Macrothink Institute™

International Journal of Learning & Development
ISSN 2164-4063
2012, Vol. 2, No. 5

A survey of the Role and the Applications of Radio Frequency Identification (RFID) Technology in the Efficiency of Supply Chain Management (SCM) with an emphasis on Food Industries

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Accepted: July 24, 2012 Published: September 12, 2012

Doi:10.5296/ijld.v2i5.2299 URL: http://dx.doi.org/10.5296/ijld.v2i5.2299

Abstract

During the last decade, most organizations have implemented enterprise-wide applications and integration platforms. These implementations have delivered benefits in terms of data synchronization and information flows within the organization, and with trading partners providing valuable inputs for planning and optimization of schedules and reporting. The best and the most important technology of these technologies is RFID or Radio Frequency Identification systems. RFID is one of the most promising and the most advanced technologies released in recent years. Perishable and short life products, especially foodstuffs, are those cases causing the largest problems and challenges for supply chain management. These challenges are mainly due to the variety in the number of products, special needs for tracing and tracking the product flow during the supply chain, the short life of the products, the requirement for controlling the temperature in the supply chain and the high volume of the products we deal with. Using the RFID system is one of the best potential solutions helping the supply chain management solve logistic problems of spoilable products. In food industries, the period of the product storage is short due to the high probability that the product spoils and the short time of the storage of the final product. Today, the changes in the ways of producing, distributing, maintaining and selling foodstuffs have caused changes in consumers' demands to increase the quality and the durability of foodstuff packages. Innovations are created in this industry to make sure of the desirable performance of packing in the supply chain of the foodstuffs, such as active or intelligent packing methods.

Keywords: SCM, RFID, automatic identification of the product, information, information technology, information systems, bullwhip effect, efficiency

1. Introduction

An essential ingredient for an effective and efficiently managed supply chain includes accurate, real-time information about products within the chain. The integration of RFID systems within a company's supply chain offers an abundance of economic and productive capabilities. An RFID is a "white" tag with an imbedded microchip containing product information which can be accessed by a receiver using radio frequencies. The "white" tag is affixed to the product at the pallet level while still at the warehouse prior to shipment (Kamaladevi, 2010). Companies such as GAP, CVS, Gillette, Proctor & Gamble and Wal-Mart have recognized the importance of leveraging RFID technology to improve and increase operating efficiencies in the supply chain, which is benefiting from recent advances in electronic cataloguing. With RFID systems, companies would have increased product visibility, reduce out-of-stock items, trim warehouse costs, eliminate stock errors, reduce theft and shrinkage and allow companies to regularly update their logistics and inventory databases. Several pilot studies are underway globally to study RFID system application and its integration within existing ERP systems. Most companies are taking a cautious approach and initially focusing their study of RFIDs at the pallet level before progressing towards each product unit stored in a box (Kamaladevi, 2010).

Due to the invasive nature of RFID tags many privacy issues and concerns exist. An issue that moves to the forefront with the use of RFID tags deal with tracing and tracking of RFID tags. The tracing and tracking of data from tagged objects in the supply chain by competitors poses the threat of corporate espionage. Tracing and tracking of data after the sale poses consumer privacy issues as tags can be well hidden in packaging. Additionally, RFID tags respond to interrogation request from all readers allowing data to be gathered by others external to the organization.

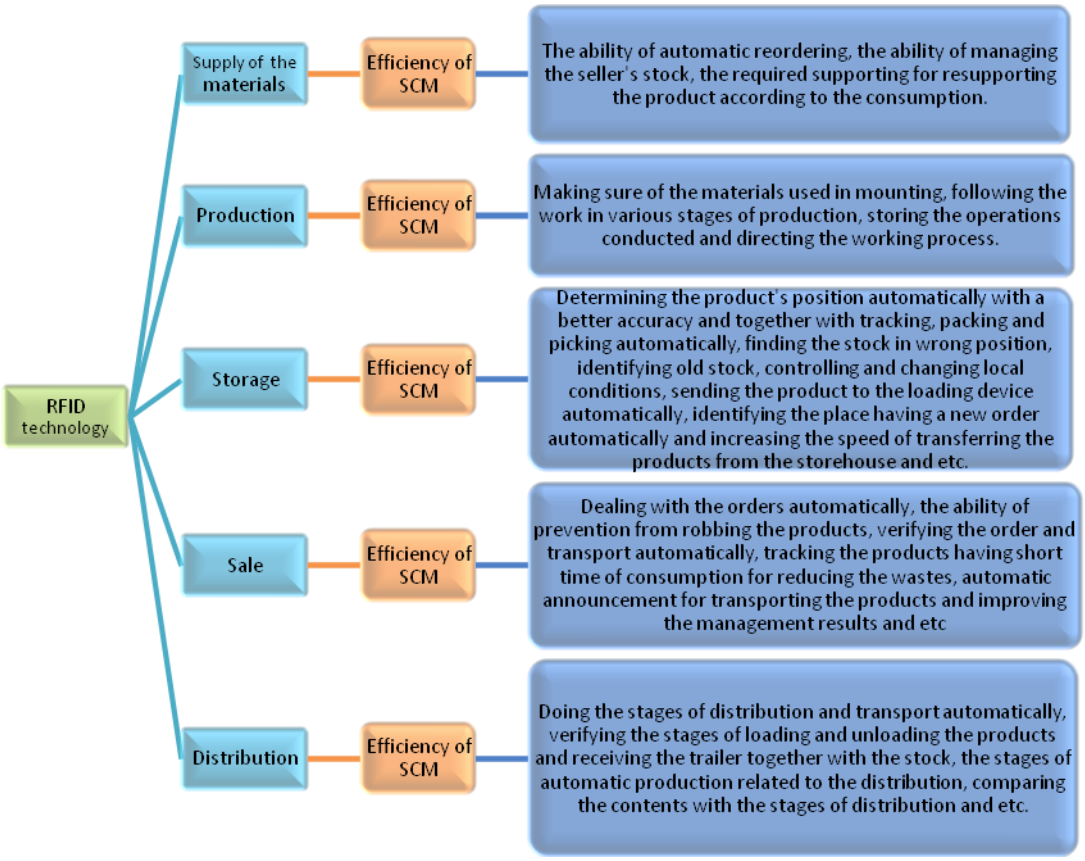
The RFID technology was introduced in 2004 and 2005 as one of the best ten technologies of the world (Janz et al, 2004). The aim of the RFID technology is to provide an environment in which objects are discovered, identified and can be tracked and traced from the factory to the selling place or the storehouse (Smith, & Konsynski, 2003). Undoubtedly, before installing a technology, the strategy of wanting and adopting it must be formulated until the organization has a clear path before it to install it perfectly. Sometimes, this strategy is called the technology strategy in circles. The technology strategy is examined by different experts. In the view of Ford, the technology strategy is a general and extensive method for achieving organizational objectives using a suitable technology in the expected competitive environment. This strategy must present some criteria for adopting a suitable technology (Arabi, & Izadi, 2005). Today, the RFID technology is noticed in scientific and practical fields as a method for providing accurate and in time information without human intervention. The RFID technology plays an extensive role in supply chain management due to improving the speed, the accuracy, the efficiency and the security in data transferring (Jones et al, 2004). Using the capabilities of RFID, one can reduce the costs of the stock, transportation and distribution and increase the sales by reducing the demands facing with deficiencies (Kakkainen, 2003). On the other hand, creating an efficient stock system and reducing the confidence storage stock, one can improve the cash flow. The RFID technology can be used for tracing the books of the libraries or other documents and also drugs and food products (Collins, 2004) and for tracing and managing hospital equipments (McGee, 2004). This research is to examine the role and the application of RFID technology in the efficiency of SCM (food industries companies).

2. Problem description

RFID is enabling companies to see further into the supply chain than ever before, providing more accurate real-time information and improvements in process efficiency. The increased visibility can result in faster inventory turns, less shrinkage, reduced labor and higher material

flow through warehouse or distribution center. Greater efficiency means RFID-enabled processes take less time and effort; entire pallets of product can be recognized in seconds without the need to break them down, and cycle counting inventory can be accomplished in hours or even minutes instead of days. RFID tags are small,
wireless devices that help identify objects and people. Thanks to dropping cost, they are likely to proliferate into the billions in the next several years-and eventually into the trillions. RFID tags track objects in supply chains, and are
working their way into the pockets, belongings, and even the bodies of consumers (Kamaladevi, 2010).
Using RFID technology in SCM has created a change that leads to the decrease of the costs in supply chain operations, promotion in service offering, and unique services for products. The capability given by RFID technology in identifying the products and obtaining information immediately with various data resources is that it can open a new horizon in supply chain operations and also supporting the decision making. Using RFID, different companies can share their information with their other commercial partners to support free usage, exchange information in a standard manner and cooperate for supporting the decision making clearly. In the operational view, this method has resulted in supporting the decision making for the following cases: storehouse management, management of development, the ability to trace the products, management of the inventories and their replacements and providing information services for the customers. Using RFID in SCM makes the partners able to readily know that at which stage of life a product is, where its present place is and where it will be. The new and low cost generation of the tags and RFID readers is created with the help of the solutions of the related software and presents new capabilities for the supply chain management including a real time access to the information of the articles and also basic changes in the way of managing the lists of the articles in the supply chain. In new systems, we may know that 10 products are available in the shelf. With the help of RFID, we can know the life times, the serial numbers, the expiration date and the location of the storehouse of these ten products. This is like we know the names of 1000 people in a city.
According to above, it can be said that in this research, we want to answer a basic question: is RFID technology effective in the efficiency of SCM?

3. Conceptual model of the research



4. The importance and the necessity of the subject of the research

The RFID technology is a pervasive processing technology introduced as a replacement for traditional bar codes. The capability of wireless identification by RFID has produced basic changes in the industry, trade and experiments. The heart of this equipment is that it readily gathers the information of a physical object. The information recorded in the RFID tag of any object can be sent simultaneously for various equipments through physical barriers from a far distance. With respect to the concept (computer presence anywhere), RFID tags can change our mutual relationship with processing structures, in some cases even with internal and mystical structures. These advantages encourage the investors, the inventors and the producers to develop RFID for an extensive field of the applications. RFID tags can help us encounter with counterfeit goods such as fake designers, drugs and money. A RFID-based automatic inspection system can give and pay our bills in a supermarket, petrol station or highway. Using RFID, we can trace animals such as cows, sheep, birds and fishes in a food supply chain and control the quality. Perishable and short life products, especially foodstuffs, are those cases causing the largest problems and challenges for supply chain management. These challenges are mainly due to the variety in the number of products, special needs for tracing and tracking product flow during the supply chain, the short life of the products, the requirement for controlling the temperature in the supply chain and the high volume of the products we deal with. Using the RFID system is one of the best potential solutions helping the supply chain management solve logistic problems of perishable products. In food industries, the period of the product storage is short due to the high probability that the product perishes and the short time of the storage of the final product. Today, the changes in the ways of producing, distributing, maintaining and selling foodstuffs have caused changes in consumers' demands to increase the quality and the durability of foodstuff packages.

5. Purposes of the research

General purposes:

1. Examining the change of the pattern of the customer's supply chain from traditional to modern methods

2. Introducing the procedures of RFID technology for producing a suitable condition in SCM

Practical purposes:

1. Presenting suitable procedures in all stages of SCM (supply of the materials, production, storage, distribution and sale) to use effective techniques and practical methods of using RFID technology.

2. Helping the SCM describe the strategies of using new technologies based on RFID.

6. The history and the background of the subject of the research

year	Description
1800	Faraday discovered a reference point to understand the electromagnetic energy fundamentally.
1846	Faraday discovers that light and radio waves are a part of the spectrum of electromagnetic energy.
1864	Maxwell published his theory about electricity movement and magnetic energy in interfering waves with a speed equal to light's speed.
1887	Heinrich Rudolph Hertz proved that there are interfering long waves that can move and reflect with the speed of light.
1896	Marconi is the first one that became successful to send and receive radio waves at two ends of Atlantic Ocean. In spite of Mchowan theory, Marconi galaxy begins.
1906	He became successful to prove the existence of continuous waves and send radio signals. This success was the beginning of modern radio communications.
1922	Radar was invented.
1939	According to the surveys, the concept of RFID was proposed from the World War II with the discovery of a technology IFF (Identify Friend or Foe) almost similar to it.
1944	RFID coil was inserted in a war plane with a size of a big baggage equipped with a battery, to identify the friend from the foe from the earth.
1946	Leon Theremin invented a spy device for sonic transmissions for the soviet republics. This device made it possible to transmit between two radio devices by radio waves. A transmitter transmitted information and the waves received shook a receiver having a diaphragm place.
1948	Henry Stockman proposed the idea of using RFID in communications that became known as communication with irradiative power, but despite many unsolved problems, it was not applied for about 30 years.
1960	Fundamental researches began about using bit transmitters-receivers for controlling the product by radio waves.
1970	Supervision of the animals became possible by RFID systems. In 1976, it was used in New York's airport.
1973	3,713,148 product permissions were issued that used RFID technology and they were called the ancestor of RFID that had 16 bit memories. These permissions were issued for New York's customs. They were a kind of verification by the customs.
1978	It was designed and used in Los Amous laboratory.

1980	Introduction of RFID for controlling the traffic of the automobiles and the entry and the exit of the employees of the companies in Norway.
1990	The introduction of RFID for the security of the skiers. It was also used for electronic payments.
1998	An Italian professor tested it on the human that was successful.
2002	The introduction of RFID as a procedure for national development of information technology in South Korea and some other countries.
2003	Using RFID in the identification cards of people
2004	Mexican Attorney General's office installed RFID tags on 18 people of its members for controlling the access to the secret information room.
2004	Using RFID system for identifying the patients in the hospital or the access of some employees to the patients' files. After that, some hospitals of the US began implanting RFID system in the patients for a better management.
2005	By injecting RFID hypodermically, it was used for identifying people.
2006	The books of the city center library in Munich were equipped with RFID tags and an intelligent library was established.
2008	RFID in the healthcare supply chain
2010	RFID In Mobile Supply Chain Management Usage

7. The theoretical framework of the research

Our purpose from presenting a theoretical framework in the present research is to state views about components of RFID and the factors effective in it that finally leads to changing the pattern of SCM. Since our purpose in the present research is to examine the application and the role of RFID in the efficiency of SCM, at the first step it is very important to determine the applications and the advantages and the benefits of RFID and at the next step, all factors of RFID effective in the efficiency of SCM must be determined exactly, so all of the factors of RFID effective in SCM are briefly shown: locating the product exactly in any storehouse, increasing productivity in production, reducing the costs, shortening the ordering cycles, increasing the speed of product transporting operations, higher speed in settlement, removing wrong transportation, reducing time intervals in in-time transportation and delivery of the order, evaluating the product quickly, reducing errors and intervals, insuring private transportation, reducing production costs, removing wrong paths of transportation, evaluating the stages of implementation and production accurately, reducing costs of human forces through reducing human forces for tracing the product and managing the storehouse, increasing the shares by increasing the productivity, offering suitable services to the customers.

8. Hypotheses of the research

The major hypothesis	**Minor hypotheses**
There is a significant relationship between using RFID technology and the efficiency of SCM.	There is a significant relationship between using RFID technology for supplying the materials and the efficiency of SCM.
	There is a significant relationship between using RFID technology for production and the efficiency of SCM.
	There is a significant relationship between using RFID technology for storage and the efficiency of SCM.
	There is a significant relationship between using RFID technology for sale and the efficiency of SCM.
	There is a significant relationship between using RFID technology for distribution and the efficiency of SCM.

9. Method of the research

The method of this study is descriptive (survey method), a cross-sectional one. The questionnaire built by the researcher was used for collecting the information that included 40 questions at Likert scale. Based on the information of 56 questionnaires, the total answers from the questionnaires were used as the sample and the statistical t-tests or the single sample Z and also Friedman test were used and the results are presented in separate tables. The correlation coefficients between independent variables (predictor) and dependent variables (criterion) were also calculated and using the statistical test K-S (colmogrof-smirnof) for examining the normality of the data distribution and determining the appropriate type of statistical test for data analysis, the significance of these correlation coefficients were examined.

10. The tool for data collection

a. The method of collecting primary information using primary resources

1. Doing interviews with experts of RFID in Iran
2. Using questionnaires that their resulting information is the basis of confirming or rejecting the hypothesis.

b. The method of collecting information using secondary resources

1. studying opinions of the officials about RFID
2. using the researches and the publications of the organizations worked on RFID and different centers
3. using the books, the articles and the magazines available in valid websites
4. using the researchers conducted in the universities

11. The method of analyzing the data

* **descriptive statistics**: including tables of frequency distribution, calculating deviated and central tendency measures such as the average, the median, the variance, the standard deviation, etc
* **inferential statistics**: for testing the hypotheses of the research, the statistical t-test or the single sample Z, Friedman test and student's t-test were used for independent groups and also using K-S test for examining the normality of the data distribution and determining the type of the appropriate statistical test for data analysis, the significance of the correlation coefficients was examined.

12. The spatial domain and the population of the research

The population of the present research is all of the employees of the companies active in food industries with more than 50 employees (the offices located in Tehran), that their educational degree is higher than Bachelor degree. In the early study, it became clear that 70 companies were not active from 200 companies that their information and statistics were taken from the ministry of industry and in the remaining 130 companies by doing interviews, visiting, questionnaires and etc, 80 companies did not have any information about this technology and from the remaining 50 companies, about 30 companies had early and elementary information and other 20 companies were gathering information to apply this technology.

13. Volume of the sample and the sampling method

Volume of the sample: since the volume of the population (N) is known (based on the number of food industries companies having central offices in Tehran and more than 50 employees), we choose the number of the sample equal to 50 and from these 50 companies, 67 people responded the questionnaires that 56 of them are acceptable. These are given in table 1.

Table1. The frequency distribution and the percents of the respondents in terms of the level of the education

The level of education	Frequency	Accumulated frequency	percent	Accumulated percent
Bachelor degree	35	35	62.50	62.50
Master's degree	13	48	23.21	85.71
PhD	6	54	10.71	96.43
Non-responded	2	56	3.57	100.00
Total	56	--	100.00	--

The allowed error in the evaluation of the parameter must be taken to determine the number of the samples required to evaluate the parameter (for example the average). The value of the allowed error (d) is usually expressed as the difference between the parameter and the evaluation $d|\mu - \bar{x}|$. Since the value of sampling error is different in various samples, using probable sampling and determining the average confidence interval, the probability of occurrence of the error at the related level can be calculated. The level of confidence (confidence coefficient) is usually taken as 95% or 99%. According to the value of d and the level of the confidence taken by the researcher, the value of n can be obtained by the following relation:

$$n = \frac{Z^2\sigma^2}{d^2}$$

Where Z is the value of the unit normal variable corresponding to the level of the confidence 1-α, σ^2 is the variance of the variable being studied and N is the volume of the population.

If we want to evaluate the ratio of the people of a society having a certain property, the following relation is used, in which p is the evaluation of the ratio of the variable attribute (using previous studies) and q=1-p. If the value of p is not available (like the present research), it can be taken equal to 0.5. In this case, the value of the variance becomes maximum, i.e. 25%. Then:

$$n = \frac{(1.96)^2(0.25)}{(0.05)^2} = 67$$

67 questionnaires were distributed that after collecting the data, 56 questionnaires were perfect and 8 questionnaires were taken away because the information was not readable or was incomplete. So the volume of the sample reduced to 56 people.

The sampling method: sampling is to choose some people, events and objects from a defined population. In fact, sampling is to choose a percent of a population as the representative of that population. One of the most popular sampling methods is simple random sampling. In simple random sampling, any individuals of the population is given an equal data probability to be chosen in the sample. In other words, if the volume of the individuals of the population is N and the volume of the sample is n, the probability of choosing any individual of the population in the sample is $\frac{n}{N}$. Simple random sampling can be done in two ways: 1. By Drawing, 2. Using

the table of random numbers. For simple random sampling by drawing, a sample with the defined volume must be drawn from the listed individuals according to the sampling framework.

In this section, we generalize the results obtained from the sample to the population. In other words, here the hypotheses and the questions of the research are examined. Before anything, K-S test was conducted to examine the normality of the data distribution and determine the type of the appropriate statistical test of the data analysis. The results of the K-S test are shown for any variables of the research in table 2[1]:

Table2. K-S test for any variables of the research

variables	Number	Maximum D	The level of K-S error
Supply of the materials	56	0.13	P>0.20
Production	56	0.09	P>0.20
Storage	56	0.09	P>0.20
Sale	56	0.09	P>0.20
Distribution	56	0.16	P>0.15
The whole supply chain	56	0.15	P<0.20

It must be noted that the null hypothesis in examining the normality of the data distribution is that there is no significant difference between data distribution and normal distribution or in other words, data distribution is normal and the unit hypothesis or the opposite hypothesis is that there is a significant difference between data distribution and normal distribution or in other words, data distribution is not normal. According to the above table, it becomes clear that in all cases, the null hypothesis is accepted at the level of the confidence equal to 95% or in other words, it can be said that the data distribution is normal. Overall, according to the results of K-S test and what was mentioned about the data scale before, the researcher decided to use parametric tests for inferential analysis of the data.

The major hypothesis of the research: there is a significant relationship between using RFID technology and the efficiency of SCM.

In fact, the researcher examines the five minor hypotheses as the following:

The first minor hypothesis: There is a significant relationship between using RFID technology for supplying the materials and the efficiency of SCM.

The second minor hypothesis: There is a significant relationship between using RFID technology for production and the efficiency of SCM.

The third minor hypothesis: There is a significant relationship between using RFID technology for the storage and the efficiency of SCM.

The fourth minor hypothesis: There is a significant relationship between using RFID technology for sale and the efficiency of SCM.

The fifth minor hypothesis: There is a significant relationship between using RFID technology for distribution and the efficiency of SCM.

For testing the hypotheses mentioned above and comparing the averages of the scores calculated with the average limit, the statistical t-test or the single sample Z was used and the significance of the statistical tests conducted was examined at the levels of confidence 95% ($\alpha = 0.05$) and 99% ($\alpha = 0.0$) that the results of the tests are shown in table 3:

Table 3. The t-test of the major hypothesis and any minor hypotheses of the research

Variables (questions)	Number	Average	Standard deviation	Standard error	Average limit	t	Degree of freedom (df)	Level of error (P)
Supply of the materials	56	3.76	0.55	0.07	3.00	10.47	55	0.00
Production	56	3.74	0.74	0.10	3.00	7.57	55	0.00
Storage	56	3.80	0.42	0.06	3.00	14.16	55	0.00
Sale	56	3.98	0.56	0.07	3.00	13.20	55	0.00
Distribution	56	3.51	0.41	0.05	3.00	9.34	55	0.00
The whole supply chain	56	3.80	0.41	0.05	3.00	14.71	55	0.00

The calculated t about the effect of using RFID technology on the efficiency of SCM is 14.71 that is significant according to the degree of freedom 55 at the level of the confidence 99% ($\alpha = 0.01$). So the null hypothesis is rejected at this level of confidence. Therefore, the hypothesis of the research is confirmed and it is known that using RFID technology is very effective in the efficiency of SCM[2]. About any stage of supply chain, the same calculations are conducted. As it is shown in table 3, the calculated t is significant at the level of confidence 99 % ($\alpha = 0.01$) for all of the minor hypotheses of the research and their null hypothesis is rejected at this level of confidence. So all of the minor hypotheses mentioned above are also confirmed and it is known that using RFID technology for supplying the materials, production, storage, sale and distribution is very effective in the efficiency of SCM. The following diagram also shows the status of any of the variables examined compared to the average limit:

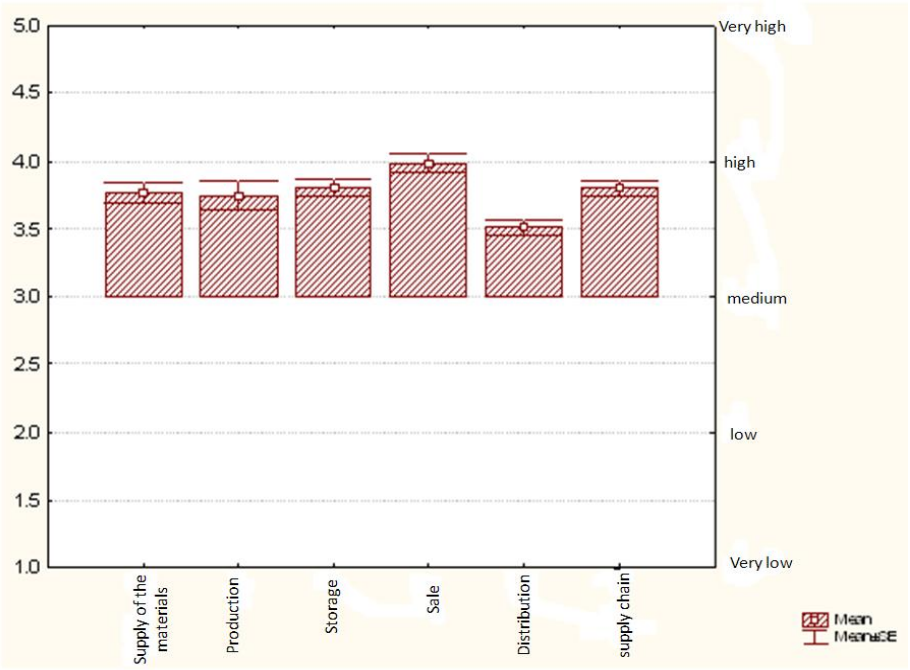


Figure1. The comparison of the degree or the level of the effect of using RFID technology on the efficiency of SCM

Subsequent Findings of the research

In this section, other findings of the research are examined. Since the researcher did not want to answer the following questions from the beginning, their results are proposed merely as the subsequent findings and they can be used in the suggestions for future researches and must be examined more accurately in future.

Question: does using RFID technology affect equally on the efficiency of supplying the materials, production, storage, sale and distribution? In other words, the researcher wants to answer the question that whether supply chain components are equally affected by this technology and if the answer is negative, how the priority or the order of these factors is and using this technology has the highest effect on the efficiency of which part of supply chain. To answer this question, Friedman test is used that its results are given in table 4[3].

Table4. The comparison of the effectiveness of the supply chain factors by RFID technology

Variables	Average of the ratings	Sum of the ratings	average	Standard deviation	Priority
Supply of the materials	3.06	171.50	3.76	0.55	Fourth
Production	3.15	176.50	3.74	0.74	Third
Storage	3.29	184.50	3.80	0.42	Second
Sale	3.70	207.00	3.98	0.56	First
Distribution	1.79	100.50	3.51	0.41	fifth
Statistical test	ANOVA Chi Sqr. (N=56, df=4) =47.18, P=0.00				

As it is seen, the calculated chi square (χ^2) is equal to 47.18 that is significant according to the degree of freedom 4 at the level of confidence 99% ($\alpha = 0.0$). So the null hypothesis based on the absence of the difference in the effect of using RFID technology on any stages of the supply chain in food industries companies is rejected at this level of confidence and according to the average of the ratings, it is known that using RFID technology has the highest effect on the efficiency for sale and after it there are storage, production and supplying the materials, respectively. Using this technology has the lowest effect on the distribution factor and in other words, the distribution factor in the supply chain is less than the other factors affected by using this technology.

Question: is there a difference between using RFID technology and the efficiency of SCM with respect to the organizational position of the respondents? In other words, the researcher wants to answer the question that whether the difference observed in the major hypothesis of the research and also the five minor hypotheses is affected by the organizational position of the respondents. In fact, the researcher examines this probability that one of the two groups (managers/ administers or the experts) evaluates the intensity of the relationship between using the technology and the efficiency of SCM more or less. For this purpose, first the average and the standard deviation of the scores of the experts and the managers/administrators are calculated for any variable and then using the student's t-test for independent groups, the averages are compared[4].

Table5. Comparison of using RFID technology and the efficiency of SCM according to organizational position

Variables	Manager/administrator			Expert			t	Degree of freedom (df)	Level of error (P)	Levene F (1,df)	Df Levene	P Levene
Supply of the materials	3.74	40	0.53	3.80	14	0.61	-0.31	52	0.76	0.18	52.00	0.67
Production	3.72	40	0.72	3.79	14	0.75	-0.30	52	0.77	0.16	52.00	0.69
Storage	3.85	40	0.42	3.64	14	0.43	1.59	52	0.12	0.04	52.00	0.85
Sale	4.00	40	0.57	3.89	14	0.52	0.64	52	0.52	0.33	52.00	0.57
Distribution	3.51	40	0.41	3.47	14	0.41	0.32	52	0.75	0.00	52.00	0.97
Supply chain	3.81	40	0.39	3.75	14	0.45	0.45	52	0.66	0.11	52.00	0.74

The above table shows that there is no significant difference between the average of the scores of the managers/administrators (3.81) and that of the experts (3.75) about the level of the effect of using RFID technology on the efficiency of SCM according to the statistical test conducted (t=0.45) at the level of confidence 95% ($\alpha = 0.05$). It means that both groups take the level of the effect of using this technology on the supply chain the same. Meanwhile, the results of the t-tests conducted about the stages of the supply chain show this and it shows that at the level of the confidence 95% ($\alpha = 0.05$), there is no significant difference between the attitudes of the managers/administrators and that of the experts. The following diagram shows this well.

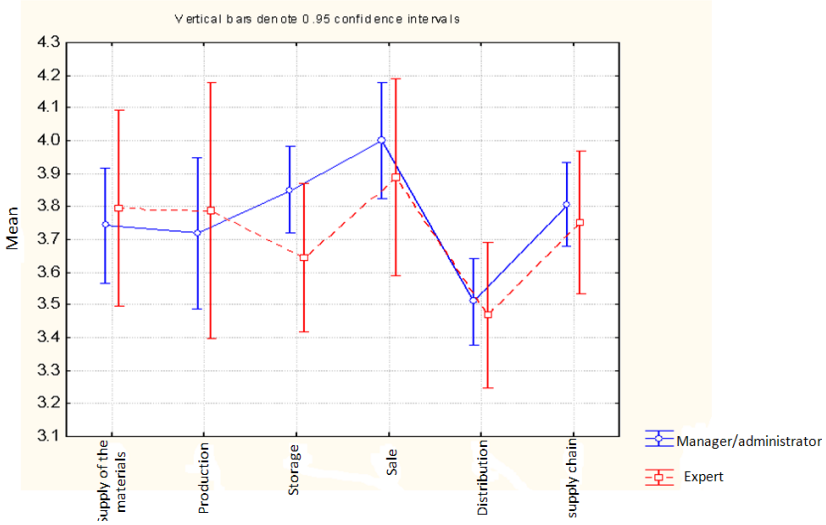


Figure2. The comparison of the attitudes of the managers/administrators and the experts to the effect of using RFID on the efficiency of SCM

Question: is there a difference between the extent of using RFID technology and the efficiency of SCM in terms of the level of the education of the respondents? In other words, the question is that whether the difference observed in the major hypothesis of the research and also the five minor hypotheses is affected by the level of education of the respondents. In fact, this probability is examined that one of the two groups (people having bachelor degree or people having master degree or higher degree) evaluate the intensity of the relationship between using the technology and the efficiency of SCM more or less. For this purpose, first the average and the standard deviation of the scores of the respondents having bachelor degrees and also those respondents having master degrees or higher degrees were calculated for any variable and then, using the student's t-test for independent groups, the averages were compared and the results are shown in the following table.

Table6. Comparison of using RFID technology and the efficiency of SCM according to the level of education

Variables	Bachelor degree			Master and phd degrees			t	Degree of freedom (df)	Level of error (P)	Levene F (1,df)	Df Levene	P Levene
Supply of the materials	3.76	35	0.57	3.74	19	0.52	0.12	52	0.91	0.22	52	0.64
Production	3.67	35	0.74	3.77	19	0.69	-0.51	52	0.61	0.06	52	0.80
Storage	3.75	35	0.40	3.88	19	0.48	-1.08	52	0.28	0.52	52	0.47
Sale	3.98	35	0.45	3.95	19	0.74	0.15	52	0.88	4.27	52	0.06
Distribution	3.49	35	0.36	3.53	19	0.49	-0.41	52	0.68	1.30	52	0.26
Supply chain	3.77	35	0.33	3.82	19	0.52	-0.44	52	0.66	2.73	52	0.10

The above table shows that there is no significant difference between the averages of the scores of the respondents having bachelor degrees (3.77) and those having master and PhD degrees (3.82) about the level of the effect of using RFID technology on the efficiency of SCM according to the statistical test conducted (t=0.44) at the level of confidence 95% ($\alpha = 0.05$). It means that both groups take the level of the effect of using this technology on the supply chain the same. Meanwhile, the results of the t-tests conducted about the stages of the supply chain show this and it shows that at the level of the confidence 95% ($\alpha = 0.05$), there is no significant difference between the attitudes of the two groups to the level of the effect of using this technology on the efficiency of the stages of SCM. The following diagram shows this well.

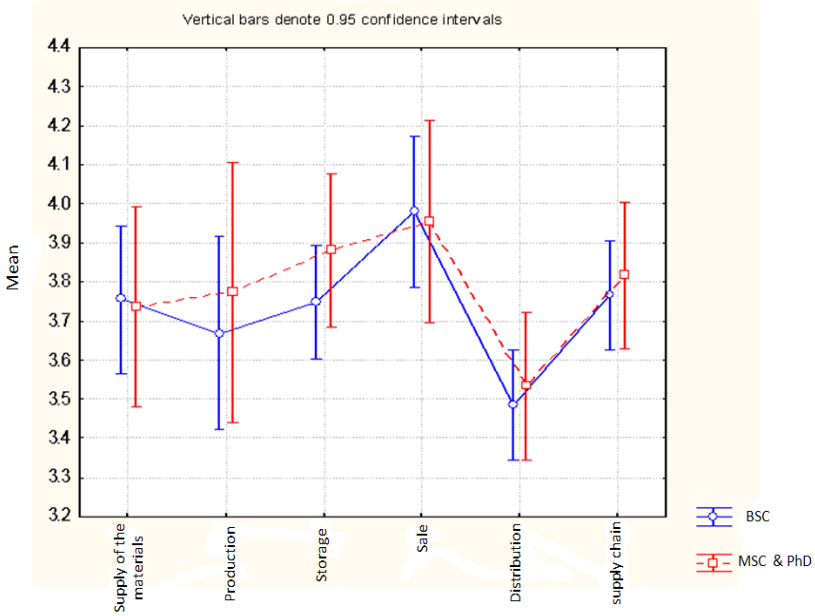


Figure3. The comparison of the attitudes to the effect of using RFID on the efficiency of SCM according to the level of education

The effect of using RFID technology on the stages of SCM: the following table shows the frequency distribution and the percents of the respondents according to the priority of the effect of using RFID technology one the five stages of SCM (including supply of the materials, production, storage, sale and distribution)[5].

As it is shown, 3.36 % of the respondents (the highest percent) take the level of the effect of using RFID technology on the efficiency of supply of the materials at the fifth priority, while the effect of using this technology on the production factor has the highest observed percent at the fourth priority (23.21%). The highest percent observed for the storage is at the first priority (33.93%) and that is at the second priority for sale. In the stage of distribution, the highest percent observed is at the second priority.

Table7. The frequency distribution and the percents of the respondents according to the priority of the stages

	Supply of the materials		Production		storage		sale		Distribution	
	Frequency	percent	frequency	percent	frequency	percent	frequency	percent	frequency	Percent
Efficiency	8	14.29	11	19.64	19	33.93	12	21.43	11	19.64
Efficiency	8	14.29	8	14.29	11	19.64	14	25.00	14	25.00
Efficiency	4	7.14	8	14.29	17	30.36	10	17.86	11	19.64
Efficiency	11	19.64	13	23.21	1	1.79	9	16.07	12	21.43
Efficiency	17	30.36	9	16.07	5	8.93	9	16.07	5	8.93
Efficiency	8	14.29	7	12.50	3	5.36	2	3.57	3	5.36

Table8. Statistical measures of any variables of the research

variables	number	Average	median	First quartile	Third quartile	Quartile domain	variance	Standard deviation	Standard error
Supply of the materials	56	3.76	3.71	3.57	4.14	0.57	0.30	0.55	0.07
Production	56	3.74	3.86	3.36	4.21	0.86	0.54	0.74	0.10
Storage	56	3.80	3.81	3.50	4.13	0.63	0.18	0.42	0-.06
Sale	56	3.98	4.00	3.57	4.43	0.86	0.31	0.56	0.07
Distribution	56	3.51	3.50	3.29	3.86	0.57	0.17	0.41	0.05
The whole supply chain	56	3.80	3.91	3.59	4.06	0.48	0.17	0.41	0.05

As it is shown, in all cases, the calculated averages are more than the average limit. So it seems that the level of the effect of using RFID technology on the productivity of the supply chain and any of its stages including supply of the materials, production, storage, sale and distribution is very high. It is worthy to note that these results must be tested in the sample of the research obtained to make sure of it that is explained in the next section.

Conclusions and practical-managerial suggestions from the findings of the research

If food industries companies tend to obtain the maximum efficiency in their supply chain, they must use RFID technology in the following sections based on the priorities obtained from the results of the research:

1. sale 2. Storage 3. Production 4. Supply of the materials 5. Distribution

according to the result of the major hypothesis, it is suggested that:

1. according to the importance of the issue of health in the society, the officials of the company must find a suitable condition for implementing a control and identification system (RFID) to trace and control the foodstuff.

2. The government must identify and focus on all levels of the supply chain using RFID technology, especially on the levels at which our country is better.

3. The government and the food industries factories must try at all levels of supply chain and according to the present research, the levels prioritized by the food industries companies.

4. We model the successful countries on using RFID technology in the food supply chain and create a positive image about accepting this technology in the country.

5. We create a suitable condition for accepting, choosing and identifying RFID technology instead of bar codes.

6. Companies successful in foodstuff industries must know that their products are welcomed more when the customers are familiar with and confident of the products (including the date, the ingredients, the way they are packed, etc) and try to present intangible advantages that RFID has in the income from reducing the costs to the

customers, including the assurance of the healthiness of the foodstuff, controlling counterfeits and guaranteeing the products.

According to the results of the first minor hypothesis, it is suggested that:

1. The foodstuff companies provide a suitable condition for automatic reordering that the required support for re-providing the product is provided according to the consumption at the least time and with the least cost.

2. RFID technology is applied by the suppliers for tagging the products and making the customer aware of the history of the product.

According to the result of the second minor hypothesis, it is suggested that:

1. The owners of foodstuff companies must set up RFID system by the support from the government and the officials of the company to follow the operations at various stages of production and meet the satisfaction of the customers and make sure of the materials used for the products and other related information.

According to the result of the third minor hypothesis, it is suggested that:

1. The storehouse of many factories is equipped with RFID system, regardless of other levels of the supply chain. Although no conditions are still provided for making RFID popular at all levels of the supply chain, it must be used in the storehouses to locate the products with a better precision and trace, pack and arrange them automatically, find the stock in the incorrect place automatically, manage the stock remotely and etc.

According to the result of the fourth minor hypothesis, it is suggested that:

1. Since one of the biggest problems in big and chain stores of Iran is standing in long queues for checking the goods and paying, if the government install and set up this system in big stores, many problems are solved and it has the following advantages: dealing with the orders automatically, the ability of preventing from robbery of the products, tracking the products with a short time of consumption for reducing the wastes, tracing the product in the store, improving the speed of recalling the products and improving management results and etc.

2. The bank system of the country is not exceptional and setting up the reader system and installing RFID tags on bank cards have many advantages: if RFID is installed on whatever you buy, it sends the information of the price of any products to the electronic price reader device. So before you arrive at the exit door, all of the prices of the goods you bought are sent to the card reader and this card reader that reads the prices from RFID tags can send them to the main seller and also to the producers of the products and on the other hand, the bank can even subtract the amount of your purchase directly from your account.

According to the result of the fifth minor hypothesis, it is suggested that:

1. In the stage of distributing the products, this technology must be also used. It does not mean to use it only in the stage of distribution from the supply chain. For example, in

distributing post packages, this system can be used to track the post parcels and obtain the information of these parcels including the temperature, the moisture, and the delivery state.

2. RFID tags are used for offerings such as the medicines sensitive to the temperature, quality and security control and tracking the path of transportation and delivery of the product.

- Suggestions to the researchers for future researches:

1. Repeating the present study at other big cities of the country

2. Doing a similar study for other cases of the application of the supply chain

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Notes

[1]Although as it was mentioned before, in the high volume samples, the data distribution goes to a normal distribution and based on it, it can be assumed that the distributions are normal, for doing the tests more accurately, the results of K-S test are the benchmark.

[2]It is worthy to note that the researcher has also calculated Wilcoxon test to compare the medians and the results obtained are similar to those of parametric test.

[3]The null hypothesis means that there is no significant difference between the order of the importance of these factors at the level of confidence 95% and the unit hypothesis means that this difference is significant at the level of confidence 95%.

[4]It must be mentioned that first due to the low number of the administers and their identical roles with the managers, these groups are merge together and ..?

[5]It must be noted that this prioritization is not accurate, because first the respondents have not prioritized these stages perfectly and second, prioritization of the stages is done using a question, while in the main part of the questionnaire, this prioritization is done more accurately. Even using Friedman test, the researcher has prioritized the stages that its result is more complete and correct than those presented in this section.