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A Study on Exploring the Variables Influenced by Utilization of "Radio-Frequency Identification (RFID)" Technology in Iran

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Abstract

The purpose of this paper is to introduce one of the leading new technologies, "Radio-frequency identification (RFID)", and investigate the effects of applying this technology on target environment in Iran.

The variables, affected by application of RFID technology in various environments, were extracted through the review of literature then a research was carried out in this field, and the obtained variables were localized by consulting with the experts in this area. A questionnaire was developed through using these variables and distributed among a sample of RFID technology providers and users after testing its the reliability and validity. Finally, the statistical tests on the obtained results from the research led to the discovery of components.

The findings of this paper would be discovered components, which are affected by application of RFID technology, are as follows:Tracking quality, decision-making improvement, error control, warehouse management, cost leadership, level of assurance, inventory data, speed of provided service, data monitoring and order management.

Considering the prevalent use of RFID technology in various industries around the world, the need for this technology and its benefits becomes obvious to everyone. This paper has created a proper vision of RFID for readers through collecting a wide range of RFID technology benefits as well as discovering the major components associated with application of this technology.

Key words: RFID technology; Tracking; Inventory management; Decision making

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BRIEF INTRODUCTION OF RFID

It can be said that the most common method of identifying objects with RFID is storing a serial number that identifies a product. Other information can be saved on a microchip that is attached to an antenna. They together form the RFID tag. The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves obtained from the RFID tag into a form that can be passed on to computers that can make use of it. When an interrogator reads a RFID tag the unique identification code of the tag can be used as a reference to a local network or Internet database which contains the information related to the individual product or references (E. IlieZudor, 2005).

RFID technology with the expedient IT infrastructure is appropriate for both main distributors and manufacturers, as well as other logistics operations dealing with complex, global supply chains in which products and product shipments must be traced and identified in a non-contact, wireless method using a computer network (Paul G. Ranky, 2006).

It is remarkable that although RFID has played an important role in supply chain as a leverage for unprecedented ease and accuracy of goods tracking to drive down costs and improve product availability for over a decade. But the technology has not achieved optimal results yet. It is particularly relevant within the retail environment where RFID tag costs make it impractical to

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take the technology beyond pallet level, undermining the vision of individual product tracking from manufacture to store shelves. However, the technology has gained significant traction in other areas, most notably passports– with countries such as the USA including RFID tags in new passports as well as in transport payment systems. Indeed, the technology has also been accepted by libraries, museums and colleges to track valuable assets.The result of this diversification of RFID application is a significant reduction in unit cost over the last few years (Karen Conneely, 2009).

1. LITERATURE

The RFID technology is changing our life and production dramatically. Its usage in manufacturing systems will profit building of real time factory. In this field, George Q. Huang presented an approach to the shop-floor performance improvement by using RFID technology for the collection and synchronization of the real-time field data from manufacturing workshops. He emphasized upon how to deploy RFID technology for managing work-in progress (WIP) inventories and also for tracing the products, tools and components as well as walking worker in factories (Huibin Sun, 2009).

The above-mentioned are just a small part of RFID benefits. Indeed researches demonstrate that applying RFID technology can provide a wide variety of advantages for its applicants which are studied in the present paper. It is undeniable that there are some common profits mentioned in different articles and some that are quite frequent, for example, improving inventory management.

Yahia Zare (2009) considering supply chain system has listed 15 benefits of RFID that are as follows: Reduced shrinkage, Reduced material handling, increased data accuracy, Faster exception management, Improved information sharing, Production tracking, Quality control, Supply and production continuity, Material handling, Space utilization, Asset management, Reduced stock-outs, Customer service, After sales service and Lower inventory (Yahia Zare Mehrjerdi, 2009).

In another essay, this researcher proceeded a number of variables for RFID adoption by using multiple case studies in 5 firms from industries with supply chain management system intact which are: Wall mart, library at the City University of Hong Kong, Sushi restaurant, Healthcare Industry and Intel. The variables of highly concerned from this subject are: RFID technology, quality, efficiency, productivity, responsiveness, better management, On-Time decision making, On-Time data collection, inventory control, security level, and accuracy in decision making.

Other variables in his research are as follows: Effectiveness, data accuracy, Labor costs reduction Short-shelf-life, Better service, Human errors, Revenue, Out of stocks, Tracking/products/production, Product safety, Lead time, Spoilage reduction , Short-shelf-life Delivery time, Asset management, Reduced shrinkage, Space utilization, Material handling and Information sharing.

It is notable that Wal-Mart has had a saving of about $800,000,000 in the year 2008 with applying RFID technology in efficiently tracking products (Yahia Zare Mehrjerdi, 2011).

Manufacturers can use RFID solutions to reduce operating costs through decreasing the labor costs, claims, and returns. It leads to an increase in the operating income. They can also reduce the working capital by reducing inventory, lowering write-offs from the returned goods, and unmarketable items. (Yahia Zare Mehrjerdi, 2008)

Main benefits of RFID can be categorized as follows: Improving the accuracy and speed of tracking pallets, cartons, and containers; reducing stock levels and operating costs; improving the management of inventory; improving efficiency in the reports of the work in process and improving inventory visibility to feed just in time (JIT) systems.

RFID technology has a supporting role in automating processes and improving operations management in many commercial applications, like supply chain management, logistics, and transportation. In fact it can empower the decision-making team by providing On Time information. This advanced technology is more useful to the management for one or more of the following facts: better supply chain and inventory management, reducing counterfeiting and fraud controlling, tracking work-in progress, reducing administrative errors, reducing rework, better management of warrantee claims, capable of working in suitable and harsh environments, better supply chain efficiency and cost saving and profit enhancement (Yahia Zare Mehrjerdi, 2011).

In another research, the author has identified a list of benefits that RFID has brought with itself to various industries. Some benefits of RFID are: Automation, Integrity, Velocity, Insight and Capability. The following is a brief description of these benefits:

• Automation – Reducing manual processes through automated scanning and data entry improves productivity, allowing resources to be reallocated to higher value activities.

• Integrity – Improving the integrity of real-time supply chain information with increased security and tracking capabilities reducing errors, shrinkage, and counterfeiting while improving customer satisfaction information is valuable if it is correct.

• Velocity – Reducing work-flow issues by minimizing thetime spent tracking needed assets, in turn increasing product flow and handling speeds.

• Insight – Providing the real-time information needed to make faster, better, and more informed decisions and the ability to be more responsive to the customer.

• Capability – Providing new applications and quality to meet supply chain partner demands and enhance customer experiences.

As Paul G. Ranky (2006) expressed some reasons

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why RFID technology is being pilot tested in hundreds of US manufacturing, assembly and distribution companies and global distribution networks; some of them the are presented as below:

• Close to real-time inventory control becomes reality, meaning less waste, tighter supply-chain integration and higher level of leanness throughout the supply-chain.

• Part numbers can be cross referenced to minimize inventory.

• Work in progress inventory can be significantly reduced, since parts and their locations can be automatically traced using a wireless computer operated network.

• Identifying parts for statistical process control data-collection, and then testing correct correlation within the batch, or product family.

• Automated part tracking throughout the cell, the factory and the global supply chain becomes reality .

• The opportunity to implement a completely new inventory management strategy, based on real-time transactions and accurate stock control.

• An RFID project can fundamentally change customer relationship management, because transactions become real-time accurate.

In a study conducted by Daniel Hellstrom on the RFID, the effect of inventory accuracy during assembly has been studied and finally, an analytical model for identifying the impact on the RFID technologies of inventory accuracy is proposed. The literature states that the average error for RFID systems, is much less when the system has not been implemented (Daniel Hellstrom *et al.*, 2010.)

In order to bring about automation of existing plant site safety processes, it is suggested that technologies such as mobile computing and RFID tags may be employed for automatic data collection. Given recent advances in plant security such as the CESAR initiative (which employs RFID as a machine identifying mechanism), the technical infrastructure to satisfy this aspiration may be partly in place already. ZainabRiaz *et al.* (2011) presented an architecture for the development of a prototype system (Sight Safety) that could integrate these technologies with management tools like MIS, to provide a comprehensive and proactive H&S management solution on construction projects.

Karen Conneely (2009) in his article intended to show the benefits of using RFID technology to improve asset management in organizations. The majority of companies have very little grasp of how inaccurate the asset register can be, believing stored data could only be a maximum of 5 percent inaccurate. RFID tags allow those responsible for managing fixed assets far greater visibility into the true condition and value of those assets. For example, workers of heavy machinery, such as mechanics and drivers, can gain instant insight to all the machinery parts' maintenance history as well as information on unique identifiers including part numbers, serial numbers and manufacturers' codes. By adopting RFID, scanning can be undertaken by line managers on a regular basis in a matter of minutes, without impacting the organization's core operations in any way. The tight integration with the full asset history and general ledger ensures unprecedented accuracy and audit ability of the entire asset register.

By placing RFID tags on the assets and readers at key entry and in exit points and various other locations, movable assets will be automatically tracked and located in real time. RFID tags are rugged, compact and inconspicuous. Even while dormant, they integrate seamlessly into business processes making it easy for utilizing the technology in yard management, tracking reusable transport items, and other high-value asset tracking applications.

ÖzdenEngin *et al.* (2011) have surveyed using RFID for pharmaceutical inventory management through system optimization and shrinkage control. In the literature, the benefits of RFID in over barcode technology has been implied as follows: No need to Line of Sight because of applying wireless technology, high data storage capacity, accurate real-time visibility, optimizing the inventory policy, shrinkage prevention, reduced cost resulting from elimination of inaccuracy, decreased human error, real time tracking, automatic inventory counting and reordering, high durability, security, e-pedigree and product recalls, automatic counting and reordering, inventory records and then real-time visibility.

Moreover, RFID technology can eliminate labor-intensive inventory processes and therefore solve barcode technology operational problems. In addition, the inventory manager can benefit from RFID by automatic counting and continuous review and by tracking shrinkage actively. It has been analytically shown that without shrinkage, the switch to a continuous review achieves savings in all the three inventory cost categories: inventory holding, backorder, and ordering costs. So the long-run average cost of inventory is constantly lower than under periodic review (ÖzdenEnginÇakıcı *et al.*, 2011).

A study of RFID in hospitality by BasarOztaysi et al. has mentioned the advantages of RFID such as Service innovation, Service quality, time saving, cashless payment, keyless room entrance, online tracking,service customization and customer loyalty by designing preference-capturing systems and integrating them with the customer relationship management systems (Bas-ar O¨ ztaysi *et al.*, 2009).

Sanghyun Kim et al. have perused RFID users' behaviors considering supply chain technology then detected these benefits of RFID in this regard: Cost Savings, reducing error rates in managing organization's data, providing information for decision-making in a timely manner, accurate information in decision making, an efficient way for a better managing product information and improving company image. (Sanghyun Kim *et al.*, 2011)

James JungbaeRoh *et al.* (2009) have classified the benefits of RFID adoption in 3 categories as follows: Cost savings, Supply chain visibility ; and new process/product creation.

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The first category "Cost Saving" includes: Counterfeiting reduction, Shrink reduction, Labor cost reduction and Inventory cost reduction. "Supply chain visibility" is the second class and it consists of "Bullwhip effects" reduction, Uncertainty of product availability reduction, Reductions in out-of-stock, delivery and safety stock, inventory obsolescence material handling costs reduction, Rich information change among suppliers, Inventory monitoring and Efficiency measurement.

"New process/product creation", the third category has contained: New process creation, Quality control, Communication of the componentparts to a reader. (James JungbaeRoh *et al*., 2009)

2. METHODOLOGY

This research is carried out on the basis of a survey-descriptive method and through the questionnaire tools.

At the first stage of the study, the key variables and concepts were extracted by the view of books about the process of identification based on the radio waves and tracking systems. The list of the extracted variables from the literature review is given in Table 1.

Table 1
List of the Extracted Variables from the Papers

No.	Variable	References
1	Reduced Shrinkage	(Yahia Zare Mehrjerdi, 2009) (Yahia Zare Mehrjerdi, 2011, RFID adoption) (ÖzdenEnginÇakıcı *et al*., 2011) (James JungbaeRoh *et al.*, 2009)
2	Reduced Material Handling	(Yahia Zare Mehrjerdi, 2009)
3	Increased Data Accuracy	(Yahia Zare Mehrjerdi, 2009) (Yahia Zare Mehrjerdi, 2011, RFID adoption)
4	Faster Exception Management	(Yahia Zare Mehrjerdi, 2009)
5	Information Sharing,	(Yahia Zare Mehrjerdi, 2009) (Yahia Zare Mehrjerdi, 2011, RFID adoption)
6	Production Tracking	(Yahia Zare Mehrjerdi, 2009) (Yahia Zare Mehrjerdi, 2011, RFID adoption) (Paul G. Ranky, 2006)
7	Quality Control	(YahiaZareMehrjerdi, 2009) (James JungbaeRoh *et al.*, 2009)
8	Supply and Production Continuity	(Yahia Zare Mehrjerdi, 2009)
9	Material Handling	(Yahia Zare Mehrjerdi, 2009) (Yahia Zare Mehrjerdi, 2011, RFID adoption)
10	Space Utilization	(YahiaZareMehrjerdi, 2009) (YahiaZareMehrjerdi, 2011, RFID adoption)
11	management of parts guarantee	(Karen Conneely, 2009)
12	Reduced Stock-Outs	(Yahia Zare Mehrjerdi, 2009) (Yahia Zare Mehrjerdi, 2008)
13	Customer Service	(YahiaZareMehrjerdi, 2009)
14	After Sales Service	(Yahia Zare Mehrjerdi, 2009)
15	Lower Inventory	(Yahia Zare Mehrjerdi, 2009)
16	Efficiency	(Yahia Zare Mehrjerdi, 2011, RFID adoption)
17	Quality	(Yahia Zare Mehrjerdi, 2011, RFID adoption)
18	Productivity	(Yahia Zare Mehrjerdi, 2011, RFID adoption)
19	Responsiveness	(Yahia Zare Mehrjerdi, 2011, RFID adoption)
20	Better Management	(Yahia Zare Mehrjerdi, 2011, RFID adoption)
21	On-Time Decision Making	(Yahia Zare Mehrjerdi, 2011, RFID adoption) (Sanghyun Kim *et al.*, 2011)
22	On-Time Data Collection	(Yahia Zare Mehrjerdi, 2011, RFID adoption) (Huibin Sun, 2009)
23	Spoilage Reduction	(Yahia Zare Mehrjerdi, 2011, RFID adoption)
24	Controlling Inventory Cost	(Yahia Zare Mehrjerdi, 2011, RFID adoption) (James JungbaeRoh *et al.*, 2009)
25	Accuracy In Decision Making.	(Yahia Zare Mehrjerdi, 2011, RFID adoption)

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Continued

No.	Variable	References
26	Labor Cost Reduction	(Yahia Zare Mehrjerdi, 2011, RFID adoption) (Yahia Zare Mehrjerdi, 2008) (James JungbaeRoh *et al.*, 2009)
27	Human Errors	(Yahia Zare Mehrjerdi, 2011, RFID adoption) (ÖzdenEnginÇakıcı *et al.,* 2011)
28	Better Service	(Yahia Zare Mehrjerdi, 2011, RFID adoption)
29	tracking work-in progress	(Yahia Zare Mehrjerdi, 2011)
30	Security Level	(Yahia Zare Mehrjerdi, 2011, RFID adoption) (ÖzdenEnginÇakıcı *et al.*, 2011) (James JungbaeRoh *et al.*, 2009)
31	Lead Time	(Yahia Zare Mehrjerdi, 2011, RFID adoption)
32	Asset Management	(Yahia Zare Mehrjerdi, 2011, RFID adoption) (Yahia Zare Mehrjerdi, 2009) (Karen Conneely, 2009)
33	Reducing Stock Levels	(Yahia Zare Mehrjerdi, 2011)
34	Increase the Operating Income	(Yahia Zare Mehrjerdi, 2008)
35	Improving the Speed of Tracking Pallets, Cartons, and Containers;	(Yahia Zare Mehrjerdi, 2008)
36	Reducing Operating Costs	(Yahia Zare Mehrjerdi, 2008)
37	Improving the Management of Inventory	(Yahia Zare Mehrjerdi, 2008) (Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
38	Improving Efficiency in Work in Process(WIP) Reporting	(YahiaZareMehrjerdi, 2008) (YahiaZareMehrjerdi, 2011, RFID and its benefits)
39	Improving Inventory Visibility to Feed Just in Time (JIT) Systems	(Yahia Zare Mehrjerdi, 2008)
40	Better Supply Chain	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
41	Reducing Counterfeiting and Fraud Controlling	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits) (James JungbaeRoh *et al.*, 2009)
42	Reducing Administrative Errors	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
43	Reducing Rework	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
44	Better Management Of After Sales Service And Warranty	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
45	Profit Enhancement	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
46	Cost Saving	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits) (Sanghyun Kim *et al.*, 2011) (James JungbaeRoh *et al.*, 2009)
47	Automation	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
48	Integrity	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
49	Tracking Velocity	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
50	Insight	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
51	Capability	(Yahia Zare Mehrjerdi, 2011, RFID and its benefits)
52	Real-Time Inventory Control	(Paul G. Ranky, 2006)
53	Minimize Inventory	(Paul G. Ranky, 2006)
54	Stock Control	(Paul G. Ranky, 2006)
55	Reduction of Work In Progress Inventory	(Paul G. Ranky, 2006)
56	Testing Correct Correlation Within TheBatch, or Product Family	(Paul G. Ranky, 2006)
57	Modernization	(Paul G. Ranky, 2006) (ÖzdenEnginÇakıcı *et al.*,2011)
58	Real-Time Transactions	(Paul G. Ranky, 2006)
59	Inventory Accuracy	(Daniel Hellstrom *et al.*, 2010)
60	Automatic Inventory Counting and Reordering	(ÖzdenEnginÇakıcı *et al.*, 2011)
61	E-Pedigree and Product Recalls	(ÖzdenEnginÇakıcı *et al.*, 2011)
62	High Durability	(ÖzdenEnginÇakıcı *et al.*, 2011)
63	Real Time Tracking	(ÖzdenEnginÇakıcı *et al.*, 2011)

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Continued

No.	Variable	References
64	Unique ID	(ÖzdenEnginÇakıcı *et al.*, 2011)
65	Service Innovation	(Bas-ar O¨ ztaysi *et al.*, 2009)
66	Service Quality	(Bas-ar O¨ ztaysi *et al.*, 2009)
67	Time Saving	(Bas-ar O¨ ztaysi *et al.*, 2009)
68	Online Tracking	(Bas-ar O¨ ztaysi *et al.*, 2009)
69	Service Customization	(Bas-ar O¨ ztaysi *et al.*, 2009)
70	Customer Loyalty	(Bas-ar O¨ ztaysi *et al.*, 2009)
71	Reduces Error Rates in Managing Organization's Data	(Sanghyun Kim *et al.*, 2011)
72	Accurate Information in Decision Making	(Sanghyun Kim *et al.,*2011)
73	Managing Product Information	(Sanghyun Kim *et al*, 2011)
74	Improves Company Image	(Sanghyun Kim *et al.*, 2011)
75	Supply Chain Monitoring	(James JungbaeRoh *et al*., 2009)
76	''Bullwhip Effects'' Reduction	(James JungbaeRoh *et al*., 2009)
77	Product Accessibility	(James JungbaeRoh *et al.*, 2009)
78	Uncertainty of Product Availability Reduction	(James JungbaeRoh *et al.*, 2009)
79	Shrinkage Out of Stoke	(James JungbaeRoh *et al.*, 2009)
80	Rich Information Change Among Suppliers	(James JungbaeRoh *et al.*, 2009)
81	Inventory Monitoring	(James JungbaeRoh *et al.*, 2009)
82	Efficiency Measurement	(James JungbaeRoh *et al.*, 2009)
83	New Process Creation	(James JungbaeRoh *et al.*, 2009)
84	Improving the Accuracy of Tracking Pallets, Cartons, And Containers	(Yahia Zare Mehrjerdi, 2008)
85	Short-shelf-life Delivery time	(Yahia Zare Mehrjerdi, 2011)
86	Better Management of Product Information	(Sanghyun Kim *et al.*, 2011)
87	Comprehensive data	(Paul G. Ranky, 2006)

Extracted key concepts were studied through the literature review, interviews and consultations with the experts, and the repeated and similar cases of composition were removed. As a result, a list of initial variables consisting of 87 key concepts, which could be raised in the questioners, was designed. Listed variables were reviewed and modified at several stages by the researchers and a list of final variables for the key concepts was prepared in order to be provided for the experts.

Afterwards, the list of key concepts variables was provided face to face or via E-mail for 10 experts (10 professionals and top managers in the field of RIFD technology) in order to assess the validity of the questionnaire content. In an attached letter, they were asked to express their opinions about whether the questions of the questionnaire examine and measure what should be questioned and examined or not. Based on the corrective feedback and suggestions by the mentioned group, 40 questions of the initial questions of the questionnaire were determined during several reliable stages and appropriate changes were made in the initial questions. Consequently, a set of 40 key concepts was put on the agenda.

At the next stage, a 40-question questionnaire was designed and developed by using these 40 variables. The research theoretical foundations and library studies were applied in order to develop the questions of the questionnaire. This questionnaire was designed with the items of completely disagree to completely agree and based on five-point Likert scale and then distributed among the research units after determining its validity and reliability.

Statistical population of this study includes the users in the centers, where this technology is used, as well as the personnel of companies which apply this system in Iran.

At this stage, 120 questionnaires of the total 200 designed ones were answered. Therefore, the response rate to the questionnaire was 60%.

Previous researches (Hemminger, 2007) indicate that the response rate in the online questionnaires was equal to 3 to 62%, and some of the researchers, like Gunter (2003), argue that the response rate in the traditional printed questionnaires is usually lower than the online questionnaires. Given these points, it seems that the response rate of 60% in this study is an acceptable rate.

After distributing and collecting the questionnaires and investigating the responses, the questionnaire data was analyzed through the SPSS Software, version 19.

At the next stage of this research, the internal consistency of the questionnaire was investigated through Cronbach's alpha method. Alpha value equal to 0.918

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showed that only about 10% of the variance of total scores in the questionnaire is obtained from the questionnaire error, thus the scale has a high reliability.

One of the main hypotheses of line regression classical model refers to when the error terms have equal variances. Among various methods of determining the inequality of variances, Bartlett's sphericity index was used in this research in order to investigate the significance of data in the correlation matrix and the amount of Chi-square equal to 2189.182 at the significance level (P<0.001) shows the existence of detectable relationships among the variables in the factor analysis. The results of this test are presented in the following Table 2.

Exploratory factor analysis through principal components analysis with orthogonal varimax rotation was used in order to determine the variables which explained the lower factor loadings and had low correlation. The validity of the questionnaire structure was assessed by factor analysis and Table 3 represents the factor matrix and Table 4 and Table5 represent the variance matrix and rotation matrix, respectively. First and before implementing the factor analysis, the proportion of data was investigated for doing the factor analysis. Then again, the exploratory factor analysis of principal components analysis was done with the varimax rotation. After implementing the factor analysis, a 12-factor structure was considered as shown in Table 5.

Table 2
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.739
Bartlett's Test of Sphericity	Approx. Chi-Square	2189.182
	df	780
	Sig.	.000

Table 3
Component Matrix

	Component											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
26	.620			-.365								
24	.599											
3	.586		.342									
13	.579	-.340										
34	.578											
38	.572											
23	.570					.350						
14	.567				-.346							
17	.558											
36	.555		.351									
2	.551					-.366						
11	.542										-.345	
9	.536	.446										
33	.529				.513							
29	.528					.389						
37	.521			-.445				-.465				
6	.520					-.356						
21	.516				.351							
39	.514		.389									
32	.513											
18	.511	.378										
22	.488											
15	.481		-.424									
31	.478						-.354					
40	.474	-.357		-.421								
5	.466						.365					.330
25	.464						.338	-.427	.448			

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	Component											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	.449				.356							
4	.446	-.415				-.340						
12	.423	-.348										
8	.413	.577										
10	.444	.550										
19	.358	.531							.336	-.339		
7	.397	.498										
20	.369	.336	-.491				-.370					
35	.400		.463	.410								
30	.337			.530						.342		
27	.342		.402	.424								
28	.358					.435						
16	.457							.472				

Extraction Method: Principal Component Analysis.

Table 4
Total Variance Matrix

Component	**Initial eigenvalues**			**Extraction sums of squared loadings**			**Rotation sums of squared loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	9.841	24.603	24.603	9.841	24.603	24.603	3.078	7.696	7.696
2	2.904	7.261	31.864	2.904	7.261	31.864	2.868	7.171	14.867
3	2.069	5.173	37.037	2.069	5.173	37.037	2.816	7.039	21.906
4	1.991	4.977	42.014	1.991	4.977	42.014	2.625	6.563	28.469
5	1.664	4.161	46.174	1.664	4.161	46.174	2.600	6.499	34.968
6	1.587	3.967	50.141	1.587	3.967	50.141	2.317	5.793	40.761
7	1.464	3.660	53.801	1.464	3.660	53.801	2.284	5.709	46.470
8	1.319	3.296	57.097	1.319	3.296	57.097	2.030	5.075	51.546
9	1.196	2.991	60.088	1.196	2.991	60.088	1.899	4.749	56.294
10	1.116	2.789	62.877	1.116	2.789	62.877	1.711	4.279	60.573
11	1.085	2.713	65.590	1.085	2.713	65.590	1.598	3.996	64.569
12	1.072	2.680	68.270	1.072	2.680	68.270	1.481	3.701	68.270
13	.944	2.361	70.631						
14	.898	2.245	72.876						
15	.865	2.163	75.039						
16	.800	1.999	77.038						
17	.795	1.986	79.024						
18	.735	1.836	80.861						
19	.703	1.757	82.618						
20	.676	1.690	84.308						
21	.584	1.460	85.767						
22	.556	1.390	87.158						
23	.550	1.375	88.532						
24	.520	1.299	89.832						
25	.424	1.061	90.893						
26	.413	1.032	91.925						
27	.403	1.008	92.933						

To be continued

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Continued

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
28	.346	.865	93.798						
29	.336	.841	94.638						
30	.310	.776	95.414						
31	.274	.686	96.100						
32	.269	.673	96.773						
33	.233	.581	97.354						
34	.218	.546	97.900						
35	.189	.473	98.374						
36	.165	.412	98.785						
37	.151	.378	99.164						
38	.130	.324	99.487						
39	.114	.286	99.773						
40	.091	.227	100.000						

Extraction Method: Principal Component Analysis.

Table 5
Rotated Component Matrix

	Component											
	1	2	3	4	5	6	7	8	9	10	11	12
8	.785											
7	.740											
10	.617											
9	.571		.429									
2	.495	.466			.447							
5	.388		.339					.340				
32		.757										
33		.660										
40		.555										
26		.477	.418					.373				
37		.458	.437									
38			.797									
39			.648									
22				.669								
21		.331		.644								
23				.626								
28				.464								
29		.427		.452						.449		
13					.716							
4					.685							
6	.354				.671							
35						.742						
31						.698						
36						.617						
20							.771					
15							.649					
19							.560					-.330

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Continued

	Component											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
18							.515					
25								.699				
12								.558				
3			.431					.456				
11									.701			
14							.345		.545			
34									.408			
16										.708		
17			.411						.395	.455		
1					.369						.669	
27						.331					.623	
30												.732
24					.351							.354

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Table 6
Component Score Covariance Matrix

Component	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	1.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	1.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
4	.000	.000	.000	1.000	.000	.000	.000	.000	.000	.000	.000	.000
5	.000	.000	.000	.000	1.000	.000	.000	.000	.000	.000	.000	.000
6	.000	.000	.000	.000	.000	1.000	.000	.000	.000	.000	.000	.000
7	.000	.000	.000	.000	.000	.000	1.000	.000	.000	.000	.000	.000
8	.000	.000	.000	.000	.000	.000	.000	1.000	.000	.000	.000	.000
9	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.000	.000	.000
10	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.000	.000
11	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.000
12	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Results of factor analysis showed that the questionnaire has appropriate structure validity.

Finally, the factors of the questionnaire were named as follows through consultation with experts participating in the study: Tracking quality, Decision making improvement, Improving Error Control, Inventory management, Cost leadership, Guarantee level, Inventory data, Speed of service, Data monitoring and Ordering Management.

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Table 7
List of Discovered Factors and the Relevant Variables

Factor	Variables
Tracking Quality	• Improving the Accuracy Tracking Pallets, Cartons, and Containers • Tracking velocity • Improving the Speed of Tracking Pallets, Cartons, and Containers • Production tracking
Decision Making Improvement	• Accuracy in Decision Making • On-Time Decision Making • Reducing Rework • Automation
Improving Error Control	• Reducing Counterfeiting and Fraud Controlling • Reducing Administrative Errors • Asset management
Inventory Management	• Reduce Stocks level • Improving the Management of Inventory • Faster Exception Management • lower inventory
Cost Leadership	• Controlling Inventory Cost • Profit Enhancement • Reducing Operating Costs • Cost Saving • Labor Cost Reduction
Guarantee Level	• Security Level • Management of Parts Guarantee • Better Management of Product Information
Inventory Data	• Real-Time Inventory Control • Increased Data Accuracy • On-Time Data Collection
Speed of Service	• Improves Company Image • Time Saving • Lead Time • Better Management of After Sales Service and Warranty
Data Monitoring	• Information Sharing • Improving Efficiency in Work in Process(WIP) Reporting • Comprehensive data
Ordering Management	• Spoilage reduction • Improving Inventory Visibility to Feed just in Time (JIT) Systems • Inventory monitoring

The Factor Analysis and Cronbach's Alpha for each factor are as the following:

2.1 Tracking Quality

Table 8
Statistic Information of the Variables of 1st Factor

Option	Factor weight	Eigenvalues	% of variance	Cumulative%
Improving the Accuracy Tracking Pallets, Cartons, and Containers	0.785	1.319	3.296	57.07
Tracking velocity	0.740			
Improving the Accuracy Tracking Pallets, Cartons, and Containers	0.617			
Production tracking	0.571			

Table 9
Reliability Statistics of 1st Factor

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.772	.772	4

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2.2 Decision Making Improvement

Table 10
Statistic Information of the Variables of 2nd Factor

Option	Factor weight	Eigenvalues	% of variance	Cumulative%
Accuracy in Decision Making	0.757	0.269	0.673	96.773
On-Time Decision Making	0.660			
Reducing Rework	0.555			
Automation	0.424			

Table 11
Reliability Statistics of 2nd Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.692	.700	4

2.3 Improving Error Control

Table 12
Statistic Information of the Variables of 3rd Factor

Option	Factor weight	Eigenvalues	% of variance	Cumulative%
Reducing Counterfeiting and Fraud Controlling	0.797	0.130	0.324	99.487
Reducing Administrative Errors	0.648			
Asset management	0.418			

Table 13
Reliability Statistics of 3rd Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.663	.675	3

2.4 Inventory Management

Table 14
Statistic Information of the Variables of 4th Factor

Option	Factor weight	Eigenvalues	% of variance	Cumulative%
Reduce Stocks level	0.669	0.556	1.390	87.358
Improving the Management of Inventory	0.644			
Faster Exception Management	0.626			
lower inventory	0.464			

Table 15
Reliability Statistics of 4th Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.660	.667	4

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2.5 Cost Leadership

Table 16
Statistic Information of the Variables of 5th Factor

Option	Factor weight	Eigenvalues	%of variance	Cumulative%
Controlling Inventory Cost	0.447			
Profit Enhancement	0.716	0.944	2.361	70.631
Reducing Operating Costs	0.685			
Cost Saving	0.671			
Labor Cost Reduction	0.369			

Table 17
Reliability Statistics of 5th Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.751	.752	5

2.6 Guarantee Level

Table 18
Statistic Information of the Variables of 6th Factor

Option	Factor weight	Eigenvalues	%of variance	Cumulative%
Security Level	0.742	0.189	0.473	98.374
better management of product information	0.698			
management of parts guarantee	0.617			

Table 19
Reliability Statistics of 6th Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.718	.719	3

2.7 Inventory Data

Table 20
Statistic Information of the Variables of 7th Factor

Option	Factor weight	Eigenvalues	% of variance	Cumulative%
Real-Time Inventory Control	0.771	0.676	1.690	84.308
Increased Data Accuracy	0.649			
On-Time Data collection	0.515			

Table 21
Reliability Statistics of 7th Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.665	.669	3

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2.8 Speed of Service

Table 22
Statistic Information of the Variables of 8th Factor

Option	Factor weight	Eigenvalues	%of variance	Cumulative%
Improves Company Image	0.340			
Time Saving	0.699	0.424	1.061	90.893
Lead Time	0.558			
Better Management Of After Sales Service And Warranty	0.456			

Table 23
Reliability Statistics of 8th Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.602	.601	4

2.9 Data Monitoring

Table 24
Statistic Information of the Variables of 9th Factor

Option	Factor weight	Eigenvalues	%of variance	Cumulative%
Information Sharing,	0.701	1.085	2.713	65.590
Improving Efficiency In Work In Process(WIP) Reporting	0.545			
Comprehensive data	0.408			

Table 25
Reliability Statistics of 9th Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.650	.652	3

2.10 Ordering Management

Table 26
Statistic Information of the Variables of 10th Factor

Option	Factor weight	Eigenvalues	%of variance	Cumulative%
Spoilage reduction	0.732	0.310	0.776	95.414
Improving Inventory Visibility To Feed Just In Time (JIT) Systems	0.345			
Inventory monitoring	-0.330			

Table 27
Reliability Statistics of 10th Factor

Cronbach's Alpha	Cronbach's Alpha based on standardized items	N of items
.325	.315	3

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CONCLUSION

RFID technology is a new generation of information technologies which are applied in the field of tracking and controlling the objects and even creatures through using the radio waves and making the wireless communications. Despite the resistance and confrontation in the adoption of this technology, the domain of proven benefits for the RFID technology is widespread and in a short time leads to its development in various industries ranging from the security and military industries to the factories, institutions, shops and retail stores, restaurants, libraries and hotels.

According to Table 1, the main advantages of RFID technology in previous research is to save the costs especially reducing the labor costs, and easy and accurate tracking of products. Furthermore, the issues such as improved inventory management, asset management, space utilization, increased data accuracy, timely decision-making, modernization and updating, reduced forging and fraud control, reduced human error, increased safety, improved efficiency in reports on performance-related components, use of materials, quality control, decreased volume loss (shrinkage) are discussed more than other advantages in the researchers' literature.

In this paper, a comprehensive questionnaire was developed and distributed after reviewing the literature and extracting the variables as well as their localization by experts of this technology. Investigating the results of questionnaires and doing the statistical tests led to the discovery of ten components.

Investigation of components, discovered from the benefits of using RFID technology in this paper shows that the tracking quality component, which is extracted from the variables of "Improving The Accuracy Tracking Pallets, Cartons, And Containers, Improving The Speed Of Tracking Pallets, Cartons, And Containers, Tracking velocity and Production tracking"is amongst the major advantages of applying this technology in Iran. Accurate, quick and easy tracking of objects and individuals with the lowest error rate is one of the main reasons of using this technology in the industries and organizations of Iran.

The second component, which is called the Decision-making improvement, includes the variables of Accuracy In Decision Making, On-Time decision-making, reduced rework and automation and refers to the use of RFID that leads to the automated affairs and facilitates the "On-Time decision-making" while reducing the rework and errors by providing the On-Time and without-delay required information.This component also increases the accuracy of decision-making.

The component "error control improvement" refers to this fact that using the RFID tags will lead to Reducing Counterfeiting and Fraud Controlling as well as the Reducing Administrative Errors and improving Inventory Management.

"Inventory Management" refers to a discovered component which is associated with the variables of Reduce Stocks level, improved inventory management, Faster Exception Management, lower inventory. This component refers more to the application of RFID in the field of warehousing. By setting the RFID tags on the goods and properties in the warehouses, the quick and easy access to the inventory then Inventory management will be improved.

In this study, the "Cost Leadership" is another obtained component which includes the variables such as "Controlling Inventory Cost, Profit Enhancement, Reducing Operating Costs, Cost Saving and Labor Cost Reduction". Reducing the operating and inventory costs by using RFID and totally by saving the costs will generally increase the profitability of companies which utilize this technology.

The component "guarantee level" includes variables such as increased level of security, better management of product information, and management of parts guarantee and indicates that RFID plays the role in increasing the accuracy of decision making by providing the accurate data, and thus provides more reliable decisions for the set. Setting the RFID tags on sold components and products simplifies the identification and provision of the services for the customers of these products. Impacts of applying this technology on the increased security level seems also clear due to monitoring and tracking the objects and properties.

The next component is "Inventory data" and contains the concepts of "Real-Time Inventory Control, Increased Data Accuracy, On-Time Data Collection". As mentioned, one of the greatest applications of RFID Technology is in the field of warehousing and inventory control. By applying the RFID, we will become fully informed about the inventory information at any time and thus will control it.

Variables such as "Improved Company Image, Time Saving, Lead Time Improvement, Better Management Of After Sales Service And Warranty " are the constituent variables of component "speed of service" and focus more on the benefits of RFID in the field of customer relationship.

The component "Data Monitoring" is related to the data and information provided by applying the RFID and consequently the increased efficiency and contains the variables of Information Sharing, Improving Efficiency In Work In Process(WIP) Reporting and Comprehensive data.

The 10th component entitled as "Order Management" includes the variables of Spoilage reduction, Improving Inventory Visibility to Feed Just In Time (JIT) Systems and Inventory monitoring, and it is still associated with applying the RFID in the field of warehousing.

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