Implementation of Internet of Things

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Abstract— Traditional methods of inventory management have been the practice of many industries and companies for a very long time. This method includes manual data collection and manual data entry. This opens up an avenue for errors and also slows down the productivity. In order to overcome these limitations many companies are adopting new methods among which Internet of Things (IOT) is being installed in majority of the companies. When we started our project in our company, we were given such a problem, where there is a need for IOT and barcode system. Our company is a global company which has the base in Korea. The major problem that they are currently facing is the lack of traceability of products. The main cause is the loss of data due to the manual entry of data. IOT provides a solution for this problem. IOT system comprises of various solutions among which barcode system is one of them. The barcode system provides a platform where data entry can be made automatic. By this we can avoid loss of data, save time and minimize errors. Also the flow of raw materials is sorted when using this system and thus the inventory is managed effectively which in turn aids in effective production. Thus by implementing this method we can not only reduce losses but also enhance the productivity of the plant. In the future the other technologies in IOT can be combined with barcode system and made into an integrated system where the time is optimized and the production can be effectively enhanced.

Keywords-Traditional methods; traceability; IOT; barcode; data; productivity; integrated system

1. INTRODUCTION

In today's fast growing industrial world, time has become a major asset. Many industries have adopted various methods to improve their efficiencies, reduce the cost and time of production but without any compromise in the quality. In the industrial world, wastage of time is considered to be a major crime. Such is the importance of time and it plays a major role in making the company successful.

One way of reducing the wastage of time is introducing Internet of things (IOT) into the system. IOT is a concept which forms a system of integrated data which helps in the easy tracking and traceability of information of different parts and products thus reducing wastage in time. One major element in IOT is the barcode system.

Our project is to analyze the different processes followed in the company and also the different products that are produced and to suggest a system of barcode that can be implemented in order to improve the traceability of products.

By implementing the system the time utilized per part can be reduced and also the cost of labor per part can be reduced. This in turn provides a way to improve the productivity of the plant.

In this report the concept of inventory management, concept of IOT, the disadvantages of the traditional method, the advantages of the modern methods, cost estimation and the time saved per part are discussed.

2. LITERATURE SURVEY

One area where any company can make changes to increase the productivity is the inventory. Michael C. Bergerac, former CEO of Revlon, Inc., noted that every management mistake ends up in inventory. It is now generally recognized that high inventory levels are wasteful (Hong Shen, Qiang Deng, Rebecca Lao, Simon Wu, 2017). Many management problems could be solved by removing excess inventory. Since inventory is strongly related to customer service, it is worth close attention. Imagine a world where billions of objects can sense, communicate and share information, all interconnected over public or private Internet Protocol (IP) networks. These interconnected objects have data regularly collected, analyzed and used to initiate action, providing a wealth of intelligence for planning, management and decision making. This is the world of the Internet of Things (IOT) (Keyur K Patel, Sunil M Patel, 2016). By using IOT we can solve a lot of problems that are faced by the current industries and also provide a new way of improving productivity and profitability.

3. INTRODUCTION TO INVENTORY MANAGEMENT

A. Inventory Management System

Inventory management is a systematic approach to sourcing, storing, and selling inventory—both raw materials (components) and finished goods (products).

In Business terms, Inventory management means: the Right Stock, at the Right Levels in the Right Place, at the Right Cost (or) Price. [1]

B. Importance of Inventory Management

Inventory is a major asset and represents a sizable investment in businesses that sell or manufacture products. In extraction, manufacturing, wholesaling, retailing, importing/exporting, and other fields, inventory constitutes one of the largest controllable assets of a business. [2]

Inventory management saves you money and allows you to fulfill your customers' needs.

A good inventory management helps us to control the costs. It helps us to know the stock available in the warehouse and thus we can make orders accordingly. This reduces the unnecessary stock up of raw materials which in turn improves the cost efficiency.

Inventory management devices, such as barcode scanners and inventory management software, can help drastically improve the efficiency and productivity.

4. TYPES OF INVENTORY

As mentioned earlier inventory management is a systematic approach and it comprises of different stages, each of which can be considered a type of inventory in itself.

Typically, inventory types can be grouped into four categories: (1) raw materials, (2) work-in-process, (3) finished goods, and (4) maintenance, repair, and operations (MRO) goods.

C. Raw Material(RM)

Raw Materials are individual components required to assemble as a Final Product. Raw Materials are received from Suppliers and stored in RM Storage area.

D. Work In Process(WIP)

WIP are Sub-Assemblies made from RM and kept In-Process. It will be waiting for next operations.

E. Finished Goods(FG)

FG is the Final product which is ready for dispatching to Customer. It is stored in FG storage.

F. Maintenance, Repair &Operating Goods(MRO)

MRO refers to Maintenance, Repair & Operating supplies, which are used to support the Production process. [3]

5. TRADITIONAL METHOD FOLLOWED IN THE COMPANY

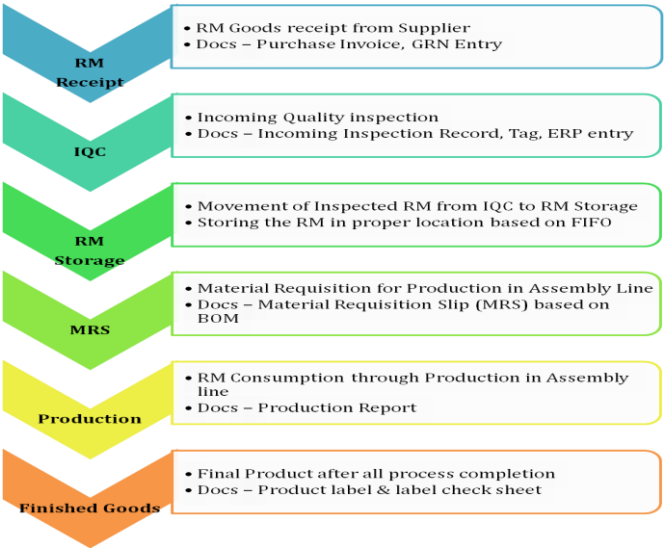

Figure 1. Flow chart of the traditional method followed

- Initially the raw materials are received at the receiving end, where the RM Goods receipt is given by the supplier. Then the Goods Receipt Note (GRN) entry is done (Figure 2) by the labors in the receiving end manually. The documents involved are purchase invoice and the GRN entry.

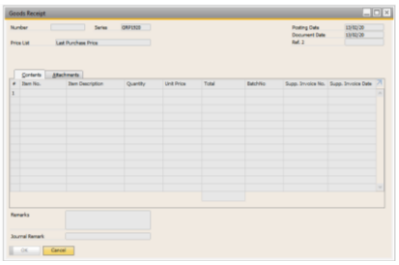

Figure 2. Goods receipt window used for GRN entry

- Now these RM's are inspected in the Incoming Inspection Area for any defects. If the RM passes the inspection it is marked as OK else it is marked as NG (Not Good). The OK parts are then sent to the inventory area and the NG parts are sent to the quarantine area. The document involved in this step is Incoming Inspection Report (Figure 3).

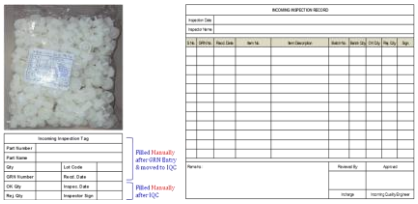

Figure 3. Incoming inspection report for quality check

- The next process is the transfer of goods from Incoming Quality Check (IQC) to the storage area. The goods are stored in racks according to the type and priority. A list of materials is present in each and every rack for tracking.
- Following the previous process, the next process is the supply of goods from the store to the assembly line. This can be acquired by having a MRS (Figure 4 and Figure 5) from the assembly line based on BOM.

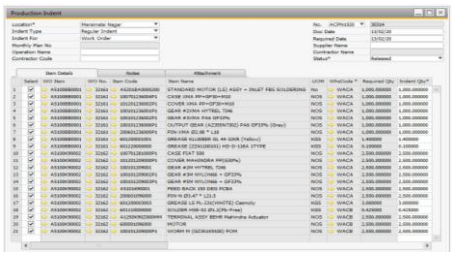

Figure 4. Production Indent window

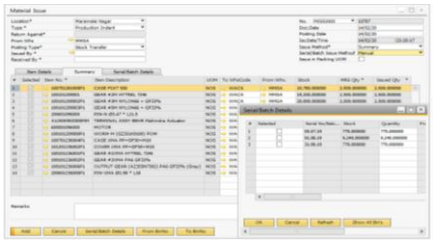

Figure 5. Material Issue window

- In the assembly line, the production is carried out. The required goods are consumed and the remaining goods are stored in the assembly line itself. The document involved is Production Report (Figure 6).

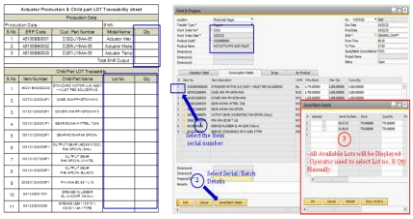

Figure 6. Work in progress window(right) and production report(left)

- The last process is the finished goods leaving the company. After all the process is finished, the product label and the label check sheet are generated and it is attached with the product (Figure 7).

Figure 7. Product label and label check sheet

5. DRAWBACKS IN THE CURRENT SYSTEM

G. *Difficulty in Traceability*

One of the major constraints in the current system is the difficulty to trace the data of the different products. This is an issue that requires attention since it incurs losses.

H. *Extensive Paperwork*

Another issue is that the data entry is done using paper and pen which requires a huge storage space and includes operational costs due to the manual labor involved and the cost of papers.

I. *Decentralized Data*

There is no proper flow of data from the stores to the assembly line and vice versa. This causes a lot of confusion among the workers with regard to availability of materials leading to loss of time.

J. *Lack of FIFO*

FIFO stands for First in First Out. This means that the products with the earliest lot number has to be dispatched first followed by the succeeding lot number. This is not followed in the current system.

K. *Human Errors*

The data collection and data entry are done manually by labors which open up avenues for many errors. Humans are prone to make errors but at an industry level it can cause lots of losses.

6. SOLUTION TO OVERCOME THE DRAWBACKS

The drawbacks of a manual system which is listed above renders huge losses. These losses have to be eliminated for an efficient and profitable production. So a new solution has to be introduced. One such solution is the concept of IOT.

L. *IOT(Internet of Things)*

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with a unique identifier and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.[4]

IOT is a dynamic network framework which intends to coalesce the physical and the virtual domains by utilizing the internet as the medium for communication and transmission of data between them. [5]

Some of the different technologies available in IOT are as follows,

- RFID
- Wi-Fi IEEE 802.11
- Barcode / QR Code
- ZigBee IEEE 802.15.4
- Sensors & Smartphone, etc....

Among the above, the most effective and cost efficient technology that can be adopted in any type of industry is the Barcode/ QR system.

M. *Barcode System*

A barcode system is a network of hardware and software, consisting primarily of mobile computers, printers, handheld scanners, infrastructure, and supporting software. Barcode systems are used to automate data collection where hand recording is time consuming and less efficient.

In order to setup a barcode system there are some devices to be used and some software updates. They are

- Printers & Scanners
- New Add-on in ERP module
- Barcode rendering Software (for Final Product Label)

7. VARIOUS OTHER TECHNOLOGIES AVAILABLE UNDER IOT

In order to choose the correct solution many factors were considered. Some of them are Capital investment of the company, the feasibility of the technology in our company, cost incurred per part, skills required by labors. The limitations of the other technologies are listed below.

N. RFID

Figure 8. Graphical representation of RFID

- RFID stands for Radio Frequency Identification
- It incurs more expense than barcode system
- The replacement cost is high.
- The budget is more than the company's investment.
- It requires a very long duration for getting profit.

O. Zigbee

Figure 9. Graphical representation of Zigbee

- It is a wireless system providing communication between sensors and control system
- Mostly used for smart devices
- It involves sensors cannot be attached with the parts produced in our company
- It involves huge investment

P. WI-FI, sensors and Smartphones

Figure 10. Graphical representation of wi-fi, sensors and smartphones

- The wi-fi and smartphone sensors also use sensors which incurs huge cost
- Sensors cannot be attached to the parts produced by the company
- Smartphones tend to distract the workers which may lead to unwanted confusions

8. CHANGES THAT CAN BE EFFECTED AFTER IMPLEMENTING BARCODE SYSTEM

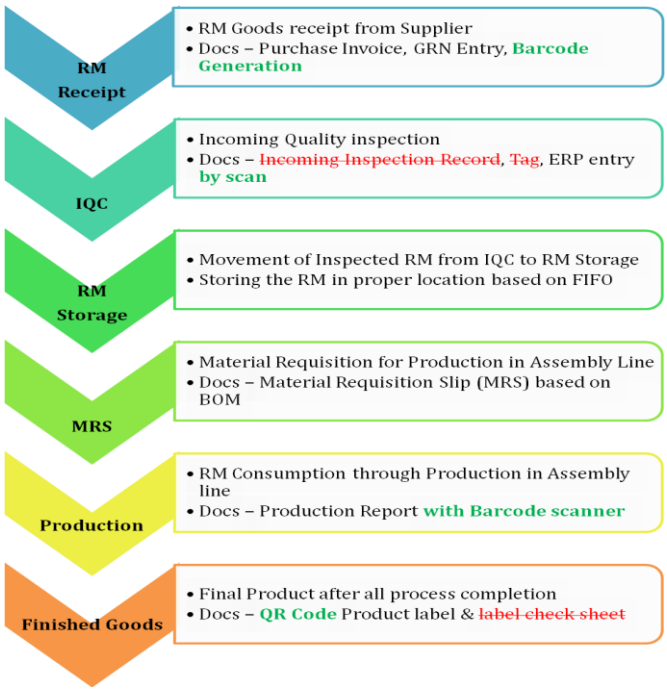

Figure 11. Flow chart of the changes affected after IOT implementation

- The method of data entry changes totally after implementing barcode system. In the barcode system, the GRN entry pane gets a new column called the barcode column (Figure 12) where the details of the barcode are generated. Also now we can generate a barcode that is to be attached with the corresponding part using a barcode printer.

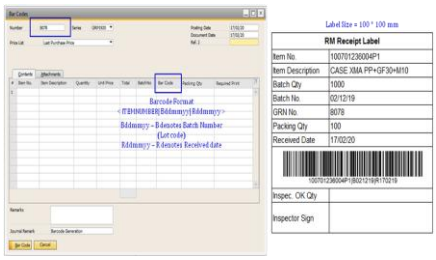

Figure 12. RM receipt label with barcode

- In the Incoming Quality Check the manual entry of Incoming Quality Inspection report and the corresponding tag can be eliminated (Figure 13) as it is done by the barcode system automatically. Only whether the part is OK or NG is manually entered.

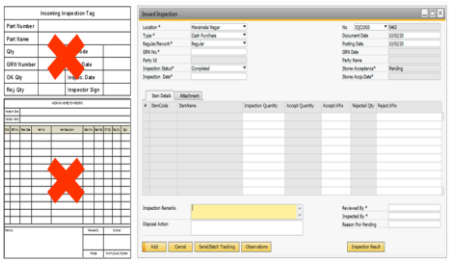

Figure 13. Elimination of inspection tags after IOT implentation

- Also the material issue window includes a blank screen where the material details will be displayed once the barcode is scanned (Figure 14). In the traditional method the user had to manually select the product according to the lot number, but now we can scan the barcode available and the details are entered automatically. This saves time and production is carried out efficiently.

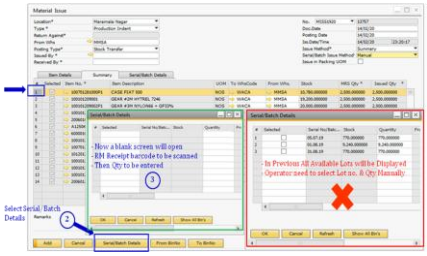

Figure 14. Barcode scanning and entry and elimination of unwanted information

- Also in the traditional method, once the production is done the details of the part produced along with the lot number, production date, number of parts and other details are entered in the system manually. By using the barcode system, these details can be included in the system by just scanning the barcode available in the part thus saving time (Figure 15).

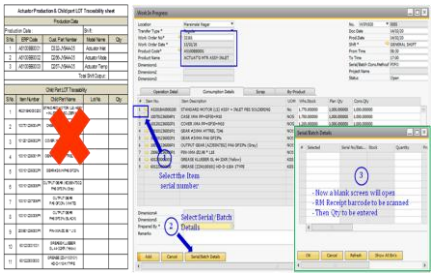

Figure 15. Elimination of manual entry of production data

- The final step is the generation of a final outward barcode for the finished goods. In the traditional method only a manual label checks sheet is attached to the finished goods which is not connected to the ERP also. But in the barcode system a separate barcode containing all the information about the product is attached with the part (Figure 16). This is connected with the ERP system and thus making it easy to trace the part.

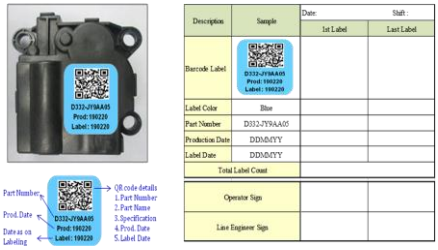

Figure 16. Barcode attached to the part

9. ADVANTAGES OF IMPLEMENTING BARCODE SYSTEM

Q. *Enhanced Traceabiity*

By implementing barcode system we can enhance the traceability of the products. The barcode system allows us to enter data in an easier manner compared to manual entry. The barcode can be scanned and the data is instantly entered into the system. This helps us to track down the product and get the information thus making traceability easy. Also the manual labor is reduced.

R. *Improved Inventory Control*

The barcode system helps us to sort the flow of materials and also helps us to manage the store. Thus it improves the inventory and ensures that FIFO is maintained and also ensures JIT (Just In Time) for the assembly process. This helps in the increase in productivity and reduces the lead time.

S. *Optimized Storage space*

The barcode system reduces the paperwork done. Thus it reduces use of files to store the papers and thus the huge volume of files is reduced. This in turn reduces the usage of space for storing the files. This optimizes the space and thus improves efficiency.

T. *Centralized Data*

The barcode system helps us centralizing the data. This helps the labors in accessing the proper data and avoids confusions. Also the human errors are reduced which in turn reduces losses.

10. COST ANALYSIS

U. *Capital Investment- Rs.3,00,000*

V. *Cost Reduced after Barcode Implementation*

1) Man hours reduced per day

- Inward receiving end- 60min/line, No. of lines- 3

  Time saved- 180min
- Inspection end- 30min
- MRS – 60 min
- Consumption end- 60min/ line, No. of lines- 3

  Time saved- 180min

Total man hours saved per day- **450 min**

Cost of labor per hour- Rs. 150(Rs. 2.5 per minute)

Total cost saved in labor- **Rs. 1125/day**

2) Material cost

- Paper saved in production report -15sheets/ line

  No. of line- 3

  Sheets saved in production line- 45sheets

- Paper saved in Inspection record- 10 sheets
- Total sheets saved per day- **55 sheets**

Cost per sheet- Rs. 0.50

Cost saved in materials- **Rs.27.5**

3) Total cost saved per day- **Rs.1152.5**

4) Total cost saved per month- **Rs. 28,812.5**

With this progression the ROI (Return of Investment) is 10 months.

11. CONCLUSIONS

Though the modern methods have a lot of benefits they are not being followed by many industries. One of the reasons is that the modern methods demand a capital investment which many industries feel is it is not worthy. But little do they know about the profit that these modern methods can get them. They are ignorant about the fact that this investment is only one time and that the profit that they can get is far greater than the investment itself. Also people are not willing to adapt any new system because they feel it may cause confusions. But a properly planned system will not cause any confusion.

The method of IOT is the best solution for the problems faced by many industries, problems such as lack of FIFO and JIT. Also the sorting of material flow and the proper documentation can be made efficiently using the system of IOT. The cost per part and time spent per part is reduced in a large scale which will help in the increase of the productivity of the plant and thereby improving the profitability.

12. FUTURE SCOPE

The barcode system is only a part of the various technologies available in the system of IOT. The various other technologies including RFID tags and various other sensors can be combined into a single system and can be used as an integrated data analysis system in the future. The future holds good for automation and IOT is the best platform to analyze and use the data in an automated and an effective way. Though the capital investment required is large, the profit it can get is way greater than the investment. The future depends on more sophisticated technologies for data handling and IOT is the best option.

ACKNOWLEDGMENT

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