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"EXPLORING RFID BENEFITS USING PROCESS SIMULATION"

CHOWDHARY AMIT[1] & KUMAR SANJAY[2]

[1]SR Manager, Hindustan Aeronautics Limited, Bangalore, Karnataka, India

[2]Professor, Management Development Institute, Gurgaon, Haryana, India

ABSTRACT

The current study was aimed at exploring the possibility of improvements in the metrics of the repair and overhaul process, using process improvement and also an improved tracking system. The company was facing problems and wanted to reduce the turnaround time of critical items (with a penalty) inducted for Repair and Overhaul Process. The objective of the study was to assess the critical reasons of the inefficiencies and estimate delays in the Repair and Overhaul process . This was done using past three yrs ERP data, and supported by interviews of managers involved in managing the process and questionnaire survey. The effect of improvement in the key processes was clubbed with the benefits of use of RFID in tracking the material flow in the process and the combined effect was studied using process simulation with ARENA simulation tool.

The study involved the following steps:

- To analyse As- Is process using real time data, by simulating the process with the help of Arena 8.01 software.
- Exploring potential improvements in process performance parameters, using process improvement also using Auto-Tracking technology.

Benefits like reduction in throughput time and delay reduction were estimated

KEYWORDS: RFID, Process Improvement, Repair and Overhaul, Process Simulation

INTRODUCTION

In the last decade, many companies started implementing RFID is a phased manner, for keeping a track of flow of materials in the supply chain. The costs of RFID tags and other hardware, have also fallen continuously, making the implementation more cost effective. However the early implementations of RFID were largely for tracking of goods in the supply chain, or in retail stores etc. Of late research has been emerging of cases of RFID implementation in internal operations of companies. This research has focused on the increased visibility and better management of information quality as the benefits from RFID implementation. Tracking data is generally used as an input to ERP systems of the organization, and the organization is able to achieve better visibility on the shop floor. With improved visibility, improved process metrics are possible with lower inventory levels, and this is often a benefit of RFID implementation. Better management of information and data quality, makes more accurate information and thus more informed decision making by managers.

Errors in manual entry of data, and the perception of poor data quality, have caused many managers to simply stop using the ERP system. There have been many cases of ERP systems being de activated temporarily, while the data is cleaned and verified before restarting the system. Automated entry of data using tracking systems has helped firms in maintaining data integrity on a sustainable basis.

This paper investigates the improvements in process metrics of the 'repair and overhaul process' at an aircraft manufacturer, using RFID with process rationalization. The company is facing cost and time overruns of the ROH (Repair and Overhaul) orders. The penalty amount for 'Late Delivery' (LD) being paid by the company is increasing rapidly, and there is an urgent need to improve the process. Inconsistency in data and delay in manual data entry, prevents the ERP system from being used for real time tracking of jobs and meeting committed dates.

The present study aims to explore the possibility of an improved tracking system of ROH process in order to reduce the turnaround time of a CAT-D item inducted for 'Repair and Overhaul'. The objectives of the present study are to model and analyze the As- Is process using real time data, by simulating the process with the help of Arena 8.01 software. The identified process improvements along with RFID implementation will now be studied using simulation to identify the potential improvement in process metrics in the repair and overhaul process.

In Section 2.0 the literature on this subject is reviewed, in section the research problem and methodology is presented and results are presented in section 4.

LITERATURE REVIEW

The literature on benefits of ERP systems is extensive. Many researchers (Shang and Seddon, 2002; Ash and Burn, 2003, Markus et al, 2000; Akbulut et al, 2006; Bradford and Marianne, 2001; Markus and Tanis, 2000) have identified the various benefits of the use of ERP systems. The benefits of availability of credible information across the organization leads to better decision making and allows more coordinated working across business processes. However problems with manual data entry, lead to poor data quality, and the reliability of the data provided by the ERP systems becomes questionable.

Benefits of ERP systems can only be sustained if data quality is maintained through use of tracking systems and automated data entry. (Markus et al, 2000) Yang and Su have used structural equation modeling to analyze and establish the relationship between ERP benefits and SCM performance. (Yang and Su, 2009) The use of ERP systems in providing benefits to the organization and the supply chain are thus dependent on the use of tracking and automated data entry systems.

Tracking Systems: This literature review now looks at the use of RFID and bar coding as tracking mechanisms along with ERP systems. Schuster et al (2004) were amongst the early researchers to go beyond the use of ERP systems and advocate the use of RFID and auto tracking in improving the operational efficiency of the key processes in the organization. Hozac et al (2008) have compared the use of RFID and bar coding as alternative systems for material tracking and have used simulation to establish that performance worsens as we use bar coding along with lot splitting. Thus the use of RFID is justified where the processes undergo lot splitting. Other researchers such as Heese (2007), Lee and Ozer (2007), Tajima (2007), and Angeles (2009) have suggested that improved visibility and transparency provided by the use of RFID ensures higher supply chain performance and responsiveness, as low stocks can be kept at various locations without affecting the service levels provided to the customers. Gaukler et al (2008) has studied RFID benefits and has used simulation to suggest that RFID benefits will be higher for a fast assembly based system such as in auto industry.

Asif and Mandivala (2005) have presented an indepth analysis of the basic components of RFID systems and the business implication of their use in business. Mehrjerdi (2009) also reviews key issues related to radio frequency identification (RFID) and it's application in supply chain management, in the form of three cases of RFID implementation. Ngai et al (2007) have tried to identify the critical success factors for RFID implementation in an aircraft engineering firm.

Delen et al (2007) provide a comprehensive and systematic review of literature pertaining to RFID related research issues. Wang et al (2011) simulate a RFID enabled global TFT_LCD supply chain associated with the Grey forecasting model, with three KPIs: Inventory cost, inventory turnover and bull whip. The simulations suggest major savings in total inventory costs in the supply chain through use of RFID. Other researchers (such as Irani et al, 2010; Whitaker et al, 2007; Wamba et al, 2009; Whang et al, 2010 and Zhu et al, 2012) have studied RFID adoption and benefits for various industries.

The literature review thus suggests that RFID implementation is useful in certain sectors specially where fast paced assembly is required, and where there is lot splitting in the process flow. Also studies suggest major benefits in inventory costs and inventory transparency with the use of RFID systems.

RESEARCH PROBLEM

To explore possible improvements in process metrics using process simplification and RFID, to reduce delay in 'Repair and Overhaul Process' (CAT – D items). Hence the research will involve the following.

- To map the as- is 'Repair and Overhaul process' using interviews and past three years ERP data and to model and analyze the process using simulation. Delays, and points of failure of the process are identified for process rationalization.
- Using simulation to explore potential improvements in process performance parameters, also using RFID technology

RESEARCH METHODOLOGY

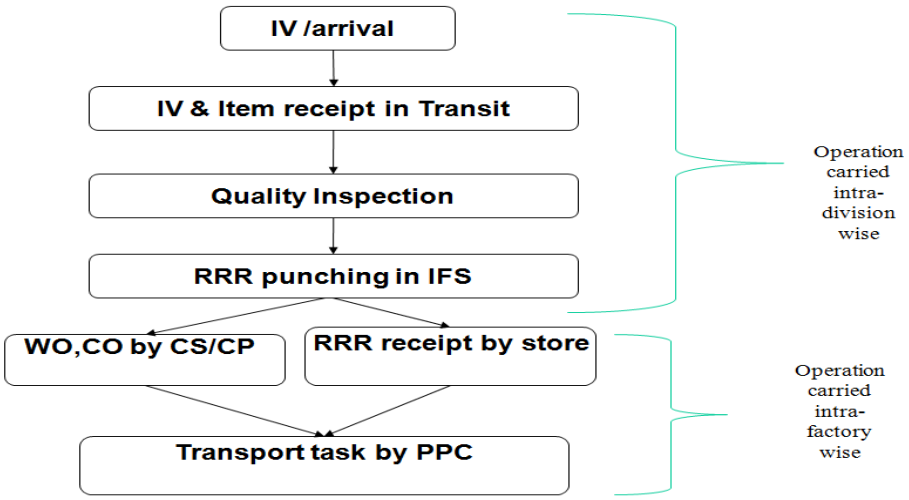
- As- Is process Mapping: Personal interviews for recording As-Is process and drawing the actual process flow on the ground. The sample chosen for the interviews consisted of experienced officers and workers directly involved in the Repair and Overhaul process randomly chosen from different parts of the division.
- Observation and tracking of 50 items over a 3 month period, to calculate the flow timing, delays etc. in the process. This was done using trained person with a stop watch. One shop (Clean Room 2) from Instrument factory was chosen for this purpose. The reason behind choosing this shop is that items are having comparatively smaller cycle time and it is possible to observe all the activities being completed within 3 month period.
- ERP data was used to establish and verify dates, delays and flow of materials related data. Last three years data was taken for this purpose.
- Simulation of results of as-is process and also improved process with tracking, and comparing the two process under various conditions of operation.

ANALYSIS AND RESULTS

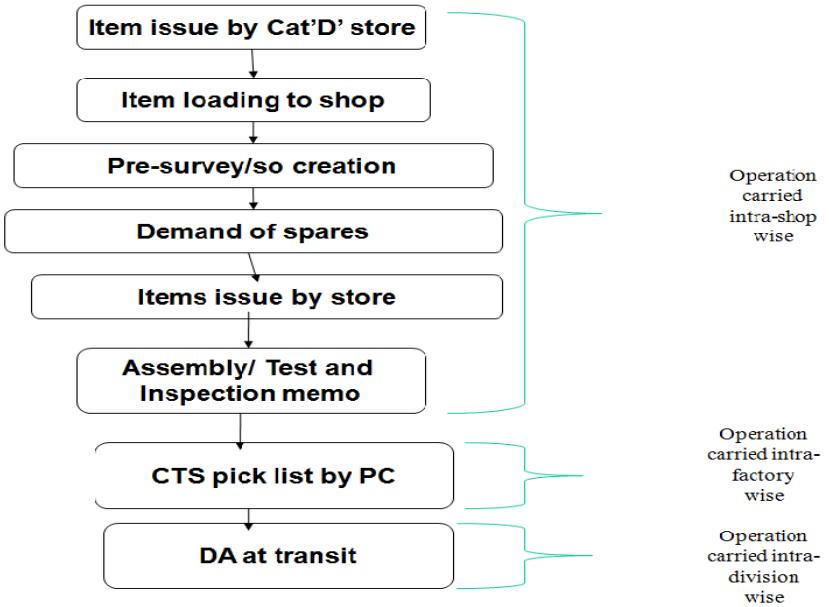
- In section 4.1 the as-is process is mapped and described. In section 4.2 the values of critical parameters of the as-is process are identified, and in section 4.3 the values of critical parameters of the improved process are obtained using simulation, and in section 4.4 the values of the critical parameters are compared for both the old as-is process and the new improved process. Expected benefits of RFID implementation are thus explored in this section.

As is Process Definition and Mapping

- After going through the operation manual, doing observation, conducting interviews and survey division wise and close follow-up of the process in one shop, it is now possible to map the process in two parts.
- Since the first part of the process feeds all the available shops in the plant –including mechanical, instrumentation, fuel etc, it is modeled separately, and the main 'Repair and Overhaul' process is modeled separately as it pertains only to the instrumentation shop. The total time taken for the process is about 17 days on an average



Process 1: IV Arrival to Store



Process 2: Issue to Instrument Shop to Repair and Overhaul Completion, Testing and Dispatch

Figure 1: Process Mapping of Repair and Overhaul Process

Process 1: (See Figure 1) Receiving with IV to RRR Creation and Issuance to Shop

This part involves all the processes being done before item is loaded in to the respective assembly and test shops for repair and overhaul work. The activities involved are- arrival of the ROH (Repair and Overhaul) item with Induction Voucher (IV) at the 'Inward Transit Point' and the items are segregated as per the customers, projects and destination factories. Then the items along with the documents are inspected by a quality control man for verification of documents

and items to insure that correct part with sufficient document has arrived. After the necessary inspection of documents and the item by Quality Control(QC) of Transit inward, repairable receiving report (RRR)/Purchase order (PO) is generated in ERP system and the item is sent to respective CAT- D stores (Instrument, Mechanical or Fuel) . Simultaneously a work order is generated on ERP system for the same CAT-D item by Customer service department/Central Programming Department/Marketing Department.

Next the items is received at CAT-D stores and kept in a specific location using a double binning system with a physical card and an online ERP card. Then based on the repair schedule, a transport task order is generated, and the item is issued to the shop for repair.

Process 2: Repair and Overhaul in the Instrument Shop

This process involves all the activities performed when item reaches the instrument shop where the repair and overhaul process will be carried out. First the item is surveyed and the nature of work required by the item is decided. Based on this a shop order is created, and the spares are requested and issued. Then the item is disassembled and parts are replaced, before final assembly and testing operations. A final inspection of the part is done and it is offered for clearance to the Director General of Quality Assurance. Finally a PC pick list for dispatch is created and dispatch papers are completed for shipping the item back to customer. (See figure 1)

Improving Process 1: IV to CAT –D Store

Observed time was estimated during the follow up of 50 CAT-D units from one shop- i.e 'instrumentation'. Stopwatch was used to measure the time wherever it was necessary. Standard time was taken as observed time when the unit was very urgent and moved ideally without any delays and errors (expedited movement).

Table 1: Time for each Activity Using Observation and ERP Data

S.No	Operation Name	Actual Time Taken to Complete the Operation (Time in Bracket = Standard Time for Operation)	Source of Data	Estimated Time Using RFID*
1	Arrival of item with IV	15 min random arrival	ERP	15 mins - random arrival
2	Receiving to Making of RRR	13 days (2 days)	observation	2 days
3	Movement to CAT-D store	4 days(1day)	ERP	1 day
4	Loading to shop	1 day(1day)	ERP	1 day
5	Offer for pre-survey delay	10days(Zero)	Observation +ERP	0
5	Presurvey	6hrs (3 hours)	observation	3 hours
6	Functional test	5 days(2.5 days)	observation	2.5 days
7	Disassembly	1 day(0.75 day)	observation	0.75 days
8	Demand spare	1 hr(0.5hr)	observation	0.5 hours
9	Stock out/procurement delay	40days(zero)	observation	0
10	Issue spare	2 hrs(1 hr)	observation	1 hour
11	Assembly process	20 days(10 days)	observation	10 days
12	Final inspection /memo	1 day(0.75 day)	observation	0.75 days
13	P/c pick list/CTS	1 hr(1hr)	observation	1 hour
14	Movement to shipping	1 day(1 day)	observation	1 day
15	Dispatch advice	1hr(0.5hr)	observation	hours

*****Based on literature as cited in section 2

Process 1

The following areas of potential improvements are identified after the study .Repair and overhaul process on about 50 CAT-D units of a shop in the instrument factory were studied and deficiencies and delays in the process were assessed by measuring value added, non value added and waiting times during the process.

Table 2: Parameters of Process 1: I V to CAT –D Store

Parameter	Instrument	Mechanical	Fuel	
Number of CATD unit inducted in year 2011	5727	3135	507	Total 9369
IV to RRR creation time in days	14	11	13	Avg.13
Transit to CAT-D store time in days	4	4	4	Avg.4

The following improvements were suggested to the process based on which the average delay would decrease from about 17 days on an average to 3 days.

- Receiving process at Transit inward involves large number of entries which can be reduced. In as-is process, units remained waiting for RRR creation for average 13 days which is very high.
- **Reducing Movement Time from Transit to CAT-D Stores:** It was observed that even after RRR is created, item takes average 4 days time to reach individual stores. The delay is mainly due to the segregation of items for different factories and unnecessary manual entries.
- **Concurrent Offering of Items for Quality Inspection / Pre-Survey thus Eliminating Delay in Offering for Pre-Survey by the Shop:** The item on average remains lying in the shop floor for 10 days before being offered to Quality control for Pre-survey. Here problem lies with the sequence of operation. Without deciding the nature of work to be done (i.e pre-survey by QC), item is loaded to a particular shop and ownership of planning is handed over to the shop in-charges even if they are unaware of the kind of repair or overhaul work to be done.

Improvements Made Possible by RFID

Based on literature cited in section 2, the improvement in process performance using improved tracking system can be summarized as follows:

- **Improving WIP Tracking:** The units waits for many days at several work centers. Knowing exact number of WIPs queuing at each work centre will help to adjust resources and remove process bottlenecks. (Lee and O"Zer, 2007; Delen and Hargrave, 2007; Meherjerdi, 2011)
- **Improving Spare Part Inventory Tracking:** spare parts are needed during the assembly operation of repair and overhaul process. (Meherjerdi, 2011)
- **Improving Tools and Equipment Tracking:** processes like disassembly, subassembly and assembly operations require specific tools, fixtures and gauges. Improved tracking of this item will save the time wasted in searching and finding these items.(Meherjerdi, 2011; Li and Visich, 2006)
- **Improving Traceability of Life Spare Items:** sometimes the life items issued to shop are expired items. The lack of traceability of these items results in sudden stock out situation. (Li and Visich, 2006)

- **Reducing Delays Due to Manual Entry Errors in the ERP System:** There have been delays due to errors in making RRR, Transport task (TT) and Identification Tags. The final inspection and release certification process gets delayed because there is always a lag in manual entries of issuance of items in the store and labour time punch in the shop. (Angeles, 2009; Schuster, 2009)

Estimating Time Savings with and without Auto Tracking System Using RFID in Process 2 –i.e. Repair and Overhaul in Instrument Shop

Simulation of the Process was Done with the Following Parameters

- Items arrive at the shop in random exponential order (arrival follows random exponential distribution)
- Activity times follow a triangular distribution
- Hours available are 7.5 per shift and simulation uses single shift working for 300 days in a year
- Only resources dedicated to Repair and Overhaul process are considered in the simulated process The simulation results show the following parameters for the ROH process at the instrument shop with and without RFID implementation

Table 3: Instrument Shop ROH Process Operational Parameters AS-IS and after RFID Implementation

SN	Operational Parameter	Value AS-IS Process	Values of Improved Process with RFID
1	Total time spent by one unit in the process(hrs)	666.14	140.21
2	value added time spent by one unit(hrs)	136.81	68.81
3	non value added time spent by one unit(hrs)	133.11	7.45
4	Waiting time spent by one unit(hrs)	396.21	63.95
5	Yearly capacity of the shop (no. of items repaired)	127	274
6	CAT-D unit WIP (no. of items)	72.4	18.6

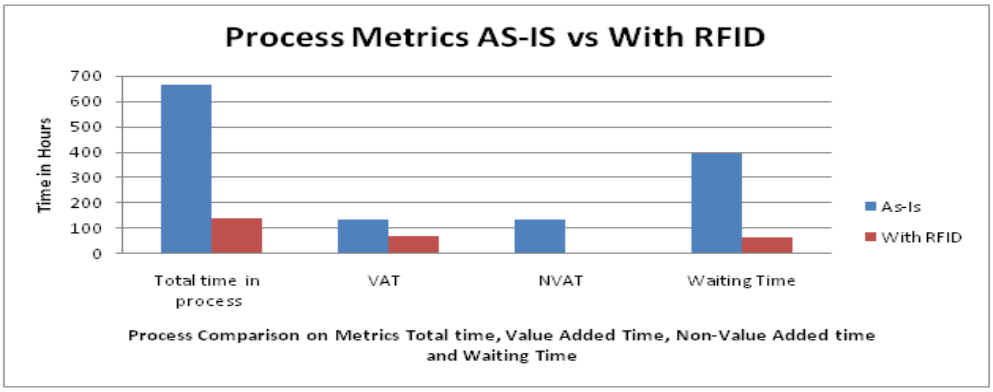


Figure 2: Process Metrics Comparison of AS-IS Process with New Process with RFID

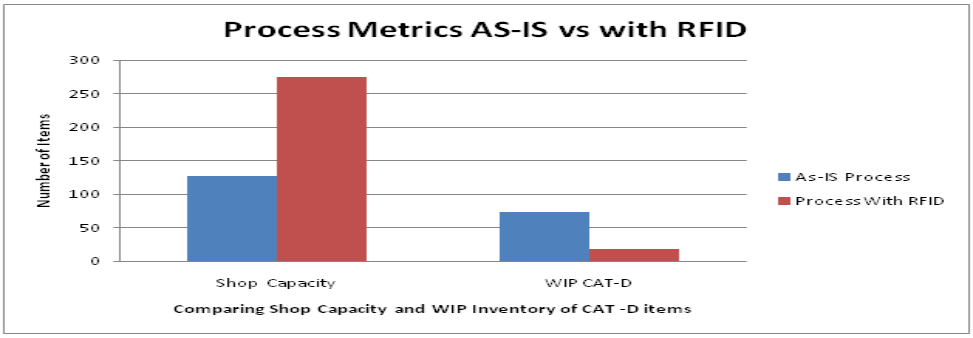


Figure 3: Process Metrics Comparison of AS-IS Process with New Process with RFID

As is clear from Figure 2 and 3, as also from Table 3, the process with RFID use and process simplification performs better on most of the relevant process metrics. The total time ha the item spends inside the process is reduced from 666 hours to about 140 hours, with the most dramatic reduction in Non Value added time from 133 hours to just 7.45 hours. Also the waiting time is reduced from 396 hours to about 64 hours. As a result the throughput capacity of the shop goes up from 127 units to about 274 units per annum. Also the WIP of CAT –D items is also reduced drastically. All these parameters show that with implementation of RFID, the Repair and Overhaul Process at the instrument shop should be able to reduce the delays in the process, and with a little managerial attention, should allow better schedule adherence, thus reducing the penalties that the unit is incurring at present.

CONCLUSIONS AND FUTURE WORK

Following conclusions from the study can be drawn, as is clear from figures 2 and 3 which show the comparative operational parameters of the existing as -is process and the proposed process with RFID based improvements.

- The improvement potentials exist in the tracking of
  - Work In Process (WIP)
  - Spare parts Inventory
  - Tools and fixtures
  - Traceability of life items lying in stores.
  - Suppliers for **spare** parts
  - Elimination of the manual entry process for ERP systems.
  - Elimination of non value added activities such as manual entriesetc.
- As a rationalization of the process 1, the present **sequence of the operations** of loading in the shop without doing pre-survey is creating problems and needs to be scheduled before the assignment of the item to any shop.
- The result of Simulation with the help of Arena8.01 software clearly shows that **Auto-Tracking system using RFID will substantially improve the operational performance** during most of the activities .
- The **RFID will Improve Tracking process** of WIP ,Spares Part Inventory ,Traceability of Life items level and tools and equipments used during the Repair and Overhaul process.
- The RFID will also reduce the delays due to **manual entry process**.

FUTURE WORK

- The techno- economic feasibility of RFID implementation has not been covered in this study. Hence future work should involve the technical aspects of RFID implementation at the division.
- Savings in the supply chain from RFID implementation and moving towards practices such as VMI (Vendor Managed Inventory) and CFPR (Collaborative Forecasting Planning and Replenishment) through sharing the real time data suppliers should yield substantial benefits and these can be explored in future work.

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