DESIGNING ELECTRONIC KANBAN TO REDUCE LEAD TIME ON CONE ASSEMBLY LINE IN PT XYZ

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***Abstract*— Airplanes manufacturing are growing along with the increasing demand from consumers. PT XYZ is a manufacturing company of aircraft included the design and development, manufacture, assembly, and services of aircraft. The helicopter's tail called Tailboom is a product of the helicopter division, where the Tailboom assembly line is a pull system. Based on observations of existing conditions that occur at PT XYZ, production is still unable to meet demands of consumers, Lead Time occurs greater than the plan agreed upon by the consumers. In the assembly process, each work station experiences a lack of parts and component needed to assemble. This happens because of the delay in getting the required part information and there is no warning about the availability of parts needed, it makes some parts unavailable in assembly warehouse. The lack of parts and components from the previous work station causes the assembly process to stop and the assembly line also stops at the next station. In its completion, the production time was late and not on schedule. In resolving these problems, controlling process is needed, which is controlling the assembly line to get all components and sub-assembly in the right amount and at the right time. This study applies one of Just In Time tools, namely Kanban and automation should be added as efficiently and effectively communication line becomes Electronic Kanban. The problem can be solved by reducing buffer such as waiting time and idle time. The proposed results of controlling the assembly line of Tailboom result in a smooth assembly line without waiting, reduced lead time and achieving production time according to the schedule agreement with the consumers.**

***Keywords*— Kanban, E-Kanban, Lead Time, Pull System.**

Abstrakt*— *Manufaktur pesawat terbang tumbuh seiring dengan meningkatnya permintaan dari konsumen. PT XYZ adalah perusahaan manufaktur pesawat yang mencakup dalam desain dan pengembangan, pembuatan, perakitan, dan perawatan pesawat. Ekor helikopter yang disebut Tailboom adalah produk dari divisi helikopter, dengan lini perakitan Tailboom adalah sistem tarik. Berdasarkan pengamatan terhadap kondisi saat ini di PT XYZ, produksi masih belum dapat memenuhi permintaan konsumen, Lead Time terjadi lebih besar dari rencana yang disepakati oleh konsumen. Dalam proses perakitan, setiap stasiun kerja mengalami kekurangan komponen yang dibutuhkan untuk merakit. Hal ini terjadi karena keterlambatan dalam mendapatkan informasi bagian yang diperlukan dan tidak ada peringatan tentang ketersediaan suku cadang yang dibutuhkan, hal ini membuat beberapa komponen tidak tersedia di gudang perakitan. Kurangnya komponen dari stasiun kerja sebelumnya menyebabkan proses perakitan berhenti dan lini perakitan juga terhenti di stasiun berikutnya. Sehingga, waktu produksi terlambat dan tidak sesuai jadwal. Dalam menyelesaikan masalah ini, diperlukan adanya proses pengendalian, yaitu mengendalikan lini perakitan untuk mendapatkan semua komponen dan sub-perakitan dalam jumlah yang tepat dan pada waktu yang tepat. Penelitian ini menerapkan salah satu alat* **Just In Time, yaitu Kanban dan ditambahkan otomatisasi sebagai jalur komunikasi yang lebih efisien dan efektif menjadi Elektronik Kanban. Masalah ini dapat diselesaikan dengan mengurangi* **buffer** *seperti waktu tunggu dan waktu* **idle***. Hasil yang diusulkan untuk mengontrol jalur perakitan Tailboom menghasilkan jalur perakitan yang lancar tanpa menunggu, mengurangi* **lead time** *dan mencapai waktu produksi sesuai dengan perjanjian jadwal dengan konsumen.*

Kata Kunci*- Kanban, E-Kanban, Lead Time, *Sistem Tarik.

I. INTRODUCTION

PT XYZ is a manufacturing company in the regional civil and military commuter aircraft, as well as included the design and development, manufacture, assembly, and services of aircraft. Currently PT XYZ is conducting a tail boom project for helicopter to meet subcontract demand from France. Company has a different demand each year. But, the company only can meet 48.39% of the average demand.

Tabel.1 Historical Demand

Year	C/O (Unit)	Target Production (Unit)	Realization Production (Unit)
2015		4	3
2016	1	5	3
2017	1	9	7
2018	1	16	14

Tail boom is the back side of a plane. It divided into two main parts there are Cone and Pylon. Based on production time data the company has a problems on Cone assembly there are some delay.

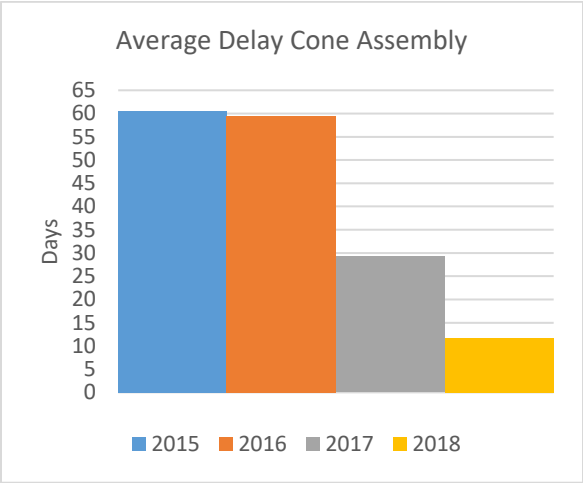

Figure.1 Average Delay Of Cone Assembly

In 2015 the average delay was 61 days, 2015 was 60 days, in 2017 was 29 days, and 2019 was 12 days which are late from the production target. Some of components are not ready to be assembled because several reasons like parts is not available to assemble the component, and reject part because does not meet the requirement to assemble the component, and late of sub assembly process time in the each workstation which results in high cycle time in making one component.

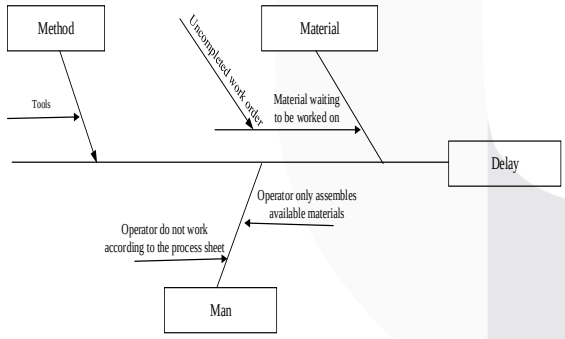

Figure.2 Fishbone Diagram

The delay causes the assembly line stop running and late of plan finish date. So that lead time for cone assembly will also be delayed. A major problem in this assembly line are late of date from each sub assembly for each component to processing final assembly. To obtain all the components and sub assembly that are needed in the right amount and at the right time, the appropriate control system that can be used is Kanban. Kanban is card that contain the product information required for production or assembly at each stage and details of the completion path. By using Kanban, the minimum inventory can be achieved at one time [1]. However, there are some problem while using Kanban card is information about Kanban cards carried out manually by the operator, this process requires time for the operator and requires a lot of paper to be used. Then, the results of manual records must be entered into the system, the delay of inputting the data will hold over the update of the latest information which is integrated by all departments.

From this problem, the electronic Kanban system is designed to solve this problem. Kanban Electronic (E-Kanban) is a variation of conventional Kanban by converting physical signals into electronics, making it more accurate in transmitting information [2].

The information provided by electronic Kanban is more efficient and effective compared to conventional systems caused by a reduction in waiting time [3].

II. LITERATURE REVIEW

As explained before, Kanban is one of Just In Time (JIT) tools to control assembly line. Just In Time is a philosophy of various concepts that produce different ways of doing business for most organizations [4] .

Kanban is a visual sign or signal that conveys a set of instructions to either withdraw parts or produce a given product. Kanban system is supported by the following things [5], namely:

1. Smooth production
2. Work standardization
3. Reduction of setup time
4. Repair activities
5. Engine layout design
6. Autonomation

While designing kanban card, Kanban calculations are done using fixed amount collection system.

To calculate the number of kanban card, there are several steps that must be done, such as determining number of part during lead time, calculation of safety inventory, and calculating Kanban cards. The following are the steps for calculating Kanban cards:

1. Determine number of parts during the Lead time of Kanban

$$NP = \text{part required} \times (\text{cycle time available hour})$$

2. Determine Safety Inventory

$$SI = NP \times 0.1$$

3. Kanban Card Calculation

$$N = \frac{NP + SI}{Capacity\ of\ one\ box}$$

In order to calculate the number of kanban, several notations are used:

N = Number of Kanban
NP = Number of Parts During The Lead Time of Kanban
SI = Safety Inventory

III. METHODOLOGY

This study purpose to design a system that can control the assembly process especially for cone assemly on assembly lines at PT XYZ. This research is done by using tools of electronics Kanban which are expected to reduce the delay and create a timely assembly process.

This research began by collecting data on the assembly line for cone assembly at PT. XYZ. Then, designing of Kanban system. In this process of designing the Kanban system adapted to the conditions that occur in the process on cone assembly, so it designing how the Kanban mechanism will work, determining amount of Kanban by Kanban calculation and the flow of the kanban is also included in the design process.

The output for this final projects is an electronic Kanban. Electronic Kanban as a Kanban system designed to display visually through the monitor. Kanban is made to reduce the delay and avoid line stop in assembling of cone, so it achieved the purpose of timely assembly process and reduce the lead time.

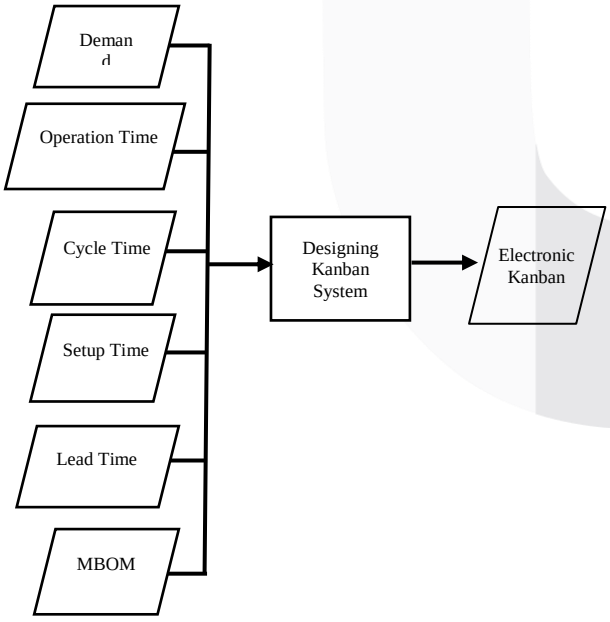

Figure.2 Conceptual Model

IV. RESULT AND DISCUSSION

A. Current State of Cone Assembly

On the cone assembly there is a differences between actual start and finish date with plan start and finish date, which mean there is a delay. This delay is caused by out of control in the assembly line, there is no getting information about the component needed and there is no warning about the availability of parts needed when the right time and right amount, it makes some part are not available in store. The delay causes the assembly line stop running and late of plan finish date. So that lead time for cone assembly will also be delayed.

B. Number of Kanban

The number of kanban should be limited. Because the more kanban in circulation, the greater the number of component on process. Also the revers, the fewer kanban cards, the fewer the number of component available. Based on Kanban card calculation using fixed amount collection system., the number of Kanban is obtained in different amount for each component.

Table.3 Number of Kanban

Component No	N	Component No	N
ABCDEF05090101	1	ABCDEF09150002	1
ABCDEF05100101	1	ABCDEF09156781	1
ABCDEF09030002	1	ABCDEF09178932	1
ABCDEF09050501	9	ABCDEF09164501	1
ABCDEF09080401	15	ABCDEF09453621	1
ABCDEF09110203	13	ABCDEF0976451	1
ABCDEF09760401	28	ABCDEF0647482	1
ABCDEF09790201	1	ABCDEF01370306	1
ABCDEF09960102	1		

The amount of Kanban card shows how many times the component will be taken. The more cards, the higher frequent to take the items. There are several advantages and weakness for the number of Kanban
.

Table.4 Advantages and Weakness of Amount Kanban Card

Result of Amount Kanban Card			
Advantages		Weakness	
1	The amount of Kanban cards has been adjusted on cone assembly line	1	Need a time to check the Kanban card
2	The number of cards is an input to controlling the schedule so it will be right at the right time and the right amount	2	There is a possibility the card will be damaged

C. Kanban System on Cone Assembly

The information flow is from assembly line area that must assemble product according to fulfill the demand. In Assembly line area, on each workstation send the Kanban card is used to control the process of cone assembly from the part package sent by the sub assembly store until it is processed into components and become a final product. From the final product namely tailboom, the card in station will be used to collect main sub assembly. When the red card has been sent to Cone Assy, it must send the cone card to each workstation. If the information appear on the kanban board, then the sub assembly store must send a part package to assembly line to assemble the product.

The use of red cards in designing electronic Kanban systems to show in the form of a data list as a trigger for sending the part or component required. When sub assembly store receives information that must be send the part package from the store to assembly line, the card will be used as a command to change the part into a package so that can be sent to the assembly line area.

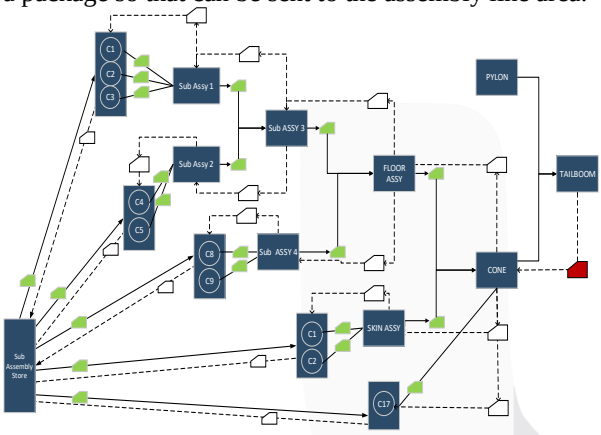

Figure.3 Kanban System Mechanism

Kanban card design is the design of a visual form that will be used on Kanban and information that would be displayed. Visual form of kanban card can be useful in helping the kanban system to be designed. While designing the Kanban card, some information will be displayed on the Kanban card. This information is useful for launching the system that has been designed. The information includes number of parts, name of part, previous of process, and number of items.

TAILBOOM CONE Product ID 332A2405090101 Card Number 001	**Production Kanban** Component No. ABCDEF002 Component Name Sub Assembly Prev Process 0 Part Quantity 16

Figure.4 Design of Kanban Card

D. Electronic Kanban System

To designing electronic kanban in detail, needed to do a drawing a kanban flow at the assembly store and assembly line.

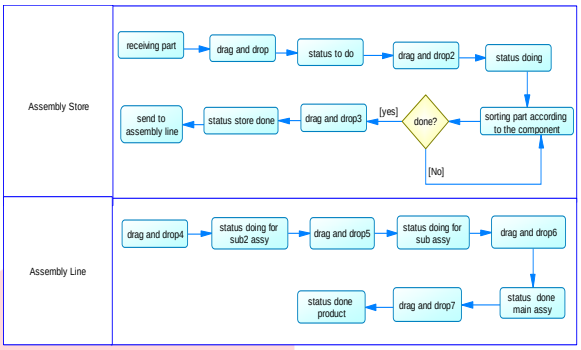

Figure.5 Mechanism of Using a Electronic Kanban

In addition, the electronic kanban also has several interfaces such as dashboard, is an information system application model provided for managers to present quality performance information. There some main information are ordered part, demand and the number of fulfilled demand, the number of available and needed part, and the percentage of work completed.

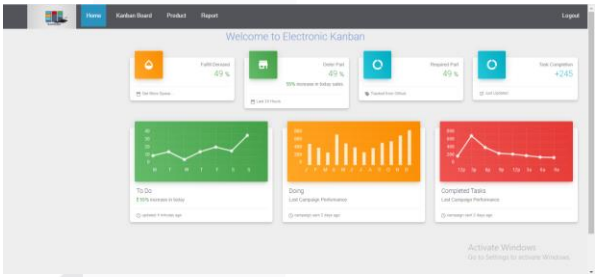

Figure.6 Dashboard Interface

Also there are kanban board visualization in general that shows the number jobs on the board to do, doing, and Done. To Do is a list of items that will be processed, Doing is an ongoing process and Done is a status for the product that has been completed.

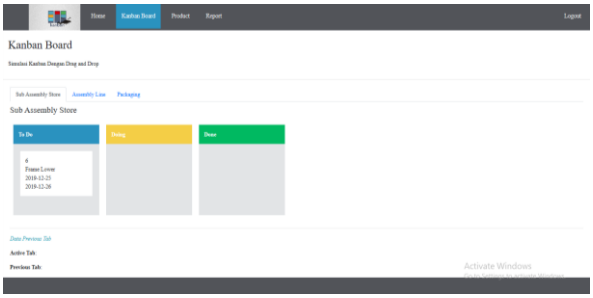

Figure.7 Kanban Board Interface

After designed the Kanban system based on electronic will give out the actual information on the components which is being worked on and input the data to the system automatically. The information explained tracking the process of product, each component to be worked on, is being worked on, and has been done. Also included the number of part and component needed, and the number of part that have been completed.

Table.5 Percentage of Lead Time

No	Component Number	Lead Time Actual (hour)	Lead Time (hour)	Tardiness
1	ABCDEF05090101	3.135	2.579	0.556
2	ABCDEF05100101	13.837	4.627	9.210
3	ABCDEF09030002	6	5.703	0.297
4	ABCDEF09050501	52.499	46.745	5.754
5	ABCDEF09080401	53.45	50	3.450
6	ABCDEF09110203	53.25	51.414	1.836
7	ABCDEF09760401	104.889	85.266	19.623
8	ABCDEF09790201	13.314	11.234	2.080
9	ABCDEF09960102	11.412	10.230	1.182
10	ABCDEF09150002	24.5	3.15	21.350
11	ABCDEF09156781	5.584	4.084	1.500
12	ABCDEF09178932	2.845	2.845	0.000
13	ABCDEF09164501	7.802	7.802	0.000
14	ABCDEF09453621	4.297	4.297	0.000
15	ABCDEF0976451	8.670	6.433	2.237
16	ABCDEF0647482	6.018	6.018	0.000
17	ABCDEF01370306	11.754	11.754	0.000
Total		383.256	314.181	69.075

The impact of this system makes assembly flow will be controlled and available in the right amount and right time so the delay will reduce and so the lead time will be reduced too. The lead time is reduced by 18%. On the electronic Kanban system design, there are some advantages and weakness.

Table.6 Advantages and Weakness of Electronic Kanban Mechanism

Result of Using Electronic Kanban			
Advantages		Weakness	
1	Automated work status for the operator	1	The operator must understand the mechanism for using Kanban system and knowing the electronic system to get the data flow properly
2	No duplicate Kanban Card, so the status of part or components flow properly		
3	The movement of flow status easly and no need much time because only drag and drop		
4	Only need a pc or touch screen monitor for the facilities to running this system		
5	Reports or history are recorded automatically in the application so the problem can easily detected		

V. CONCLUSION

The result of this research is a Kanban system, based in electronics that is able to control the flow of production so that parts and components needed to assemble are appropriate in the right time and the right amount, and in the end there are no stopping lines on the assembly line.

This Kanban system expects to reduce lead time up to 18%. This result is obtained through comparison the actual lead time and the standard lead time of cone assembly. This is caused by reducing delays. With a reduction of 18% delay, the assembly line will run smoothly and according to the time requested. Lead time reduction occurs because of card information that shows the availability of goods needed. If a demand arrives, the system will show the components needed through an electronic based monitor, then the required components must be sent immediately. In addition, there is also information about the system in the sub assembly store to send the items needed immediately. When sending parts with a work packages, the required parts or components must be sent to replenish. This will have the effect of sending the part in right time and right amount.

The design of an Electronic Kanban System also has a good impact that will increase accuracy and ease when compared with manual systems. This accurate level is based on a display that monitoring processes, such as what processes need to do, the process that is being carried out and processe has been done, and reports on all components. And the easiness is that the operator only drag and drop to change the status in the system, so it will not distrub the operators while

working. When designing an Electronic Kanban System, there are a number of things that must be present such as the Kanban card and the Electronic system application must be according to the demand requirements and the flow of the assembly process. However, to implement this system, the facilities needed are Monitor and Personal Computer.

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