CHAPTER 13

Application of IoT Technology for Effective JIT Implementation in the Automotive Industry

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ABSTRACT

The Internet of Things (IoT) is rapidly changing the world in various ways. It is a new wave of Internet that is expected to transform manufacturing by making the plants more efficient, productive and smarter. Just-In-Time (JIT) in the Indian automotive industry aims to streamline production by minimizing inventory, reducing waste, and enhancing efficiency. By ensuring timely delivery of parts, JIT lowers cost, improves quality, shortens lead times, and increases flexibility, boosting competitiveness and responsiveness to market demands in a global context. The present research addresses the issues related to application of IoT in a Just In Time (JIT) manufacturing setup in the automotive industry. The IoT technologies may play a very important role towards in enhancing JIT manufacturing by providing real-time data, improving supply chain visibility, and enabling seamless communication between various elements of the production process. Hence the research focuses on Internet of Things based JIT, its application and impact on manufacturing process. A significant improvement in parameters of a case study such as inventory saving by 5.5 days, space saved up to 9.144 sq.mtr. and reduction in manpower required supports the hypothesis.

Keywords: Industry 4.0; Internet of Things (IoT); Manufacturing; Just In Time (JIT).

1.0 Introduction

In the present scenario, IoT (Internet of Things) is developing with a great pace which draws the attention of researchers, academicians and industrialists. It is being used in every field. IoT basically refers to the connection of various devices with sensors, software, modules etc. for the exchange of information over the internet. IoT stands out as an excellent technology in today's world as it is helping in making work simpler and automated. Due to technological developments and the increasing inter-connectedness of the world population, the Internet of Things (IoT) has become reality.

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The internet-based IoT infrastructure provides an unprecedented opportunity to achieve effective digital integration of the entire manufacturing enterprise. Japanese industries have developed a reversion towards all kinds of wastes. They view scrap and rework as waste and hence strive for perfect quality. They strongly believe that inventory storage wastes space and results in locking up of valuable material and capital. Anything that does not contribute value to the product is viewed as waste. Thus, it is quite natural for the JIT philosophy to develop in Japan. Traditional JIT systems face limitations that hinder scalability and adaptability in dynamic manufacturing environments. Some of the major limitations include Manual Kanban Processes, No Real-Time Visibility, Poor Communication system, Static Production Planning, Inaccuracies in Inventory tracking along with the Scalability Issues: The objective of this study is to overcome some of the limitation by using the IoT technologies for JIT implementation in an auto manufacturing industry.

2.0 Literature Review

The JIT system along with IoT applications are documented through research papers, articles but survey of the most relevant papers is presented here. Ahmad Naufal Bin Adnan, et al (2013) implemented Kanban pull system to a high-volume medium variety of manufacturing line at a local auto-component company in Malaysia. Total areas from material store to assembly junction were analyzed by researchers and they concluded that inventory and lead time reduces while there is improvement in WIP store process.

Bo Hou et al (2011) presented various issues related to implementation of JIT for an automotive company. In their study, they also provided evidences for supporting the benefits of employing JIT. F.T.S Chan (2001) suggested that Kanban sizes were important while implementation of JIT and Kanban system. Researcher observed that smaller the Kanban size lowers the inventory but 100% fill rate is not possible with that.

Fengfu Xu (2021) proposed how to use The Internet of Things technology to assist the effective implementation of inventory timely management method from the perspective of product distribution and summarized the feasibility and concrete implementation of the IoT. Kalpesh V Bhagat et al (2018) described that implementation of the Kanban (Barcode scanner) system with reduced lead time, minimized inventory on floor and optimized storage area. The objective of their study was to show that Kanban system improves a manufacturing system as well as achieving Just in Time practice.

Ritesh Kumar Shrivastava and Dr. Sridhar (2015) implemented and operated the Kanban system in tractor assembly plant and made conclusion after six months by analysis flow. Data was collected for a sample of 20components from the records of SAP (System

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and Process) i.e., ERP (Enterprise Resource Planning) package and compared for the inventory levels before and after the implementation of Kanban system which is graphically presented. Suprasith Jarupathirun, et al (2009) presented 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. Yuchun Xua and Mu Chena (2016) presented a research on using IoT based solution to enhance JIT manufacturing. The general challenges of JIT implementation are identified and subsequently IoT based solution is proposed to address the challenges in a selected case study. A framework to support the proposed IoT solution is developed and its implementation steps are suggested.

3.0 Methodology for IoT-based Kanban System Design

Kanban is one of the important tools of JIT. In this study, IoT is applied to the Kanban sytem, which is an important tool of JIT. IoT based Kanban is a signaling system that uses a mix of technology to trigger the movement of materials within a manufacturing or production facility. To overcome the traditional Kanban process flow, we have chosen IoT based Kanban (electronic Kanban), which is differs from traditional Kanban in that it uses technology to replace traditional elements such as Kanban cards with barcodes, scanners, WIFI system and electronic data interchange. The IoT based JIT (E-Kanban) explained in details as follows:

3.1 Masters

Data to be uploaded in pre-defined format for each of the Masters. To get excel format for each of the master click on “Download Template” option provided with all Master forms. Below Master Forms are provided with E-Kanban application.

1) Kanban Master: a) Auto Cutting & Crimping b) Twisting & Bonding
2) Machine Master
3) Location Master: P1, P2, P3
4) Applicator Master
5) Wire Master
6) Seal Master
7) Machine Group Master
8) Project Master

3.2 IoT based JIT/ Live E-Kanban

Following Fig. 1 represents the Live E-Kanban process flow. To process E- Kanban Application, refer details which process data to achieve component traceability from P1 location to P3 location.

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Figure 1: Live E-Kanban Flow

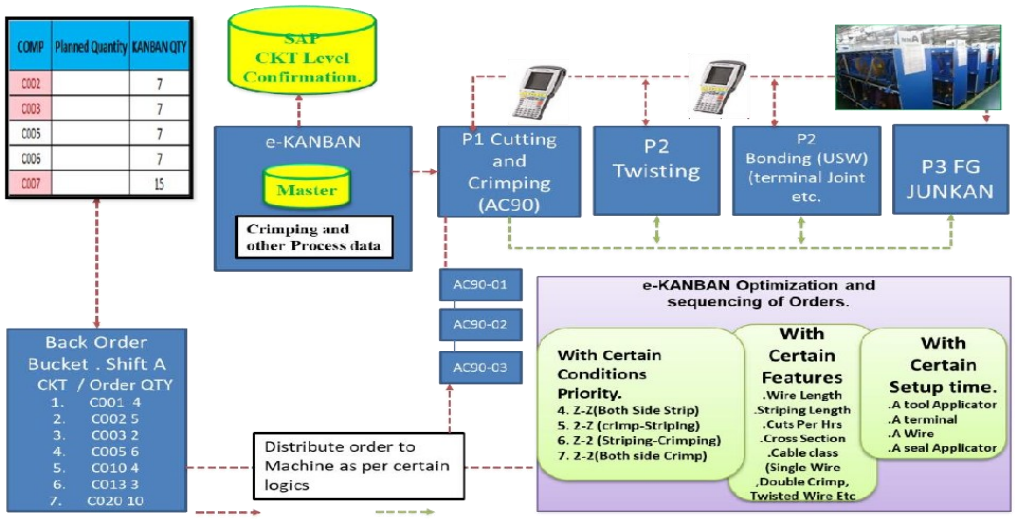
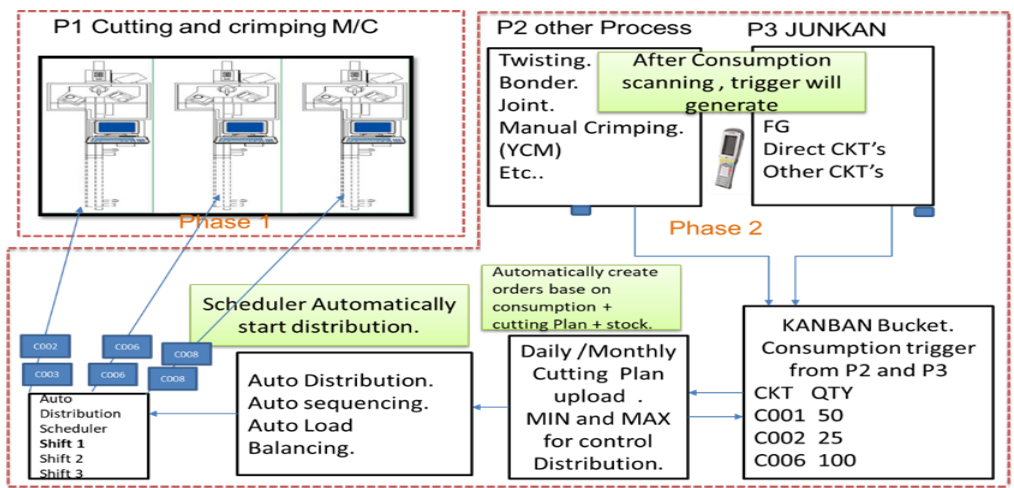


Figure 2: Process Flow of E-Kanban



The process of E-Kanban is as follows:

- Prepare E Kanban cutting, twisting, jointing data & load in E Kanban system
- Wire cutting process (P1): AC-90 machine will cut wires considering uploaded Kanban. As soon as each Kanban quantity gets completed system will trigger Printing of Kanban Label.

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- User need to paste these Kanban stickers on wire for further processing and place bunch on trolley.
- Each of these labels will be printed with next location details which will help users to identify.
- Kanban and move trolley to next location. e.g. Twisting location (P2), Bonding location (P2) and also Junkan location.

With each Kanban print, unique barcode will be printed which is expected to be scanned on defined location, system will not allow further process in case scanned at wrong location and highlight error on screen. Find E-kanban process flow as below Figure 2.

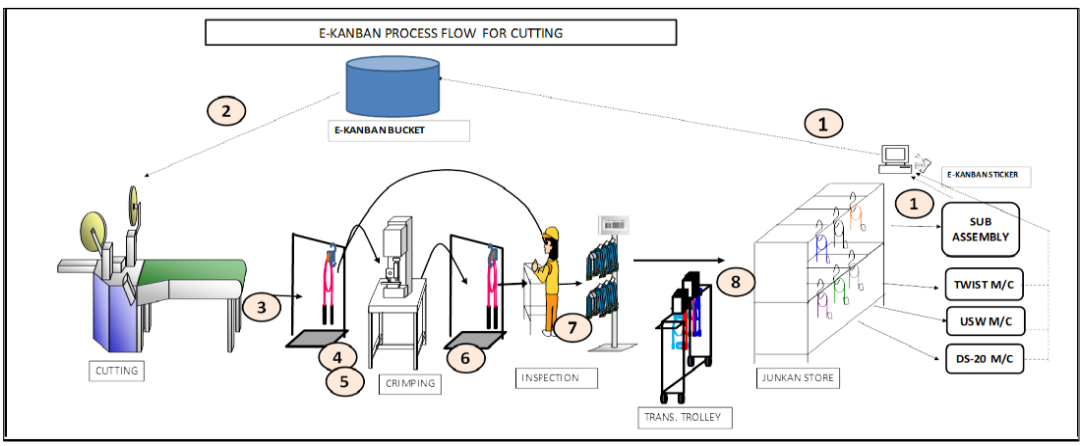
4.0 E-Kanban Process Flow

The E-Kanban process implemented for multiple functions like wire cutting, twisting, joint and crimping in the manufacturing company of wiring harness. E-Kanban process flow for wire cutting operation is as follows.

4.1 E-Kanban process flow for cutting

The process flow of wire cutting has multiple stages like wire store, E-Kanban bucket, marking VO tube rubber seal, crimping and inspection area. Following Fig. 3 shows the E-Kanban process flow for cutting.

Figure 3: E-Kanban Process Flow for Cutting



The wire cutting process flow starts with scanning the E-Kanban sticker in E-Kanban system by wire supplier. Then the cutting load is pushed from E-Kanban bucket to

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cutting work station. Wire cutting process is done by the operator with E-Kanban sticker. After finishing the wire cutting process all the sub assembly wire goes to inspection area. As soon as inspection of the wire is finished, all inspected wires are loaded into trolley and moved to JUNKAN storage area. The detailed wire cutting process flow (5W2H) is shown in below Table 1.

Table1: E-Kanban Process Flow for Cutting

Sr. No	Where		When	Who	What	By what	Howmany	How act
	From	To						
1	Wire store	E-kanban bucket	At the time of wire collection for feeding in SA/ USWM/C etc.	Wire supplier	E-Kanban sticker	By system	1 for each wire bundle	1. Find the wire at store as per requirement. 2. Take off E-kanban sticker from wire while loading 3. Scan the E-kanban stickerin E-kanban system
2	E-Kanban bucket	Cutting machine	every 8hours	Cutting in charge	Circuitwise cutting load	By system	One shift load	Push the cutting load from E-kanban bucket for cutting M/C for wire cutting.
3	Cutting machine	Inspection	After cutting	Cutting operator	Cut wire with Ekanbans ticker	Hand	One lot	Make the bundle of the cut wire by using rubber band, attach e- Kanban sticker to wire bundle and put them into inspecting area and inspection of the wire by Inspector
4	Cutting machine	Marking VO tube Rubber seal	Every 1hour	Wire transporter	Wire with E-kanban sticker	Trolley	Previous one hour	Put inspected wire into trolley and move to marking area
5	Marking VO tube rubber seal	Crimping	Every 1hour	Wire transporter	Wire with E-kanban sticker	Trolley	Previous one hour	Put wire with rubber seal into trolley and move to crimping machine
6	Crimping	Inspection	After crimping	Crimping operator	Wire with E- kanban sticker	Hand	Each time	Put crimped wire into inspecting area and inspect the wire by inspector
7	Inspection	Temporary storage	Each time	LQC Operator	Wire with E-kanban sticker	Hand	One lot	Put crimped wire into Temporary storage
8	Inspection area	Junkan store	Every 1hour	Wire transporter	Wire with E-kanban sticker	Trolley	Previous one hour	Put wire was inspected into trolley and move to store

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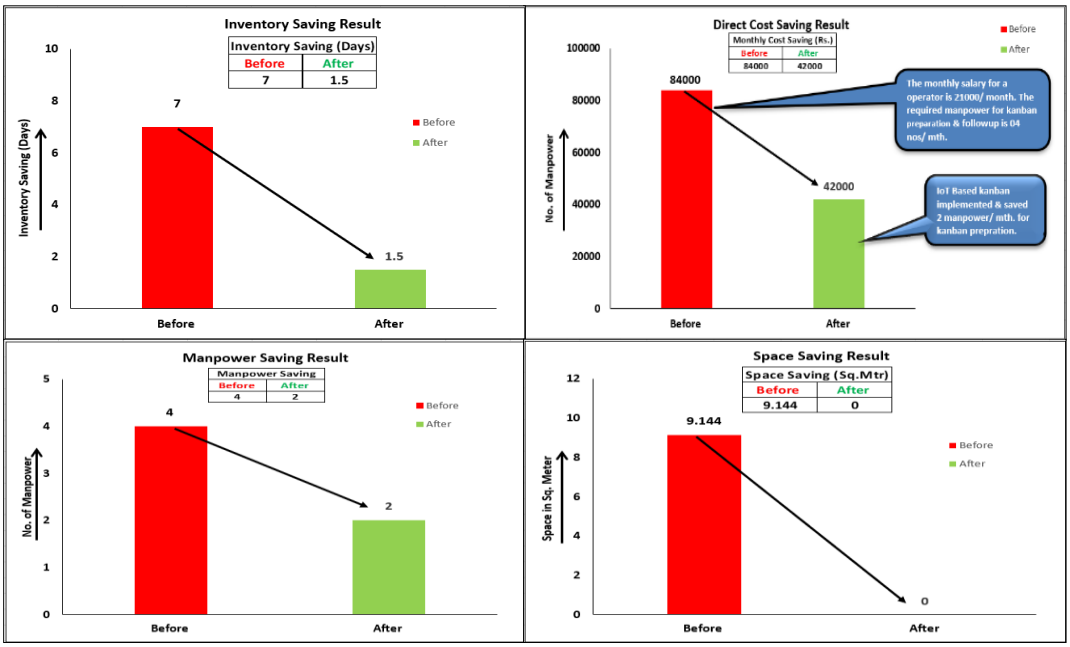
5.0 Results and Discussions

This primary goal of this study is to implement effective JIT by using IoT technologies. The overall results are as shown in Figure 4.

Figure 4: Results of IoT Based JIT



The overall inventory has been cut to 1.5 days from the initial 7 days. Around 9.144 sq.m storage space has been saved. The supply chain operations which were previously handled by four persons can now be done by only two workmen. The direct cost has been lowered from ₹84000 to ₹42000. These improvements show that through JIT, the production schedule can be adjusted as per the actual demand and wastage of products can be reduced to a large extent.

6.0 Conclusion

Just in Time (JIT) manufacturing has been used by industries for decades for achieving simplicity, waste elimination and time reduction. The difference between traditional kanban (a signal to trigger specific quantities of supplies in a just-in-time system) and IoT based JIT (e-kanban) is to work more efficiently and effectively with a lean process. The IoT based JIT system is an effective and simple method to optimize task

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management. It not only increases transparency but also boosts motivation because team members gain flexibility and influence in the working process. The study suggests that the most of the original Kanban ideas can be followed while planning an electronic kanban system. However, an IoT based JIT system gives possibilities to solve some of the limitations of existing kanban system, like the model mix change management and failure recovery.

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