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MAJOR CHALLENGES IN ADOPTION OF RFID FOR INDIAN SME'S

Parul Sharma[1], Anbesh Jamwal[2], Ankur Aggarwal[3], Shaurya Bhardwaj[4], Rohan Sood[5]

[1]B. Tech Student, Dept. of Electronics and Communication Eng., SRM Institute of science and technology, NCR Campus, U.P, India
[2, 3]M. Tech Student, Dept. of Mechanical Eng., Amity University, Noida, U.P, India
[4]B. Tech Student, Dept. of Computer Science and Eng., VIT University, Chennai, India
[5]B. Tech Student, Dept. of Electronics and Communication Eng., SRM Institute of science and technology, Chennai, India

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Abstract - *In the present time RFID has emerged to be a promising technology which has evidently gained popularity in the global industries. In the past few years RFID technology has moved from obscurity into mainstream applications that is helping the industries in the handling of manufacturing goods and materials at a very fast rate. But it is still being explored by academic and business fields in India. This paper aims to analyze the state of art on RFID and the practical challenges it poses on the implementation in Indian industries. The research was carried out through a structured questionnaire survey and literature review. Analytical hierarchy process was adopted to analyzed the RFID challenges that resist the RFID implementation in the Indian industries.*

Key Words: **RFID, Analytical hierarchy process, Implementation challenges**

1.INTRODUCTION

The change in the view of the Indian logistic system has become prominent due to the adoption of a new technology called RFID. The Radio frequency identification is a smart label which has fostered seamless wireless transactions [1]. The RFID is one of the most popular electronic discovery and is a substantial asset in globalizing the market. RFID is an intelligent device that is capable of tracking any product. At present, RFID is helping the big organizations to track their inventory and maintain the market value of the products [2]. RFID is composed of a radio identification reader, any operating system-based computer and the RFID tags or the transponders which are attached with the inventory [3]. The beginning of the RFID technology was marked in the world war2 when Scottish physicist Sir Robert Alexander Watson-Watt developed the first active identity friend or foe system(IFF) which detected if the war craft belonged to the British army or the enemy and whether to attack or not. This technology was initially used in the unlocking of car doors but now finds its application in various fields [4]. The RFID is composed of integrated circuits(ICs) made of silicon, it contains information about a particular product which is used to transmit the stored information to a remote server [5]. In the present time, the tags can be active or passive depending upon the requirement and working environment. RFID is providing the solution in the logistic world for the smooth flow of products [6]. The RFID tags have an identity that is broadcasted to the operator which is on the same frequency, under the same server or using the same protocol [7]. With the higher capital cost, the RFID is being used in only those areas where the optical based system fails. RFID reader is also a device which is used to read data and write data that is compatible with Radio frequency identification tags [8]. There is a communication server which is required to locate the information between the RFID tags and the RFID reader. This communication server helps to locate the information of goods, thus allowing the movement within or outside the organization [9]. To ensure the compatibility, the tag and reader must have to work at the same frequency, server, and same protocol. In the past, the RFID was only limited to logistics and manufacturing purposes, but these days the applications of RFID extend vastly in animal detection, textiles, construction areas, food safety purposes and health [10]. Almost all the educational institutions and big organizations are using the RFID's for attendance as well as entrance purposes [12]. The RFID is being widely used in the field of aviation to detect the exact location of the target and is also finding a way in the transportation systems like vehicle tracking etc. The barcodes are being replaced by the RFID's, which cater to many advantages of RFID's over the barcodes like the portable data base and long read range [11]. There are some advantages which urge to adopt the RFID in present time which are:

1. Oversee the long lead time-The RFID is capable of curtailing the supply chain between the initialization and the finalization of any product due to its explicit inventory management techniques [13].

2. Management of inventory-The dealing of products in a warehouse can be done efficiently as the RFID never lets the products to go out of stock and eliminates any increase in the quantity. The intelligent reader detects the need of stock when depreciating and this information can be transmitted to the main reader [14].

3. Reduction in employment cost-The smart reader eliminates the need for employing humans as it does the production work itself [15].

4. Minimum errors- Due to the absence of human intervention there are chances of minimum error in data management and inventory control [16].

5. Improved fault tolerance-The information stored on the tag can be a boon in improving the tolerance of any product as the details will be known prior [17].

6. Prioritize the product-Its ability to give a unique identity to all the items so as to make it better than the normal UPC bar code readers [18].

In the past few years RFID has gained more popularity in the developed nations and is still gaining in the developing countries. After the invention of RFID, a lot of study has been done in the implementation and its working, but there are still many research gaps. Relatively less study has been done to eliminate the barriers which industries are facing in the developing countries like India. This paper aims at identification of such major challenges which act as a bridge in the implementation of RFID in the Indian Industries.

2.LITERATURE REVIEW

The RFID has wide range of use in the present time. The origin of the RFID can be traced from the World War-2 when the Germans, Americans, Japanese and British Army utilized the radars to monitor the activities of their aircraft [19]. Later the department of agriculture in the United states used the RFID's in 1950's to study the movement of cows for the health purposes [20]. The RFID system came into use in the late 1970's when a group of scientists in the USA worked on a system to track down the nuclear material [21]. This marked the era of RFID, which eventually gained popularity in the business world [22]. RFID is the leading edge with an immense growth potential and a vivid spectrum of use in the prevailing world [23]. In 2008 Gartner Inc. forecasts that the RFID market achieved the worldwide revenue of 1.2 billion which was 31% more than the revenue of the past year [24]. Ever since RFID has seen sky-high expansion and has gained tremendous popularity in the corporate world [25]. In the field of animal detection, the growth is such that any sudden change in the diet of the animals, any bacteria or virus the animals can be automatically detected [26].In the efficient management of warehouse, logistics based management is done so as to increase the productivity and reduce the cost of operation as the RFID can visualize the supply chain processes [27].The further implementation of this smart reader is visualized in the library management which provides better operational efficiency and precision but is a limitation because of the low budget[28]. A method for measurement of the backscattered signal from the tag has been studied and a thorough study on the orientation has been done [29]. The environmental effects on the tag as well as the antenna are considered and a tentative solution is put forth so as to make the RFID adaptive [30].Starting from the 17th century there has been a potential use of RFID in the locking of cars i.e. in the security spectrum, a vivid use in the industry as supply chain management due to its anti-corruptibility and traceability features [31].The future directions in this field are clear due to its vast scope and exquisite exhaustibility potential leading to an advanced digitalized future [32]. There is a surety of its ubiquity in the future. On the introduction of item level tagging 10 years hence, there shall be a better control in the production cycle [33]. On using tags, the use of antenna and chips as an embedded component shall be eliminated and maximum cost will be cut off adding ease to the production [34].

3.METHODOLOGY

AHP is the one of the simplest and an effective tool for the multi-criteria decision making with plenty of applications which has been reported in various fields like management science, social science and industrial engineering [35]. AHP was initiated by the mathematician Saaty during the 1970's. This analytical process ranks the several conflicting options which help to find out the best alternative [36]. The AHP involves pair wise comparison of the challenges for the Indian Small-Scale industries which implement the RFID [37]. AHP is the best tool for finding the best alternative by decomposing the problem into the criteria's and sub-criteria's [38]. The following steps are taken in AHP model:

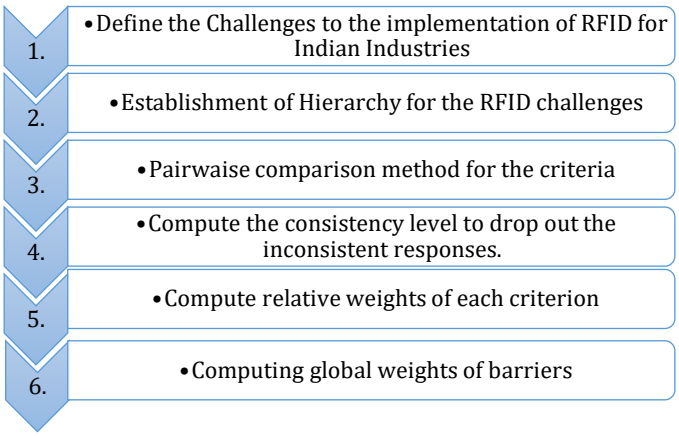

Fig – 1: Steps of AHP Modelling

3.1 Identification of RFID Challenges

The challenges for the RFID implementation in the Indian industries can be tracked with the help of literature survey and data collections from the industries. The challenges are shown in the Table 1. Three criteria are chosen for the

establishment of the hierarchical structure which is shown in the Table 2.

Table – 1: List of RFID Barriers

Barrier No.	Barrier Name
B1	Standardization issues
B2	Security and Confidentiality
B3	Environment
B4	Management Commitment
B5	Cost Factor: High Cost
B6	Legal and Patent Challenges
B7	Tag Failure rates
B8	Technology Support for RFID Adoption
B9	Selection of Hardware and Software

Table – 2: Criteria's of the Barriers

S.NO	Criteria C1 (Performance)	Criteria C2 (Administrative)	Criteria C3 (Technology)
1.	Standardization issues	Management Commitment	Tag Failure Rates
2.	Security and Privacy	Cost Factor: Higher Cost	Technology support for the adoption of RFID
3.	Environment	Legal and patent Challenges	Selection of hardware and Software

3.2 Description of the RFID Barriers

1. Standardization Issues (B1)

The RFID technology has not been considered as a global standard due to wide range of frequency application worldwide. Interoperability is a major issue in frequency allocation in various regions. The ability of a tag to be read by the reader varies geographically, hence the interoperability of the RFID becomes a challenge. The ultimate battle between EPC global (Electronic Product Code) and the ISO (International Standardization Organization) makes it impossible to standardize the frequency.

2. Security and Confidentiality (B2)

The ability of unauthorized entity to read RFID system's data information has become a potential threat to the RFID system. The RFID tags can be menaced by the humans by either destroying the tag or separating it from the items deliberately. Hackers might also attack the system by invading the data privacy. Spoofing is also a method of hampering a tag by twinning the tags by various frauds. Intercepting of messages by foreign recipients so as to extract data and extracting the location of the user.

3. Environment (B3)

Radio signals are not attenuated by wooden and concrete walls, as a result the RF signals that should be blocked by the tag reader will also be read. This indeed will result in cross reading between different stores in a particular shopping center. The isolation of rooms with metal, diamond plating can cause multi reflection of radio waves which prevents reading. The environmental factors like heat, pressure, moisture, radiation can altogether affect the RFID tag performance. The liquid products can cause hindrance to the tag reader, as water absorbs energy in UHF region and prevents reading.

4. Management Commitment (B4)

Management of any industry plays an important role in the adoption of any new system within the industry, without the support from management, adoption of a new system within the industry becomes uncertain. It requires a lot of cost and practice which can be a major factor in the production system and growth of industry.

5. Cost Factor: High Cost

The biggest challenge of RFID is its high cost implementation. In comparison to barcode readers the RFID tag readers are more expensive in terms of maintenance. The cost of equipment in active, passive or semi-passive i.e. any sort of RFID is extortionate, that's why copious investment by the business companies becomes mandatory.

6. Legal and Patent Challenges (B6)

Legal and patent challenge is also a main issue which resists the implementation of RFID because there is a tough competition in the trading relationship and any fraud by a vendor can be made easily as RFID can be overwritten. In the present time still there are many RFID technologies whose intellectual properties are not clear. RFID needs to be royalty free so as to establish this technology worldwide.

7. Tag Failure Rates (B7)

The inability of a tag to read data accounts for the rate of failure of a tag. The passive RFID tags are more prone to failure due to the short-read range of these tags. The improper tag orientation, position of tag and tag polarization can decrease the antenna gain of an RFID

reader. Materials like liquids, metals also increase the inability to read tags.

8. Technology Support for RFID Adoption (B8)

The RFID tag or reader collision causes bounteous inconvenience among the customers in a store as it leads to the reading of multiple data simultaneously, as well as disruption of the system. At present RFID is still an emerging technique in India and needs a handful of skilled machines, workmen and technical staff.

9. Selection of Software and Hardware (B9)

The hardware technology requires technical staff and machines for maintenance whereas the software uses system programming to ensure its dynamic functioning. Whether to select hardware or software for short and far range RFID tags becomes a dilemma. So as to solve this problem the hardware in RFID is integrated with software programming, so that if one fails the other serves as a substitute.

3.3 Establishment of Hierarchy

The following hierarchy has been designed from the identified barriers, using (1) performance (2) administration (3) technology as a criterion which is decided after discussion with the experts.

Table - 3: Distribution of barriers among the criteria's

Barrier No.	Barrier Name	Criteria No.	Criteria Name
B1	Standardization issues	C1	Performance
B2	Security and Confidentiality	C1	Performance
B3	Environment	C1	Performance
B4	Management Commitment	C2	Administrative
B5	Cost Factor: High Cost	C2	Administrative
B6	Legal and Patent Challenges	C2	Administrative
B7	Tag Failure rates	C3	Technology
B8	Technology Support for RFID Adoption	C3	Technology
B9	Selection of Hardware and Software	C3	Technology

3.4 Pairwise Comparison of the factors

After the construction of criteria hierarchy, next step is to determine the priorities for the element at each level. To start the AHP process, a set of comparison matrices of all elements in a level of the criteria hierarchy with respect to an element of the immediately higher level is constructed so as to prioritize and convert individual comparative judgments into ratio scale measurements. The preferences are quantified by using a nine-point scale known as Satty scale. The meaning of each scale of measurement is explained in Table 4.

Table - 4: The Saaty rating scale

The fundamental scale for the pairwise comparison	
Intensity of importance	Definition
1	Equal importance
3	Moderate Importance
5	Strong Importance
7	Very strong importance
9	Extreme importance

The pairwise comparisons in the AHP model is used to generate a matrix of relative rankings for each level of the hierarchy. The number of matrices depend upon the number of elements at each level in the AHP. The order of the matrix at each level depends upon the number of elements at the lower level that it links to. After the development of all matrices and all pairwise comparisons then the Eigen vectors or the relative weights, global weights and maximum Eigen value for each matrix is calculated. The λmax value or the Eigen value is an important validating parameter in AHP methodology, which is used as a reference index to screen information by calculating the consistency ratio CR (Saaty,2000) of the estimated vector in order to validate if the pair-wise comparison matrix provides a completely consistent evaluation or not. The consistency ratio for the AHP model is calculated as per the following steps:

1. Calculate the Eigenvector or the relative weights and λmax (Eigen value) for each matrix of order n.

2. Compute the consistency index for each matrix of order n:

$$CI = (\lambda max - n)/(n-1) \qquad (1)$$

3. The consistency ratio is then calculated using:

$$CR = CI/RI \qquad (2)$$

Where RI: random consistency index

The pair wise comparison tables with respective computed CR values are shown below (Table 5 – Table 8):

Table - 5: Pairwise comparison of Criteria's

CRITERIA	C1	C2	C3	3RD ROOT	PRIORITY VECTOR
C1	1.0000	0.5000	0.2000	0.4642	0.1220
C2	2.0000	1.0000	0.3333	0.8736	0.2297
C3	5.0000	3.0000	1.0000	2.4662	0.6483
				3.8040	
SUM	8.0000	4.5000	1.5333		
SUM*PV	0.9762	1.0334	0.9941		
LAMBDA MAX	3.0037				
CI	0.0018				
CR	0.0032				

Table - 6: Pairwise comparison of barriers under Criteria (C1)

C1 CRITERIA	B1	B2	B3	3RD ROOT	PRIORITY VECTOR
B1	1.0000	0.2000	3.0000	0.8434	0.2123
B2	5.0000	1.0000	2.0000	2.1544	0.5424
B3	0.3333	0.5000	1.0000	0.5503	0.1385
				3.5482	
SUM	6.3333	1.7000	6.0000		
SUM*PV	1.3448	0.9220	0.8312		
LAMBDA MAX	3.0980				
CI	0.0490				
CR	0.0845				

Table - 7: Pairwise comparison of barriers under Criteria (C2)

C2 CRITERIA	B4	B5	B6	3RD ROOT	PRIORITY VECTOR
B4	1.0000	4.0000	5.0000	2.7144	0.6833
B5	0.2500	1.0000	2.0000	0.7937	0.1998
B6	0.2000	0.5000	1.0000	0.4642	0.1168
				3.9723	
SUM	1.4500	5.5000	8.0000		
SUM*PV	0.9908	1.0990	0.9348		
LAMBDA MAX	3.0246				
CI	0.0123				
CR	0.0212				

Table - 8: Pairwise comparison of barriers under Criteria (C3)

C3 CRITERIA	B7	B8	B9	3RD ROOT	PRIORITY VECTOR
B7	1.0000	0.5000	0.3333	0.5503	0.1385
B8	2.0000	1.0000	5.0000	2.1544	0.5424
B9	3.0000	0.2000	1.0000	0.8434	0.2123
				3.5482	
SUM	6.0000	1.7000	6.3333		
SUM*PV	0.8312	0.9220	1.3448		
LAMBDA MAX	3.0980				
CI	0.0490				
CR	0.0845				

3.5 Computing normalized weights of each criteria

If there are more than two levels, the various priority vectors can be combined into priority matrices, which yield one final priority vector for the bottom level (Satty,1996). Local priority is the priority relative to its parent. Table shows the priority of each criterion in the final selection of the challenges which are majorly affecting the Indian industries in the RFID implementation. Global priority, also called final priority, is the priority relative to the goal.

Table - 9: Normalized weights of Criteria's

	C1	C2	C3	Weight
C1	0.1250	0.1111	0.1304	0.3665
C2	0.2500	0.2222	0.2174	0.6896
C3	0.6250	0.6667	0.6522	1.9438
SUM				3.0000

Table - 10: Normalized weights of barriers under Criteria (C1)

	B1	B2	B3	Weight
B1	0.1579	0.1176	0.5000	0.7755
B2	0.7895	0.5882	0.3333	1.7110
B3	0.0526	0.2941	0.1667	0.5134
SUM				3.0000

Table - 11: Normalized weights of barriers under Criteria (C2)

	B4	B5	B6	Weight
B4	0.6897	0.7273	0.6250	2.0419
B5	0.1724	0.1818	0.2500	0.6042
B6	0.1379	0.0909	0.1250	0.3538
SUM				3.0000

Table - 12: Normalized weights of barriers under Criteria (C3)

	B7	B8	B9	Weight
B7	0.1667	0.2941	0.0526	0.5134
B8	0.3333	0.5882	0.7895	1.7110
B9	0.5000	0.1176	0.1579	0.7755
SUM				3.0000

3.6 Computing global weights

Table no. 12 shows the global weights for the barriers affecting the RFID implementation in the Indian industries. As the barriers have been distributed in different criteria's using the data collected through the Industries. In order to compare the global weight of all the barriers, they have been normalized and also have been presented in %age form. Therefore, the global effect of a particular barrier has been calculated by multiplying the normalized weight of the barrier with the normalized weight of its respective criteria. Further, table no. 12 shows the ranking of barriers which affect the RFID implementation in Indian Industries.

Table - 12: Global weights of Barriers affecting RFID implementation

Barrier	Global Weights	Normalized Weights	%
B1	0.2843	0.0316	3.1586
B2	0.6272	0.0697	6.9686
B3	0.1882	0.0209	2.0910
B4	1.4081	0.1565	15.6460
B5	0.4167	0.0463	4.6299
B6	0.2440	0.0271	2.7113
B7	0.9980	0.1109	11.0889
B8	3.3260	0.3696	36.9555
B9	1.5075	0.1675	16.7503
SUM	9.0000	1.0000	100.0000

Table - 13: Ranking of barriers affecting the RFID implementation

Barrier	Name	%	Rank
B1	Standardization issues	3.1586	7
B2	Security and Privacy	6.9686	5
B3	Environment	2.0910	9
B4	Management Commitment	15.6460	3
B5	Cost Factor: High Cost	4.6299	6
B6	Legal and Patent Challenges	2.7113	8
B7	Tag Failure rates	11.0889	4
B8	Technology Support for RFID Adoption	36.9555	1
B9	Selection of Hardware and Software	16.7503	2

4. RESULTS AND DISCUSSION

RFID implementation challenges for the Indian industries are studied from the literature survey, industrial inputs and academia. Barriers put up in the study are analyzed through the Analytical hierarchy process. There are nine major challenges brought up in the study which have been stated as the major challenges for the Indian industries in the adoption of RFID. It has been then concluded that technology support is the greatest challenge for RFID adoption in Indian industries. Selection of hardware and software is also one of the biggest hurdles in RFID implementation after which ranks the management commitment which has been a great time issue for RFID adoption. Adoption of new technology in the existing Industrial environment is a very demanding task as it faces a lot of complications and uncertain reaction. On the 4th ranks the Tag failures rate, which is also a main reason for sedating the RFID implementation because the RFID tag life depends upon its orientation, read range, physical environment etc. At 5th Security and confidentiality is also a main issue for the Indian industries because of unauthorized access of data or hampering of tags by any individual. Security and privacy technology adoption is a cumbersome task and it is not easy for any industry to secure its data and system without the adoption of latest technologies. At 6th cost factor is also a main issue for the Indian industries. Though, many of Indian industries can invest on the RFID technology adoption but still RFID implementation within the industry costs a lot for company which also affects its implementation. Standardization issues are also a main challenge for the Indian industries because RFID technology works on different frequencies worldwide and a global frequency cannot be set easily. Environment is also a challenge which affects the RFID implementation for the Indian industries. Out the all nine challenges, environmental challenges put up very less weight as compared to other challenges. It is concluded that Environmental challenges have the least impact on the RFID implementation.

5. CONCLUSION

Besides the major challenges in the adoption of RFID, this paper also gives an idea as to how implementation of RFID can help Indian industries to enhance their quality of service and their production system. It is expected that this paper will also help the readers to have a better understanding of the current major challenges which Indian industries are facing in the RFID adoption. There are lots of studies which have been carried out in past in order to improve the tag quality, signal ranges and reduction of frequency interfaces which improves the RFID technology and makes the RFID implementation easy for the industries. It is found in study that the major challenge for the Implementation of RFID is Technology support and the selection of proper hardware and software. In the Indian industries cost factor influencing the RFID adoption is not a major issue if supported by the management because without the support of management RFID implementation is not an easy task. Beside this it can help in the growth and increase the production of the industry. The limitation of this work is that this study can be analyzed more precisely with the hybrid techniques and by surveying the different sectors of Indian industries. Further this study can be extended by finding the drivers which can help the Indian industries in the implementation of RFID adoption.

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BIOGRAPHIES

Parul Sharma is pursuing B. Tech in Electronics and communication engineering from SRM University, NCR campus Ghaziabad. Her research interest includes microprocessors and Multi-criteria decision making.