Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 41 (2012) 1721 – 1726

Engineering Procedia

www.elsevier.com/locate/procedia

International Symposium on Robotics and Intelligent Sensors 2012 (IRIS 2012)

Development of Kanban System at Local Manufacturing Company in Malaysia – Case Study

Ahmad Naufal*, Ahmed Jaffar, Noriah Yusoff, Nurul Hayati

Faculty of Mechanical Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

Abstract

Kanban system is inventory stock control system that trigger signal for production of product based on actual customer requirement. This study presents the development of kanban system at local manufacturing company in Malaysia. The study discusses flow of implementation activities in manufacturing site prior to kanban system. The paper concludes that implementation of kanban system would reduce lead time, minimize inventory on floor and optimize storage area. Therefore, the objective of this study is to highlight the kanban system implementation that improve manufacturing system as well as achieved Just In Time practice.

Keywords: Just In Time; Kanban system; Manufacturing lead time reduction.

* Ahmad Naufal Adnan is a master student in Faculty of Mechanical Engineering Universiti Teknologi MARA Malaysia. (*E-mail address:* ahmadnaufaladnan@ yahoo.com).
Ahmed Jaffar is now a Professor and Dean of Faculty of Mechanical Engineering Universiti Teknologi MARA Malaysia. (*E-mail address:* ahmedjaffar@salam.uitm.edu.my).
Noriah Yusoff is now a lecturer in Faculty of Mechanical Engineering Universiti Teknologi MARA Malaysia. (*E-mail address:*noriahyusoff@salam.uitm.edu.my).
Nurul Hayati is now a lecturer in Faculty of Mechanical Engineering Universiti Teknologi MARA Malaysia. (*E-mail address:*hayatihalim@salam.uitm.edu.my).

1. Introduction

Traditional manufacturing strategy is driven by ‘Push system’ with aimed to keep large of inventory of product according to customer forecast. However, this has created big problem to people on floor in dealing with high of WIP inventories, unsynchronized production processes and producing unnecessary stock. Due to that, established company like Toyota Motor Corporation has moved to next level of manufacturing approach or strategy by adopting Kanban system [1]. The adoption of kanban system has improved their efficiency and flexibility of manufacturing according to customer needs. Kanban system is pull system approach that giving authorization to produce at required rate and at specific time in order to replenish part that already consumed by customer [2, 5].

Nowadays, many companies faced pressure to meet global market demand. The increase of global competition forces company to produce high value and good quality of product, on time delivery and competitive price. They have focused to meet these needs as requirement to remain in global market [4]. The success of Japanese company has attracted attention from entire world particularly Western company. The implementation of Just in time (JIT) practice through kanban system

* Corresponding author. Tel.: +6019-2747054; fax: +603-5543-5160.
E-mail address: ahmadnaufaladnan@yahoo.com

1877-7058 © 2012 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
doi:10.1016/j.proeng.2012.07.374

mainly at manufacturing area has improve their efficiency, reduce operation cost, enhance competitiveness and achieved the goal of zero inventory [10]. Therefore Japanese company is able to provide affordable price with high quality of product to customer. In many researches had reported that it would gain maximum benefits from JIT and Kanban system implementation [3, 6].

'Just in time' (JIT) approach is based on lean manufacturing system which develops to optimize and improve manufacturing efficiency by reducing manufacturing lead time through waste elimination and kanban. It was derived from Toyota Production System as a principle to minimize inventory and improve throughput [7]. Takt time is used to regulate manufacturing pace on floor [8]. As a result, smooth material flow and synchronized manufacturing process has established to increase efficiency and productivity of manufacturing system and expose all wastes at entire area for improvement.

Kanban system emphasizes minimum level of inventory. It ensures the supply of right part, in right quantity, in the right place and at the right time [3]. Kanban system is mechanism to manage and control flow of material in manufacturing. Card is used to regulate pattern of material flow throughout process. It was driven from downstream need and trigger upstream production. Upstream production is then initiated to replenish those parts that have been withdrawn [1, 2]. Most of researchers had concluded that Kanban system could lead to reduction of lead time and manufacturing excellence [2, 3, 9].

There are two types of kanban system which are single card kanban system and two card kanban system [4]. Single card kanban system uses only 1 type of kanban card to trigger upstream production when it needed. This card called Production Instruction Kanban (PIK). While two card kanban systems are using two types of card which are Production Withdrawal Kanban (PWK) and Production Instruction Kanban (PIK). PWK card is used to withdraw needed goods from preceding process and PIK card is used to give instruction to preceding process to produce what is needed for inventory replenishment.

In order to achieve lean goal, essentially kanban system is established on factory floor to align flow of material by removing all waste and source of waste. Waste is anything that customer not willing to pay for and it could be categorizes into 7; transportation, over inventory, excess of motion, waiting, over process, over production and defect [3, 4, 6]. Kanban system that implemented at manufacturing area was equipped with relevant tools such as heijunka board, lot formation post, kanban chute and kanban post. These tools are used to visualize abnormality and assist production associate to work according to takt time. JIT approach enables company to achieve high product quality with minimal resources.

The research is about the implementation of kanban system to high volume medium variety of product at local manufacturing company in Malaysia. This paper is a case study research that involves manufacturing company. The objective of this paper is to highlight flow of activities to establish kanban system and ultimately achieving the pull manufacturing system.

2. Methods

In this section, method to develop kanban system is presented. The method for this case study consist of

i. Gathering relevant parameter
ii. Calculating kanban quantity
iii. Establishing pull mechanism and rule

As a started, relevant production parameter was gathered such as cycle time, withdrawn time, time for waiting kanban, time to replenish, part variant, safety stock and container capacity. All the parameters were taken directly from production floor and history record. Another important parameter was customer demand. Basically, 3 consecutives of customer forecast demand was collected to determine the highest volume within the period. This to ensure that kanban system is capable to cater the highest demand from customer. Gathering of accurate and appropriate parameter must be done prior to kanban calculation to ensure that numbers is optimum and sufficient to cater customer need.

Next, kanban calculation was carried out to determine optimum number of kanbans in system. Toyota formula (derived by UMW Toyota) was used to determine kanban numbers. Due to current manufacturing system, two kanban cards system was suggested to suit with current condition. The cards are Production Instruction Kanban (PIK) and Production Withdrawal Kanban (PWK). The calculation was carried out by:

$$PIK - \left(\left(W_K + T_w + T_L\right)/T_T + \alpha\right)/c \quad (1)$$

where,

PIK = number of production instruction kanban,
W_K = withdrawal time,
T_W = time for waiting kanban,

T_L = time to replenish part
T_T = takt time
α = safety stock
c = container capacity

$$PWK = (D + K_W + \alpha)/c \quad (2)$$

where,

PWK= number of withdrawal kanban
D = customer demand quantity,
K_W = quantity of kanban waiting
α = safety stock
c = container capacity

The total numbers of kanban must be tally with inventory to achieve smooth circulation of kanban card in the system. Therefore accuracy and reliability of parameter is important for kanban calculation.

Once optimum number of kanbans was defined, it is time to establish pull mechanism and rule for kanban system. For the start, kanban tools were fabricated to visualize kanban flow then kanban rule was established to assist production personnel regarding kanban system. Finally analysis would be carried out to measure the effectiveness of the kanban system.

3. Case Study

BLM Cylinder Head Cover (CHC) manufacturing process is production assembly line that produce cylinder head cover product for Proton model. The major process steps of BLM CHC are sketched in figure 1. Currently this line is producing 3 different product variants for Proton.

This line is running in push system where forecast schedule is used to determine production quantity. As the push system type, completed product is pushed to storage area without consideration of actual requirement by customer. As a result production output was not synchronized against customer requirement, stagnation of WIP part on floor and long lead time occur. Beside that congested and unorganized of finished goods at warehouse was occurred that made large space was needed. Therefore, material flow was not happen in the system. Due to this, the company has difficulty to respond to changing demand requirement. To overcome this problem they had decided to implement kanban system to this manufacturing process in order to respond actual requirement from customer.

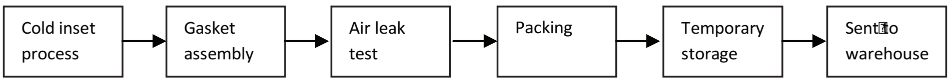


Figure 1: Major process step of BLM Cylinder Head Cover manufacturing process.

4. Development of Kanban system

4.1. Gathering relevant parameter.

As a start gathering of production parameter and forecast demand was carried out as shown in table 1 and table 2.

Table 1: Relevant parameter; a) Production parameter, b) Customer forecast

a)

1	Number of product variant	3 variants
2	Number of working days	22 days
3	Working hours	10.25 hours
4	Change over time	5 minutes
5	Cycle time	30.7 seconds
6	Container capacity	5 pieces

b)

Part no.	October	November	December
11001-PTN	6180	5685	3540
11003-PTN	6040	6565	6570
11004-PTN	0	500	1100

This parameter is based on current condition of manufacturing process line. From the customer forecast data in table 1 the highest volume for each product was selected in order to define takt time for this process line.

4.2 Calculating of Kanban

To ensure that manufacturing process is able to meet demand, kanban calculation was carried out. It was started with Production Instruction Kanban (PIK) calculation and then followed by Production Withdrawal Kanban (PWK) calculation. All parameter like cycle time, change over time, available time, number of working days, part variant and container capacity were taken into account to determine optimum numbers of kanban, refer table 2 for optimum numbers of kanban in the system.

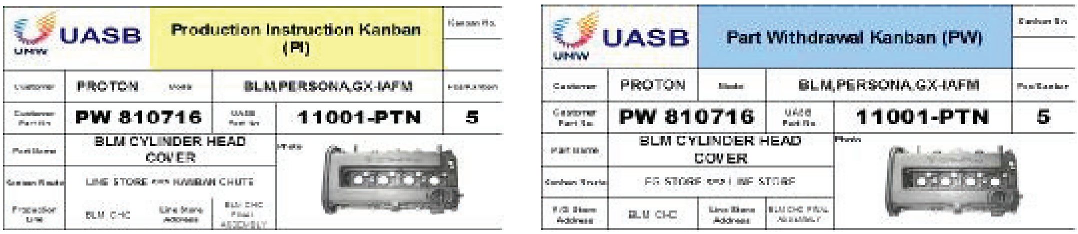
Table 2: Numbers of kanban, PIK and PWK.

Part no.	PIK	PWK
11001-PTN	31	107
11003-PTN	33	114
11004-PTN	9	19

Based on the table 2, numbers of PWK for each part number was higher than PIK because due to current manufacturing capability, the company had decide to use 1 day of inventory for safety factor in order to ensure that delivery to customer was not effected when machine breakdown or short supply of component occurred.

4.3 Establishing pull mechanism and rule

Before kanban pull system is realized on manufacturing floor, establishing of their mechanism and rule is needed in order to assist kanban activity. For the start kanban card was designed and produced.



a) b)

Figure 2: Example of kanban card; a) Production Instruction Kanban card and b) Part Withdrawal Kanban card.

The Production Instruction Kanban card is a production order, which give the instruction to process line to produce the required product and quantity needed while the Production Withdrawal Kanban card is authorization signal for withdrawal process according to customer need. The kanban cards should contains required information for production process to ensure that, they are producing right part and right quantity to customer. The following is guidelines to design kanban card.

- Customer information such as customer, customer product name and type of model,
- Product information such as part name, part picture and quantity per packing,
- Production process address and storage area.

Next was establishing heijunka post that used to level and mix of production. In manufacturing, heijunka is used as planning schedule which evenly distributes volume and variety of product throughout available time. Every kanban card that detached from container during withdrawal process then was loaded into heijunka post. Then card at heijunka was used to withdrawn product at process line to replenish Finished Good (FG) that had been delivered to customer. The frequency of withdrawal is according to takt time. Therefore heijunka prevent uneven loading of volume occurred in production floor. To establish this post, few guidelines have to be followed such as;

- Determine frequency of withdrawal process and conveyance time,
- Determine quantity of heijunka slot based on product frequency and product mix,
- Defined product variant and maximum production quantity according to customer demand,
- Gathering relevant delivery and manufacturing data for heijunka post information,

Lot formation post was then fabricated to prioritize the part need to be produced (refer figure 3) based on withdrawal of product at process line inventory. The lot formation post is used because this process line required change-over activity to switch production from one product to another product. However before switching was occurred, the withdrawal of product at inventory has met pre-specified quantity which called as lot size. The lot size is defined from PIK calculation. When the lot size is met, cards were picked up and drop by to process line to trigger production of product.

By having the lot formation post, optimum number of change-over activity would be determined and inventory of product would be reduced by producing based on actual demand. The following is information required for lot formation post;

- Product variant involved,
- Lot size number.

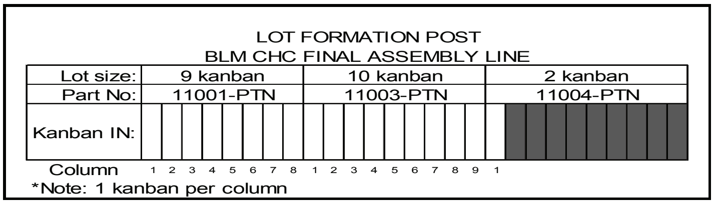


Figure 3: Example of Lot formation post

Based on figure 3, lot size for 11001-PTN, 11003-PTN, 11004-PTN is 9, 10 and 2 kanban respectively. Every column represents 1 kanban card. The cards are picked when quantity of cards at post is equal to lot size number.

After that other kanban tools were setup such as kanban chute and kanban post. Kanban chute is used to arrange part sequence in 'First In First Out' manner. Other than that, kanban chute serve as visual performance tool for process line. Color sign was used to visualize the performance of process line;

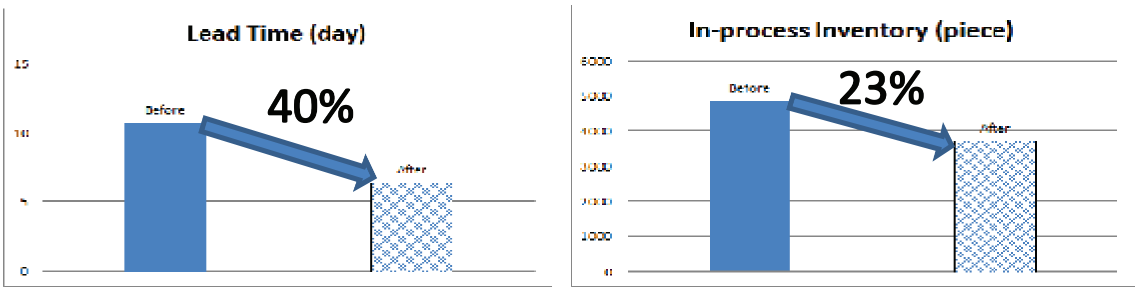
- green mark shows that cycle time below than takt time,
- yellow mark shows that cycle time equal or above than takt time,
- red mark shows that cycle time above than takt time (higher).

Second tool was kanban post. This tool is used as collection post for kanban card while waiting to load into heijunka post. To govern these kanban activities, a kanban rule was established. This rule documented all the guidelines and references for all the production personnel that involves in this activities. It helps the operation to manage and monitor the kanban activity systematically.

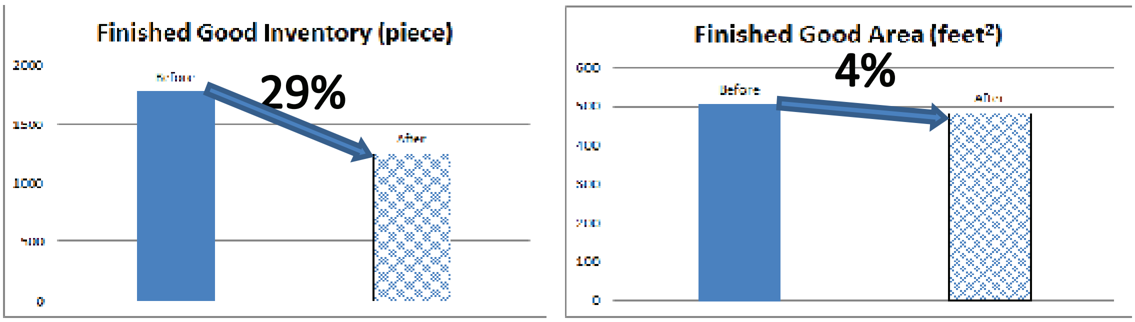
5. Results and Evaluation

After implementation of kanban system at BLM CHC manufacturing line, this company had achieved excellence improvement in few areas. Kanban system that triggers upstream production based on downstream requirements had improved relevant areas such as;

- lead time reduced by 40%,
- in-process and finished good inventory minimized by 23-29%
- finished good area optimized by 4%.



a) b)



c) d)

Figure 3: % of reduction after kanban implementation; a) Lead time, b) In-process inventory, c) Finished good inventory, d) Finished good area.

Based on the result above, significant improvement has achieved after implementation of kanban system. Manufacturing lead time has been shortened compare to before kanban system is implemented. This is due to production of product according to kanban card instruction only. Consequently, inventory at both area and space for finished goods also minimised. The use of heijunka post to level and mix variety of product throughout production time has prevented uneven demand to production process line. Other than that, kanban tools such as lot formation post, kanban chute and kanban post has help production department to determine product need to be produce. Therefore, implementation of kanban system indicates that manufacturing performance has improved by creating synchronization between process lines in system with customer need.

6. Conclusion and Recommendation

This paper presented a real industrial case study of kanban system implementation in manufacturing site. The results of research study demonstrate kanban system is essential in ensuring the success of Just In Time practice and to create smooth flow of part throughout manufacturing system. The implementation shows that lead time, in-process and finished goods inventory and also finished good area will certainly improve. Systematic and full commitment in implementing kanban system has optimized and enhanced manufacturing capability in meeting customer demand. Subsequently manufacturing pace will be controlled and synchronized with market demand. Therefore, it can be concluded that implementation of kanban system has improved manufacturing system and this should be part of the core task of JIT practitioner.

References

[1] Asbjoern M. Bonvik, Stanley B. Gershwin. Beyond Kanban: Creating and analyzing lean shop floor control policies[1]. Manufacturing and Service Operations Management Conference; 1996.

[2] N. Singh, Kwok Hung Shek. The Development of a Kanban System: A Case Study. International Journal of Operations & Production Management 10 (7), 28-36 (1990).

[3] C. Sendil Kumar , R. Panneerselvam. Literature review of JIT-KANBAN system. The International Journal of Advanced Manufacturing Technology (32), 393-408 (2007).

[4] Arawati Agus, Mohd Shukri Hajinoor. Lean production supply chain management as driver towards enhancing product quality and business performance: Case study of manufacturing companies in Malaysia. International Journal of Quality & Reliability Management, Vol. 29 Iss: 1pp. 92-121.

[5] Yannick Frein, Maria Di Mascolo. On the design of generalized kanban control systems. International Journal of Operations & Production Management, Vol. 15 No. 9 1995, pp.158-184.

[6] Bhim Singh, S.K. Garg, S.K. Sharma, Chandandeep Grewal. Lean implementation and its benefits to production industry. International Journal of Lean Six Sigma 1 (2), 157-168 (2010).

[7] Stump, B., Badurdeen, F. Integrating lean and other strategies for mass manufacturing: a case study. *Journal of Intelligent Manufacturing* 1-16 (2009).

[8] Ruth A. Kasul, Jaideep G. Motwani. Successful implementation of TPS in a manufacturing setting: a case study. *Industrial Management & Data Systems* 97 (7), 274-279 (1997).

[9] Marc E. Levitt, Jacob A. Abraham. Just-In-Time Methods for Semiconductor Manufacturing. Advanced Semiconductor Manufacturing Conference; 1990.

[10] Judith Matzka, Maria Di Mascolo, Kai Furmans. Buffer sizing of a Heijunka Kanban system. Journal of Intelligent Manufacturing 23 (1), 49-60 (2009).