CHALLENGES IN THE APPLICATION OF RFID IN RETAIL INDUSTRY

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Abstract: Every organization is constantly looking for opportunities to make their operations cost effective, efficient and agile. In a manufacturing organization, supply chain management should be efficient. Every asset has to be managed well. Realizing the right value of each asset is critical in the supply chain process. Traditional methods involve significant time and resources to track and manage assets. It is not about understanding where the asset is at a fixed point of time, but using active information to make effective decisions. Radio-frequency identification (RFID) is used to automatically identify and track tags attached to objects. These tags contain information stored in electronic format. It is important to understand RFID error rate. RFID errors impact the transactions and causes delay and rework. There is a direct impact to operation costs. This paper illustrated how RFID error rates can be predicted and analyzes two factors contributing to these errors. This would help reduce the inefficiencies and the operating costs.

Keywords: RFID, Read errors, signal interferences

1. Introduction to Asset Management

Asset management includes a set of critical processes for any organization. There is a direct impact to productivity when any equipment, tool or asset is not available at the right time at the right place. It is not only the inconvenience or the time to market delay, but also the impact to operational costs. Time spent searching for assets hurts productivity, reducing profitability. Productivity of the workers is directly impacted due to effort spent in searching for the right asset. Assets need to be planned well. It cannot be accumulated at one place for long. It has to be on the move. It directly eats up the capital. Companies lose quiet lot of amount due to the inefficiencies as they are not able to track the right asset. To improve competitiveness and profitability, enterprises must manage assets with the same care and innovation they use to drive excess inventory and costs out of operations. RFIDs help to track the assets in the organization.

2. Managing RFID Errors

RFID tags are a boon for managers. They are able to track every product part by part using these RFID tags. They know very well where exactly their product lies in the process and where it is heading to. Efficient asset management ensures all the employees have access to right tools and equipment when they need them. Case studies prove that it is much more cost effective to ensure asset availability by managing information instead of physical goods. The whole process is dependent on the RFID tags and that is key to maintain the records current. If information is inaccurate or out of date, assets will unexpectedly be out of service, leading to costly productivity and replacement losses.

Given the importance of RFID, it is crucial that there are no errors associated with RFID. In reality, RFID tags do have errors associated with it which would have a direct impact to the costs. Hence it is important to get the RFID process implemented right. As a first step the project objectives should be clearly documented and agreed upon. What is the purpose of RFID, is it going to be active or passive, which materials are going to be tagged with RFID. RFID errors have to be minimal or eliminated. Managers should have the ability to predict RFID errors and take corrective and preventive actions. Quantitative models like process performance model (PPM) can be used to predict the outcomes. PPMs are used to estimate or predict the value of a process performance measure from the values of other process, product, and service measurements. PPM can predict interim outcomes; it can model the variation of factor and help in predicting the range of outcome variation.

Managers should understand the importance of PPMs and its usage. Managers need to manage projects by metrics. They should track the RFID errors of the process regularly. Quality Assurance team main metric should be RFID read errors. The number of read errors will directly correlate to process inefficiency as some products couldn't be tracked. Managers are supposed to understand how the RFID reader identifies the tags and update the process based on the learning. Process performance models can be used to predict outcomes. Specific performance model to predict RFID error rates can be built. Managers can then use these models to predict the read errors. Based on the factors, team can decide to use the model as it is or customize it to their current need. During planning phase itself, managers are expected to implement process models to manage the objectives. Managers can set the specification limits and track the performance against these limits. Whenever they see a spike, they can look for root cause analysis and understand the reasons for variations. This will help them to take right action at the right time instead of allowing the defect to flow through the entire process. The advantage of performance models is to predict the errors upfront.

3. Read Errors and Variables associated in prediction model

An error is a failure to interpret a returned signal from a transponder tag. By measuring the errors against the total reads, any problem in RFID scanning can be identified. Read errors are associated with the number of times that an antenna must probe the incoming container to properly detect the tag. A read error can be generated because of various reasons like faulty tag, antenna or improper placement of antenna or improper tag types on the container material or poor signal interference or low signal strength.

1. Y – Error Rate – It is the number of read errors over the time interval (1 hr) divided by the number of reads (the number of successful reads plus the number of read errors) in this time period. In effect this is the percentage of errors in a given time period.
2. X1 – Technical experience – Average technical experience of the technician who laid the RFIDs, in person months
3. X2 – Signal Interference – RFID frequencies range is mapped to a scale of 1 to 5, 1 being the lowest and 5 the highest.

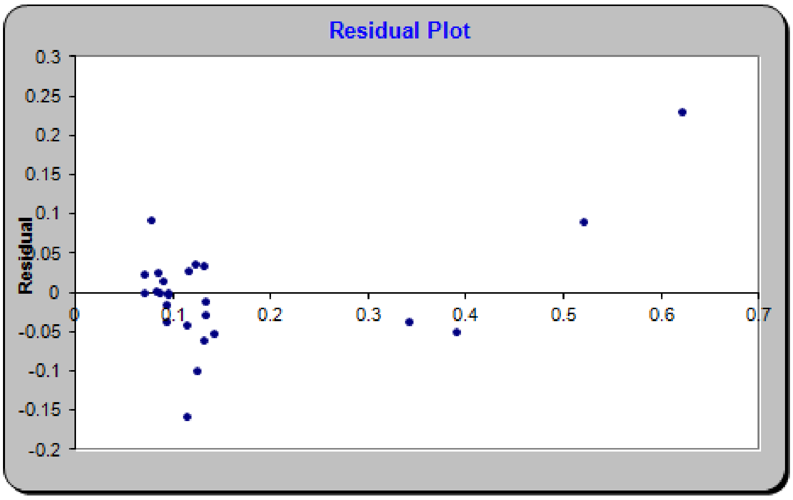
Also, by studying the co-efficient of correlation and co-efficient of determination, it can be ascertained that no other influencing factor need to be added to the model to explain the error rate, which is the Y.

4. Data Analysis and regression equation

The data collated for the x and y factors are as shown in the Table 4.1. Data points from 25 instances in an experiment were collected and considered for analysis.

Y	X1	X2
Error Rate (Ratio)	**Technical Experience (in months)**	**Signal Inference (scale 1-5)**
0.085	35	3.000
0.092	31	3.000
0.092	33	3.000
0.123	35	3.000
0.114	25	2.000
0.113	21	4.000
0.124	22	3.000
0.132	33	4.000
0.115	35	3.000
0.141	18	1.000
0.095	34	3.000
0.070	40	4.000
0.071	42	4.000
0.078	48	4.000
0.083	39	4.000
0.084	41	4.000
0.131	34	3.000
0.133	28	3.000
0.131	25	3.000
0.342	4	2.000
0.620	3	2.000
0.390	5	4.000
0.089	43	5.000
0.095	41	5.000
0.520	6	4.000

Table 4.1 – RFID Data



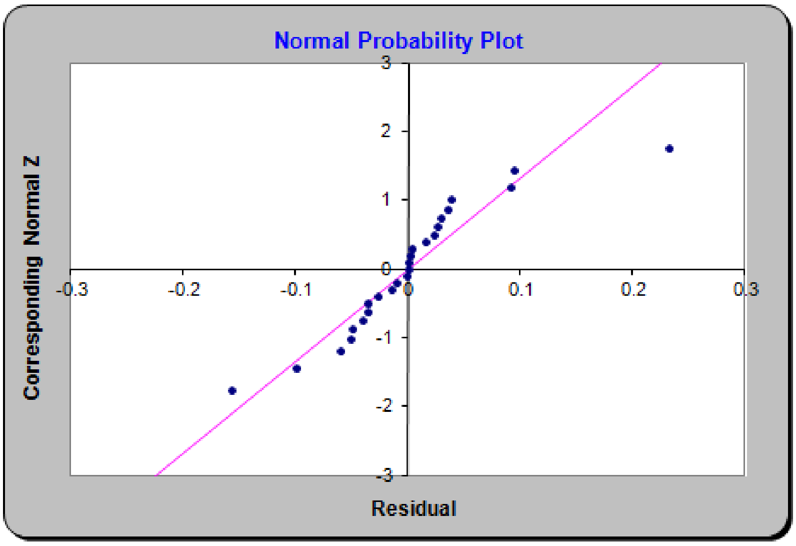


Figure 4.1 – Residual Plot

Mirror pattern is not found in Figure 4.1, Residual Plot and hence no hetero-scedasticity is found. The normal probability plot is approximately linear. This would indicate that the normality assumption for the errors has not been violated.

The p value for technical experience, is 0.0002 which is < 0.05 and p value for signal interference is 0.043 which is also < 0.05, null hypothesis is not valid, which means the variables selected have an impact to error rate.

Intercept	Technical Experience (in months)	Signal Interference
0.34742	-0.0106	-0.0364

Table 4.2 – Regression Equation

As shown in Table 4.2, technical experience has a negative influence on error rate. As the team's technical experience increases the error rate is reduced. The influence of signal interference is also negative. This means that when the values of technical experience and signal interference are low the error rate will be high and vice versa.

5. Determining the sub process and selecting the parameters

Based on project data analyzed it is evident that error rate is critically influenced by RFID tagging sub process and technical experience of the technicians involved in the tagging process. For tagging sub process the number of steps involved in testing the tagging is the parameter. The number of rounds of testing can also be considered as the parameter. For example, first, second and third round of testing can be the parameters factored. There should be standard baseline values that will include lower specification limit (LSL), goal and upper specification limit (USL). The same can be gathered for error rate as well. Based on the sub process selected, the goal for signal interference and technical experience would be calculated. It is also important for the project team to justify why they have gone with a particular sub process and the rationale. Table 5.1 gives the sub process performance baseline for signal inference and technical experience. The values are represented by A1, A2, A3 and so on. Based on the current project context, the parameters and rounds of testing chosen are shown in Table 5.2, Selected Sub process performance baseline. Based on the actual data collated, compare the expected and actual error rates captured. Based on the actual value in each phases, the predicted value for next phases are accordingly impacted. The data is compared against the goal and continuous improvement measures to reduce error rate is focused on.

Sub process	Metric	Parameter	LSL	Goal	USL
Signal Interference Testing	SIT	Test steps (< 4)	A1	A2	A3
Signal Interference Testing	SIT	Test steps (>4)	C1	C2	C3
Technical Experience in Testing	TET	1 round of testing	D1	D2	D3
Technical Experience in Testing	TET	2 rounds of testing	E1	E2	E3
Technical Experience in Testing	TET	3 rounds of testing	F1	F2	F3

Table 5.1 - Sub process performance baseline

Sub process	Metric	Parameter	Goal	Comments
Signal Interference Testing	SIT	Test steps (>4)	C2	
Technical Experience in Testing	TET	3 rounds of testing	F2	

Table 5.2 – Selected Sub process performance baseline

6. Conclusion

Intelligent asset tracking allows businesses to know precisely where high-value assets such as tools, forklifts, and other equipment are located, when they move, where they move, as well as the asset's physical and environmental condition. It shortens the time to find the item, reduces incidence of theft, and accelerates inventory turns. Accurate tracking of all parts throughout the assembly line enables streamlined production and lower labor costs. When businesses can ensure the right asset is at the right place at the right time, there is a measureable, positive impact on efficiency. Products that cost less to produce, store, and ship mean higher profits. It is important that RFID errors are minimal or nil. This practical case study demonstrated the influence of technical experience while installing the RFIDs and signal inference testing. The importance of the right experience technicians, the testing steps and signal frequency is the key to deduct RFID errors. The case study also helped us to use the right tools for analysis, the steps around what-if analysis, the defect prevention plan and the tracking mechanism. Steps should be taken to ensure that the technicians are experienced. This illustration gave the practical applicability of process performance models in RFID error deduction thus enabling opportunities to eliminate errors and improve process efficiencies.

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