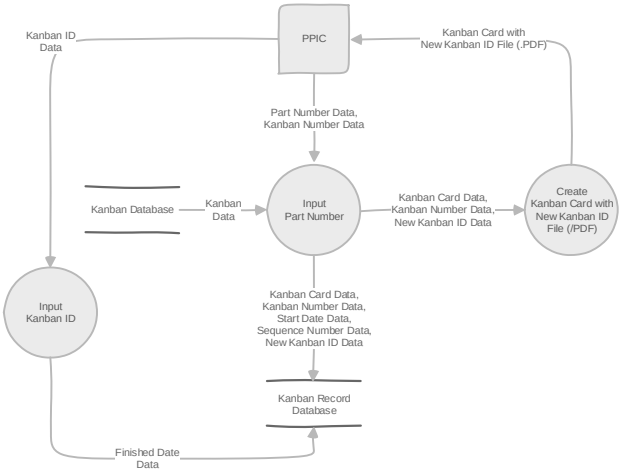


Figure 9 Data Flow Diagram level 1

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.

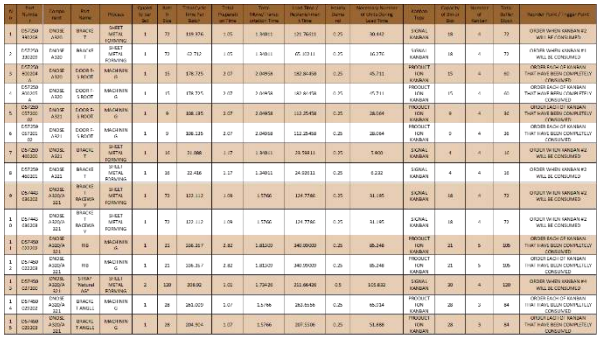


Figure 10 Kanban Database

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.

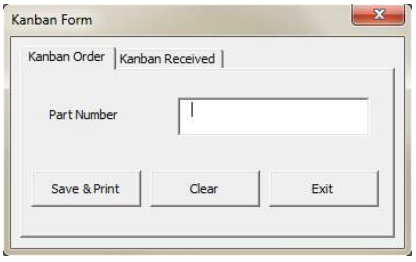


Figure 11 Kanban Order Form

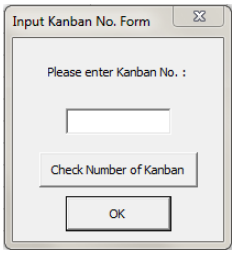


Figure 12 Kanban Input Form

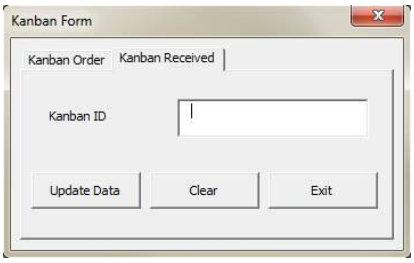


Figure 13 Kanban Received Form

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.

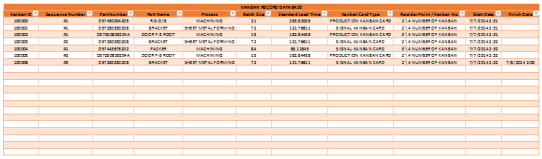


Figure 14 Kanban record Database

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.

	PART NUMBER		PROCESS	
	PART NAME			
	BATCH SIZE			
	STANDARD LEAD TIME			
	REORDER POINT			

Figure 15 Kanban Card template

4.1.5.3. Designing Kanban Flow

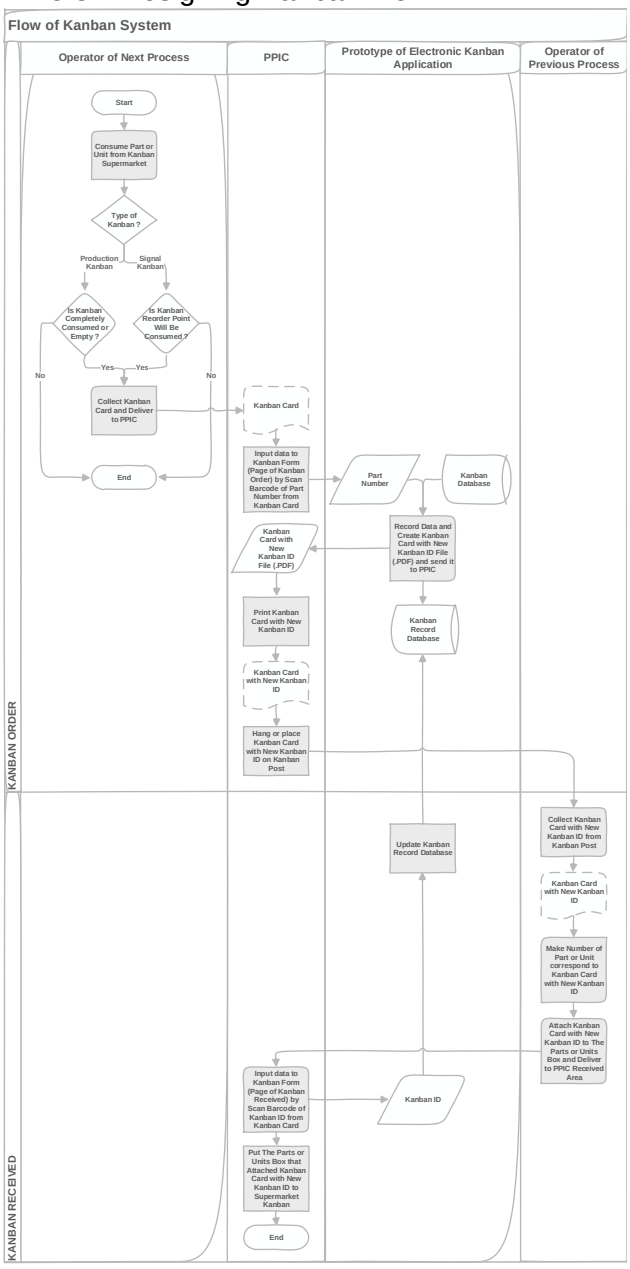


Figure 16 Kanban Flow

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

Element of Kanban System	Advantages	Disadvantages
Desagn Kanban Card	1. All information displayed on Kanban card is complete and clear as required. 2. Has the information in the form of a barcode that is useful in facilitating the data input. 3. It has been integrated with a prototype application of electronic Kanban. 4. Using the visual aspect of the colors that are distinguished by the intended process or department.	The possibility of damage to the Kanban cards such as bent or torn because of the materials used are paper.
Mechanism Using Kanban System	1. Useful as procedures or guidelines in the use of Kanban cards, Kanban post, and trigger point or reorder point. 2. Shows the flow of Kanban are all activities that must be performed by the parties involved in the use of Kanban System. 3. Using a prototype application that is useful in making the recording of orders placed on the Kanban system and also in the manufacture or Kanban card printing.	It takes adaptation to apply Kanban system to workers, because of differences in the procedures of the old system with a new system procedures (Kanban system).
Amount of Kanban Card	1. The number of Kanban cards are in accordance with the capability of the production process at PT. Indonesian Aerospace. 2. There is a trigger point or reorder point corresponding to the lead time in making a part number or replenishment time. 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 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.	The need for adjustment or setting the layout of a buffer stock in a storage area for the number of Kanban cards.
Design of Kanban Post (Whiteboard)	1. Function as a stopover place Post Kanban Kanban cards can be achieved. 2. Easy to be made, all the necessary materials in the manufacture of Kanban Post can be purchased. 3. Costs incurred in making Kanban Post was not too expensive.	Require additional activity by operators in arranging the order of Kanban cards.
Design	1. Function as Kanban Post	Possible damage to

Table 1 Advantages And Disadvantages Analysis of Design Kanban System

Element of Kanban System	Advantages	Disadvantages
of Kanban Post (Hanger)	that as a stopover place Kanban cards can be achieved. 2. With a downward sloping hanging, Kanban card sequence settings will regularly without operator assistance or eliminate the activity of the sequence settings Kanban Cards.	the Kanban cards are used due to the clamp.

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.

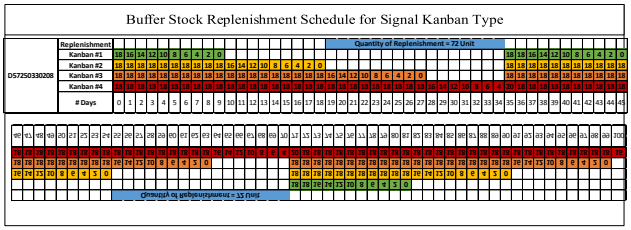


Figure 17 Buffer Stock Replenishment Schedule for Signal Kanban

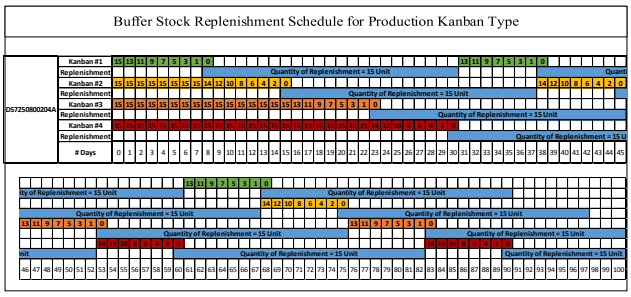


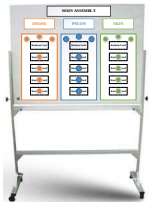
Figure 18 Buffer Stock Replenishment Schedule for Production Kanban

5. CONCLUSION

The results of this study are a Kanban system that is able to meet the schedule buffer stock replenishment. The elements of the Kanban system is designed is:

1. Kanban Post Design

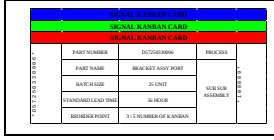
Table 2 Result of Kanban post

Kanban Post	
Kanban Post Whiteboard	**Kanban Post Hanger**
	

There are 2 types of Kanban post designed in this study are shown in Table that are Kanban post whiteboard and Kanban post hanger.

2. Kanban Card Design

Table 3 Result of Kanban Card

Kartu Kanban	
***Signal*Kanban**	***Production* Kanban**
	

In the Kanban card designed shown in Table 3, there are two types of cards that signal Kanban and production Kanban. In addition, there are also differences in the colors used on the Kanban cards by type of process in making a part number, which is blue for sheet metal forming process, green for the machining process, and red for the assembly process.

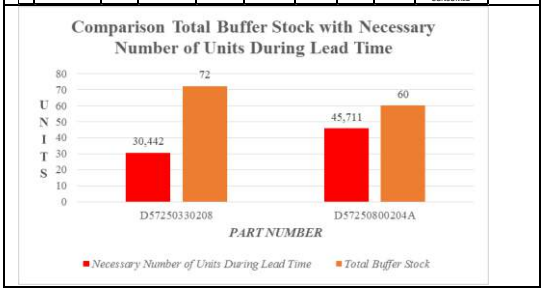
3. Amount of Kanban Card

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

Sample of Calculation Amount Kanban Card Result for Signal Kanban dan Production Kanban

No	Part Number	Batch Size	Lead Time / Replenishment Time	Necessary Number of Units During Lead Time	Kanban Type	Capacity of Bin or Box	Number of Kanban	Total Buffer Stock	Reorder Point / Trigger Point
1	D57250330208	72	121.76611 hour (16 days)	30.442	SIGNAL KANBAN	18	4	72	ORDER WHEN KANBAN #3 WILL BE CONSUMED
2	D57250800204A	15	182.84458 hour (23 days)	45.711	PRODUCTION KANBAN	15	4	60	ORDER EACH OF KANBAN THAT HAVE BEEN COMPLETELY CONSUMED



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.

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