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# Electronic Kanban System

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***Abstract-*** The project's objective is to study the role of Kanban in Production system. With the present rate at which the technology is evolving and the competition among the company there is a must among the manufacturer to produce their product at cost efficiency. The theory below hence describes about the impacts of KANBAN in an industry and its basic framework. In this paper we have talked about the Kanbans efforts on a multi stage in order to improve planning and production and role of Kanban size in Just in Time Manufacturing are discussed. The problem faced by a manufacturing company (Oral B) and how they overcame it by implementing Kanban with a great margin of profit is discussed briefly. Future trends in implementing Kanban such as digital and E-Kanban and also the scope of their effects is explained as a part of study. The scope of the project is limited to discussion of current and future Kanban strategy.

This paper presents a case study of the use of an e-Kanban system to minimize operational and logistics issues for a parts supplier within the automotive industry. Measures of operations and logistics performance are examined both before and after the implementation of the e-Kanban system through a series of observations, in-depth interviews, and documentation reviews. The results indicated improvements in production lead times, financial costs, effective and efficient work processes, and reductions in waste. The enhancement of the e-Kanban system through radio-frequency identification (RFID) is also discussed.

## I. WHAT IS KANBAN?

According to Wayne Scott Ross (2003), the word "Kanban" is Japanese word for "advertising hoarding". A Kanban Card is merely advert giving the message 'Production Component for me'. Many decades have passed ever since the introduction of Toyota's production systems by Sugimori et al. (1977) and Monden (1983). Today, Just-in-Time (JIT) production system of Toyota is generally regarded as one of the most excellent system in the world (Spear and Bowen 1999). The Kanban system is the key to the success of JIT production. Ohno (1988) usually recognized as the developer of Kanban, states that the proposal for the system came with his observations of American super- market.

The process of using Kanban cards in the in-process inventory and controlling production has been proven to very simple and best for the implementation of the Just In Time (JIT) (Monden 1981). The number of authors examined the advantages of the Kanban system in the recent years (Kimura and Terada1981, Monden 1981, Schonberger 1983, O'Grady 1988). One of the most widely studied topic is the serial system which sends single item to the workstation, by applying constant intervals (inter arrivals) for the demand, the Kanban system is the best option. The mainstream of the research was rigorously concentrated on finding the number of Kanban as soon as replenishing the lead time is variable and the demand is inactive (static) (Monden 1981, Ress *et al* 1987) and so did Philipoom *et al.* 1990, Deleersynder *et al*. 1981, Pinault 1988, and Wang and Wang 1990)

In brief

Kanban is a Japanese word that means "signboard". This is a word that has developed into identical with "Demand Scheduling" or "Just in Time (JIT) Manufacturing". Its pedigree are 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 famous during the global recession of the 1970s, when it was vital for companies to decrease waste and hack costs in order to be successful. (Nilesh R. Aurora, 2009).

According to Nilesh R. Aurora, (2009) the principle of Kanban is to generate Visual Indicator's to permit the operators to be the ones who decides how much of a 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 starts production, rather than forecasted usage. The products that are consumed by the customer(s), they start producing those goods, and immediate next method. Only those goods are produced that are on the visual board and sent by the customer(s).

In view of the fact that the bulk of the decisions in the Kanban system are prepared by the operators, besides, by using of visual indicators also helps supervisors and managers to see the schedule position of a line at a momentary look. Now the Kanban schedule replaces the weekly or traditional production schedule. It replaces. It directs the production on a day-to-day basis.

### 1.1 What is Electronic Kanban (e-Kanban) System?

In order to attain the maximum efficiency, it is very important to lower the fluctuations in the order quantity (Monden 1983), and as a result of focusing on this matter, the Kanban system is developing continuously. Other methods are being implemented which promotes a constant consumption for all the products in the assembly line (S Kotani 1983, Monden 1983).

To further develop the Kanban system, the Toyota Production Company has introduced a new system called "e-Kanban" system where "e" stands for electronic, which uses the communication network and computers for maintaining a constant communication between the company and their suppliers. Generally the Kanban cards are controlled manually.

But in the e-Kanban system the entire system is efficiently controlled by the computers in a timely manner.

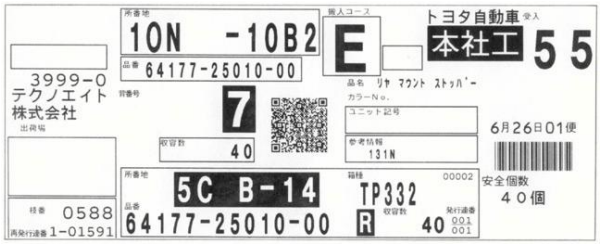



**Figure1. Print of a sample e-Kanban sticker (Source: S. Kotani 2007)**

## II. RESEARCH QUESTIONS

The objective of the dissertation is to study the role of e-Kanban in Production system.

E-Kanban efforts on a multi stage in order to improve planning and production and role of e-Kanban size in Just in Time Manufacturing.

The problem faced by a manufacturing company (Oral-B) and how they overcame it by implementing e-Kanban.

In the CVG, within an automotive section, measures are taken to minimize the logistics and operational issues for the parts supplier.

## III. RESEARCH METHODOLOGY

The main aim of the dissertation is to study the role of e-Kanban in Production system. The problem faced by a manufacturing company (Oral-B) and how they overcame it by implementing e-Kanban. The company had most problems occurring at the packaging section and lost control over the inventory. In such a situation the management implemented e-Kanban and how they got out of the problem is stated in the following lines. Within the automotive company (CVG) measures are taken to minimize the logistics and operational issues for the parts supplier. Implementation of the system has shown the successful results. And finally, the e-Kanban efforts on a multi stage in order to improve planning and production and role of e-Kanban size in Just in Time Manufacturing.

In the present business competitive world, many companies and management institutions rely on the research methodology. It is system of data collection which is used for very dissertation. The collected may include theoretical or practical ideas along with operational planning methods which are conceptualised strategically. Research data and validity should be included in the research methodology. The finishing of the dissertation is measured by ethics and reliability.

### 3.1. RESEARCH METHODS:

There are different types of research methods that are being in use. But each particular type of method gives a different approach to a particular problem. In general, the research methodology is divided into four types

Experimental Method
Survey Method
Observation Method

Existing Data Method

The other general methods that are being used that are used in the management and I used in my dissertation are not much different from the above ones. They are

Analytical Research
Applied Research
Fundamental Research
Case Study Research

### 3.2. Analytical Research:

This type of research involves the person to make use of data that is already available. The person should go through the data and take the facts that are necessary for his/her purpose, analysis it and use it for his benefit. This requires the writer to be more concern about the critical analysis of the data available. (Umesh Dubey 2005)

### 3.3. Applied Research:

The main aim of the applied research is to find an immediate solution to the problem that is prevailing any organisation, industry or any society. Basically it can be defined as a fact gathering technique which is conducted with a point of acquiring and applying knowledge which solves a particular problem or serves the need.

### 3.4. Qualitative and Quantitative Research:

Meta analyses on mixed method studies have shown that combining both qualitative and quantitative methods can lead to research results which are unrelated. (Bryman 2005).

Both Qualitative and Quantitative approaches must be used, because the combination of both these research methods helps in getting more data and accurate evaluation. This combination is also referred to as triangulation. In research when interviews combined with surveys, the information collected using interviews was complimentary when compared to the surveys. (Glenn 2006)

My research will include both the Qualitative and Quantitative methods. Qualitative methods are about the verbal information where as the Quantitative method is about the numerical information. Observations, case study, surveys and Interviews are some of the Qualitative methods used and Quantitative method because the research is about the vulnerabilities, loopholes in the security system, so this method provides the percentage of security provided using the latest pen-test tools.

### 3.5. Fundamental Research:

This type of research deals with the generalisation of a formulation of a theory. For example, research relating to pure mathematics.

### 3.6. Case Study Research:

This type of research brings an excel quality of understanding about a complex situation which adds extra point

as it is already know through previous experience. A case study gives a clear picture of the analysis with limited conditions and important events and their relationships. Many researchers are very beneficial with this type of study.

## IV. INVESTIGATION METHODS AND FURTHER RESEARCH

### 4.1. Data collection:

My research begins by collecting information on how the implementation of traditional card-based Kanban system took place. I studied the principles and techniques used in Kanban system. And to accomplish this task I will use the case study method discussed above to review previous case studies and collect information on the history of Kanban system. Later my research included the information regarding e-Kanban system. I have gone through many journals and articles and carefully studied almost every authors views regarding electronic Kanban system. And this handful of information is enough to start my research and complete the first and second objective of the research.

My second phase of data collection included the details of the e-Kanban system applications in the industry. I was very much immersed going through the success stories of the e-Kanban system and its applications even in food and chemical processing industries. I have gone through many case studies which a clear picture of the e-Kanban system's in the industry.

The third phase of my collection was the review of many case studies which provided a lot of information. I had gone through the case study which was published in "lean.org" and read almost every articles of Tom Cutler. A brief part of my study given below shows the implementation of electronic Kanban system helped to increase the production and topped the Oral-B toothbrush Company in the world.

### 4.2. CASE STUDY

#### 4.2.1. ORAL-B TOOTH BRUSH COMPANY

Oral-B Toothbrush Company was first constructed in 1958, in 311,000 sq.ft., was one the largest producers of the toothbrushes in the world. With a study stream production, the sales of the company were approximately one million units per day. By the year 2000, the productions of the company got worsen and the plant's items are competed with other products of countries like Mexico and China. The company's traditional MRP has driven the situation of over-production, causing more inventory and stocks of useless products in the company. The plant management decided for the closure of the company by the end of 2000.

The company was situated in the heart of North America and has good relations with Costco, Wal-mart and Target. But these things dint saved the company's future. The company has strong technical skills and good work floor. Besides, the company performed jobs like packaging and distribution; usually which is not handled by many companies. Later one employee of the company thought that Oral-B is lagging in lean principles, which has the capacity to reduce the lead time and inventory costs.

**REALISATION:**

The management of the company realised that the organisation would not produce the desired results, until and unless the organisation change the old traditional system, MRP. According to the old system, each machine was sent a schedule production for moulding, brush manufacturing and finally packaging. Cassidy, an expert in lean, was appointed by the management for the implementation of the lean principles.

**THE PROBLEM:**

The main problem of the Oral-b company is packaging. On a certain occasion, the company has produced 51 finished brushes, with different types of handles, different coloured and large varieties of filaments. But for the 51 finished brushes, the company has to perform 372 different types of packaging, including buy-one-to-get-two offers, foreign languages and the packages also includes the dual offers of the Gillette products. The company management wanted a study packaging line. At the end of the packaging section, a store—supermarket is maintained which release trigger when the finished brushes are consumed by the customers. In the same way, each different item has a unique supermarket. So in each process, the consumed materials are replaced by the newly finished brushes, when they are withdrawn from the supermarkets by the customers. In other words, the finished brushes are being "pulled" by the customers from the supermarkets. This is in turn, the packaging lines are pulling from brush making machines. Again the brush making process pulls the handles from the handle making process. The materials needed for the handle production are being pulled from the store by the downstream process, which sends a Kanban card in the upstream process for the replacing the materials which being drawn from the store.

Another major problem was that the company was not able to maintain or failed to separate the production unit from the material-handling process. It was very difficult for a mechanical technician to collect the required item from140 rough items. The management wanted the company's material handlers not to get involved with the technician works.

"Faster is better", said Cassidy. "You build up adrenaline and momentum and sweep people along." Running old and new system in parallel sub optimizes both, he noted.

**IMPLEMENTATION OF THE E-KANBAN SYSTEM**

The company arranged three teams which are given three different transitions: the first team controlled all the logistics and the movement of the raw materials from the ware house. The second controlled the movement of the materials from the production division to the finished goods. The finally team helped the former two teams by providing sufficient data needed for their purpose. The management also changed the IT department with simple and user interface and applications used for kitting, which is very important under the pull system. The management spent around four weeks for the plan to be implemented on the shop floor with all machines shut down. During this period the workers are trained with lean principles and other basic training of the pull system.

The new system the company implemented was e-Kanban system, not MRP which is used for the production of daily consumed items like filaments, handles, brushes, wires and

shipping boxes. The Oral-B company uses the e-Kanban system to trigger the refilling for the brush-making and moulding departments. Racks or empty bin locations are used for the refill of finished raw materials from the ware house and stores. Items that are used for packaging some unique items are kitted on the racks in the ware house and removed when they are needed. This system even separated the jobs for different machines.

The system starts at the beginning of the packaging section, where the electronic Kanban tickets are posted which states the production for the next two weeks. It is repeated every Thursday, and the management issued the e-Kanban tickets for the next week's production after confirming the production with the Gillette Company in Boston. At this particular point, the schedule is owned by the production department. If everything is finished by the end of the week, the sequence orders can be changed by the production. The e-Kanban system gave ownership and improved the efficiency on the work floor.

The e-Kanban system triggers a signal to the material handlers who replaces the empty kits with the stock needed for the production to run continuously. In the ware house, the completed kits are stored at the designated places. The scheduled production is watched by the material handlers, so they pack the amount of brushed needed for that particular schedule and thus the order of running jobs are determined. One or two days of working more than the scheduled date, makes the packed brushed staged in the packaging machine. Kits are emptied, so that the ware house material handlers order for more raw materials form the suppliers and which increases the number of the kits. These handlers replenish the empty floors and kits with the raw materials.

A signal is triggered for the material handler when the empty trays are removed from the finished brushes in the supermarket, so that the brush making machines starts producing more brushes which should be replaced by the amount of empty trays removed from the supermarket.

No transactions are recorded during the production process. The material handlers after packaging enters the part number and the total number of cases produced into the computer. Transactions are made as a back flush, after the entire goods production is finished.

In a period of three months, about 70% of the shop floor was improved to new system, cutting down the inventories dramatically. Weekly basis production system was followed in the company. By 2002, the Oral-B Company was strong in the areas of cost along with the Gillette. In 2004, the company achieved the top rank in the production of toothbrush.

## V. DEVELOPMENT OF E-KANBAN SYSTEM

### 5.1. Implementation of Equation:

One of the important goals for introducing e-Kanban is to change the number of Kanbans effectively, once the required number is achieved. At the same time, it is very important to control the changes of the Kanban. By using the e-Kanban, the study gives the effective method of changing the number of Kanbans. Usually, there are many types of Kanbans. In this study, we are dealing with supplier Kanban using e-Kanban system.

Using monthly production plan, the number of Kanbans for each part is calculated. Some containers are arranged along the assembly lines which are attached with Kanbans, till parts are not taken from them. Kanban is removed from the container and placed on the Kanban post, if the first part is taken from the container. These Kanbans are read by the e-Kanban system (i.e., computer) at regular intervals. After the information is stored in the computer, these Kanbans are binned. The information which is obtained from each Kanban is complied and sent to Toyota's supplier by a corporate network at appropriate time. The supplier takes the prints of the received Kanbans. Finally, Toyota receives the predetermined parts from the supplier at the predetermined time.

In the e-Kanban system, the Kanbans are collected and sorted and given to the truck driver of the supplier who delivers the parts at the appropriate time. Considering the lead time is the amount of the time order placement and the delivery of the parts from the supplier. Using e-Kanban, the lead time is decreased.
In the Kanban system, each delivery represents a standard order time because, the next order is transported to the supplier by the same truck which delivered the latest parts to the company.

Order time of e-Kanban is given by:

(Delivery time of order to the company) – (Lead time) Equ.(1)

Therefore, in the e-Kanban system, the order time is not always the delivery time. There are many instances that the operating timings of the company may be different from the supplier's timings. So it is not possible to calculate the order time with equation (1). So while determining the order time, the following should be considered.

Care should be taken, to maintain the constant time intervals between one delivery time to the factory to the next delivery time.

Lead time should be reduced to the minimum extend.

The Kanbans in the e-Kanban system move in one-way methods i.e., from suppliers to the company. Here the Kanbans are controlled by the e-Kanban by using a computer. If an optimal way of changing the number of Kanbans is developed, then the Kanbans in the e-Kanban system can be controlled effectively and efficiently.

Conditions for changing the number of Kanbans:

If N is the number of Kanbans for a certain part, then N is given by the following formula (Monden 1983):

$$N = \left\lceil \frac{D(K+L)+S}{M} \right\rceil,$$

D = part average daily demand
K = time interval between one order and the next order
L = lead time
S = part safety stock
M = capacity of container

'K+L' is known as Kanban lead-time, which is the sum of order time and lead time. This term K+L is expressed in terms of a-b-c which is called Kanban cycle (Monden 1983). The meaning of the cycle a-b-c means that the part a-b-c must be delivered in

'b' days for every 'a' days, and the part should be delivered in 'c' delivery time after the order is given to the supplier. The Kanban cycle are specified for each and every part and from the definition of the Kanban one gets:

K = a/b
L = (a/b)*c

Therefore, K+L = [a (c+1)]/b Equ. (3)

Normally, a=1, sometimes a>1 is very special case. b is always a integer and b>1. In the Kanban system, delivery time always corresponds order time. Therefore in the e-Kanban system, c is calculated as c = L/(a/b)
Assuming that c is not an integer and substituting the equ (2) in equ (3)

$$N = \left\lceil \frac{Da(c+1)/b + S}{M} \right\rceil$$

$$= \left\lceil \frac{aD(c+1)}{bM} + \frac{S}{M} \right\rceil. \quad \text{Equ. (4)}$$

From the equation (4) it can be explained that N depends upon the Kanban cycle, capacity of the container and daily demand of the part. The number of Kanbans required will change if there is a change in the daily demand. For example, the daily demand changes for the next month, which implies that the number of Kanbans for the next month also changes accordingly. The procedure is first calculation of number of Kanbans for the first month and again calculating for the next month.

Changing the Kanban depends upon two decisions:

- From which order to another order the Kanban should be changed?
- The number of Kanbans to be added or subtracted from the order quantity.

While changing the number of Kanbans, care should be taken that:

- Does not increase the fluctuation of the order quantity
- Must be performed at adequate order times

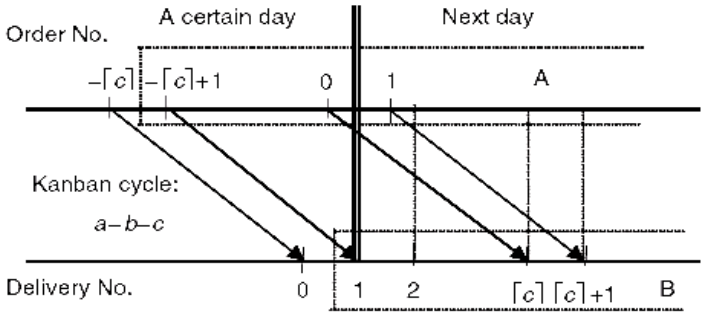
Let us consider, the number of Kanbans determined by safety stock $N_s$ and Kanban cycle $N_k$

Then, $$N_K = \left\lceil \frac{aD(c+1)}{bM} \right\rceil$$ for safety stock, S = 0

Finally, from equ (4), we get $N_s = N -- N_k$ Equ., (5)

While changing the number of Kanbans, we should determine the Kanban number for safety stock and Kanban cycle separately.

Assuming the time interval between first delivery and the next delivery is same and the time of the supplier's first delivery is the starting time of the shift for any particular day. The assumptions are shown in the figure below.




Relations of orders and delivers in the Kanban cycle a-b-c

In the above figure, the delivery time are denoted from 0 to [c]+1 and the order time is denoted from –[c] to 1, and the first delivery and first order are set to 1 for the next day.

**METHODS FOR CHANGING THE NUMBER OF KANBANS:**

Changing the number of Kanbans by Kanban cycle:

Based on monthly production plan for every part, the number of Kanbans is changed. The average monthly production plan for the current month will be different from the next month's average production plan.

D = average daily demand for the part

Therefore, from equ.,(5), the average order quantity is aD/(bM), mean of number of Kanbans in one order. Equation (5) also states that the number Kanban is affected with 'Kanban delay coefficient' and 'mean Kanban number'. For a certain part, the following notations are used.

$D_T$ = average daily demand, current month
$D_N$ = average daily demand, next month
a-b-c = Kanban cycle, current month
α-β-γ = Kanban cycle, next month
$H_T$ = mean Kanban number, current month
$H_N$ = mean Kanban number, next month

Therefore, from the definition,

$$H_T = \frac{aD_T}{bM}$$

$$H_N = \frac{\alpha D_N}{\beta M}.$$

Assuming the change in the Kanban number based on the Kanban cycle is

$$N_K = \frac{aD_T(c+1)}{bM} = H_T(c+1) \quad \text{Equ., (6)}$$

From equation (5), the change in the Kanban numbers from the current to the next month is given by

$$\Delta N = H_N(\gamma+1) - H_T(c+1). \quad \text{Equ., (7)}$$

Finally equation (7) shows the key factors for changing the number of Kanbans are the Kanban coefficient factors and mean

Kanban number of order which is determined by the Kanban cycle.

Considering the case of new order in the next month is 1, and the order number is denoted and started from –n+1 to 2 after –[c], 'n' is the current months new order number. Therefore 'n' can be calculated by the following formula

$$n = \left\lfloor \frac{a(c+1)/b}{\alpha/\beta} \right\rfloor$$

Since the time interval from –[c] order time to the first shift starting time of the next month is a*(b+c)/b and the next months order cycle is γ/β.

Case (i) n = [γ]

The change in number of Kanbans is given by i.e.,
Mean change, $\Delta N = (H_N - H_T)*(c+1)$
Here a = α, b = β, c = γ

Case (ii) n > [γ]

This case deals when the lead Kanban approaches small and results of improvements appear.
$\Delta N = - H_T(c - \gamma) + (H_N -- H_T)*(\gamma + 1)$
Case (iii) n < [γ]

This is real case where the Kanban lead time increases in real production system
$\Delta N = - H_N (\gamma - c) + (H_N -- H_T)*(c + 1)$

## VI. CONCLUSION

In the last decades, with rapidly shifting the environmental challenging high flexibility and also asking for high adaptability ways of ways of ordering of materials, it was a logical step that the traditional Kanban system should be substituted by e-Kanban system.

The important difference between the electronic Kanban and traditional card based Kanban system is to work more effectively and efficiently with a lean process. The transparency of supply chain is very much increased with the implementation of e-Kanban system. The gives an assurance of handling with high amount of materials in a good way without losing cards and with changing demand with the customers, the system reacts more flexibly.

It very important to take into considerations of the financial things of the system; it involves high investments because of the expensive terminals and other expenses connected with the IT department. Also, for the successful implementation, the communication within the IT departments, logistics and production is very important. E-Kanban is very big successful, if the implementation of the system is well-done, as it helps in optimization of the process.

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