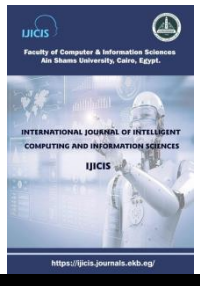
**IJICIS, Vol.22, No.4, 126-145**
**DOI: 10.21608/ijicis.2022.151347.1203**


**International Journal of Intelligent Computing and Information Sciences**

https://ijicis.journals.ekb.




# IMPROVING TRACEABILITY SYSTEMS IN THE FOOD INDUSTRY WITH RFID SUPPORT TO ACHIEVE HACCP REQUIREMENTS

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Received 2022-07-20; Revised 2022-08-29; Accepted 2022-09-01

***Abstract:*** *Achieving HACCP requirements for food control has become a basic requirement in the food industry, and the food control system needs an effective and low-cost tool for food control during work in the supply chain, and this research is based on studying the effectiveness of the RFID-based traceability tool used to identify units Defective supply chain and the traceability system identifies defective units in the supply chain in an easy and cost-effective way in combination with RFID technology. Through research, the effectiveness of the traceability system was studied to achieve the requirements of HACCP for food control, as this system is built and applied in many food factories by discovering defective units in finished products, as well as identifying potential defects during operation and supported by RFID technology dynamically. In order to identify the defective units, the study was carried out by distributing sixty survey forms to workers in ten food factories with a total of 600 forms, but the completed forms were 511 forms to identify the effectiveness of this system and its compatibility with HACCP requirements for food control. It became clear through field study that the system needs to be modified to include all phases in the production chain and to be more dynamic and support it to obtain a final system that helps to track down the defective units during the phases of the supply chain.*

***Keywords****: HACCP, RFID, traceability systems, food industry, supply chain*

## 1. Introduction

Traceability systems based on RFID technology allow to locate many things such as ingredients of food products during manufacturing in the supply chain, which has become used in monitoring systems in the food industry in general, these systems consist of RFID technology that carries codes for a component of the food product With the identifiers that link this component to the food unit, it also provides information

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for tracking this component by following the signals of the RFID reader, which enables coverage of all operations throughout the supply chain. The data is transmitted on the components of food products, and the use of this type of technology allows employing several places to read the RFID throughout the supply chain, which provides the flexibility required for this application and provides the ability to read information about the component of the food product during the manufacturing process.

However, the application of traceability systems alone is not considered sufficient [1], but it must be employed to achieve HACCP requirements, the traditional production of food is not considered sufficient to meet these requirements, and it also ensures that the manufacturing process of the food product is safe and sound. The integration of RFID technology allows for accurate and clear information to be provided in food supply chain systems. These systems can also be improved with the support of other technologies such as sensors or the Internet of Things for each element of food processing in the supply chain.

The RFID technology is embedded and linked in the communication system in the supply chain providing a means of direct connection between the parts of the manufacturing system, as well as providing realistic data on the progress of the manufacturing process [2]. The use of RFID technology allows each component of the production to be identified by a unique code. The system is divided into groups according to the way they are arranged, connected to power sources, the functions of each component, and the amount of data transmitted or stored.

## 2. Literature Review

### 2.1. Traceability Systems Powered By RFID

It is a system that constantly monitors the characteristics of the food product and mixture used in manufacturing and takes automatic corrective actions without disrupting the process flow.

### 2.2. Traceability Systems RFID-Powered Components

1. Data analysis software.
2. predictive and preventive maintenance software.
3. process monitoring equipment.
4. Communications systems linked to the supply chain management-based RFID

### 2.3. Features of an RFID-Based Traceability System

1. Ensuring the flow of work in the mechanisms of food production.
2. Providing closed control loops.
3. Early detection of process deviations.
4. Providing flexibility in dealing with new product variables in food production.
5. Providing the necessary data for decision-making.

## 2.4. The Role of RFID-Assisted Traceability Technology in Production Mixture Monitoring

1. Controlling rheological behavior.
2. Improving the environment surrounding foodstuffs.
3. Monitoring the viscosity in the production line.
4. Processing of raw materials.
5. Preparing the mixture before starting manufacturing.
6. Monitor the mixing of the mixture.
7. Managing the mixing process for the ingredients of the food product.
8. Controlling production processes and determining the actual mixing time.

## 2.5. Providing Material Flow Systems in Food Manufacturing

Material flow analysis is a good way to model, understand and reach the optimal use of resources, and this method relies on trying to overcome two characteristics of the food manufacturing system [3], the first of which is that it differs in its degree of complexity, which depends on the size and structure of the system and the relationships between the components of the system, and the second is that they differ in the degree Uncertainty, which increases when the available data on material flow is limited, but the complexity and uncertainty can be overcome when linked to digital measurement methods, where both uncertainty and complexity are calculated with informational standards from a theoretical point of view and entered as a function in material flow analysis.

## 2.6. Success Factors in Food Control

In order to succeed in controlling food, the following must be done:
1- Developing a communication system and information infrastructure [4] in the field of developing communications and installing environmental sensors in places that can be used to measure natural or physical measurements, so that this technology is employed, whether wired or wireless, to cover all places that need to follow up food control in all phases of food manufacturing.
2- Setting strategy: after providing the infrastructure of devices and the communications network in the food processing area, the strategy used is developed to enable the maximum benefit from the communications systems that have been installed, and follow-up to identify areas that may need to increase the installation of sensors and link them to the means of communications.
3- Following up the system infrastructure: Continuously follow up on the renewable needs to restructure the infrastructure.
4- Encouraging activities associated with the equipment operations: focusing on encouraging activities associated with the operation [5] of new equipment, such as training workers on skills to deal with new technology, taking into account compliance with the regulations and laws binding on food processing.
5- Controlling food production processes: ensuring the follow-up of the control over food and compound products from a group of food items and their movement between the manufacturing phases using modern handling systems associated with RFID systems, as well as environmental monitoring using sensors [6] and linking them to open reporting sensors.

6- Hazards identifying: identification of physical, natural, chemical, microbiological and allergen hazards.

## 2.7. (HACCP) Meaning

Hazard Analysis and Critical Control Point: it is an application or management tool designed to ensure that a food or food product is safe [7], as it identifies critical areas during handling processes and monitors the flow of raw materials used in food processing, with the aim of reducing exposure to risks that could lead to food spoilage.

## 2.8. Seven Principles of HACCP

Conduct a hazard analysis (Principle 1): When implementing food safety systems, it is necessary to identify the possibilities of exposure to risks that can spoil food or change its properties. There are many chemical treatments that have dangerous effects on food processing processes or exposure such as chemical, biological or physical contaminants, and this danger takes any form that can cause Carries an adverse effect on health, and risks to food include bacteria, viruses, parasites, chemical pollutants, and foreign substances that can lead to a negative impact on consumer health.

### 2.8.1 Hazard Analysis

When analyzing the sources of danger [8] in food to identify what food ingredient is used, how it can be used and how to combine it with other ingredients of the final food product. At this stage, all types of potential risks that may occur in each manufacturing stage are identified, the essential risks are identified, as well as the standards used to control food products.

#### 2.8.1.1 Biological, Physical and Chemical Hazards

When analyzing all kinds of risks, the percentage of pollution in the environment surrounding the food components of the food product, such as air, water, equipment used in manufacturing, or surfaces that may come into contact with the food product, must be measured.

#### 2.8.1.2 Information Sources

It is necessary to track all sources of information [9] that allow monitoring the food product, whether it is traceability systems, or environmental sensors that can measure any changes in the surrounding environment consisting of air, water, surfaces or tools that may come into contact with the food product. The manufacturing room must be designed so that it is easy to clean in case of exposure to any contamination quickly and discover the occurrence of this contamination at the same moment in which it occurred, and it is important to emphasize that all aspects of interaction with materials or equipment are subject to a good cleaning regime based on standards determined through devices Measurement or various environmental sensors.

### 2.8.2. Determine critical control points (CCPs) (Principle 2)

Track critical control points in the food manufacturing environment, whether in the materials used in manufacturing or the surfaces in contact with the food product and all components in the manufacturing environment that can be considered critical exposure points, as these components may carry bacterial organisms that lead to microbial danger, it must be emphasized to sterilize the place or clothing worn by workers, and sanitize their hands even if they are wearing gloves.

#### 2.8.2.1 Identifying Critical Control Points

In this principle, it is necessary to determine at what stage control is necessary, after all types of danger and standards used in food control have been identified, and control points are identified for critical areas in which the danger increases or the safety decreases. For Using the Decision Tools to determine CCP's, The information collected should be used to identify critical control points and in accordance with decision-making rules.

### 2.8.3. Establish critical limits (Principle 3)

When establishing critical limits, standards must be defined that must be adhered to ensure product safety and Establish Critical Limits. The limits are defined to monitor the measures associated with the points identified in the critical control points. Critical limits describe the difference between the safe or unsafe position of the product at the critical points. This must be done based on specific safety measures and limits that are established for allowance.

### 2.8.4. Establish monitoring procedures (Principle 4)

When establishing a control system, it is necessary to determine what method is used to identify whether there is an error in the manufacturing process, and here comes the role of the traceability system in identifying this, as a system is established to control not to exceed the limits that were determined at critical control points. In Monitoring Procedures, determining follow-up procedures is done after employing the tools used in that from tracking systems or environmental sensor systems and linking them to the database for monitoring the manufacturing process.

### 2.8.5. Establish corrective actions (Principle 5)

A corrective action is established if it is found that the critical control points are not under observation or if an error is detected through the traceability system. Corrective Actions determines what reaction must be taken to overcome this crossing of the critical limits or the error that occurred.

### 2.8.6. Establish verification procedures (Principle 6)

Corrective actions and responsibilities necessary for implementation are identified, which need to be identified, and reference is made to databases as well as to records of traceability systems to track the phases of raw material flow into the manufacturing environment to the production of the final product.

#### 2.8.6.1 Verification Procedures

Establish procedures to ensure that the HACCP system is operating efficiently and that the devices connected to the traceability systems are working well as well as ensuring that the HACCP system is being monitored and continued to operate efficiently

### 2.8.7. Establish record-keeping and documentation procedures (Principle 7)

Create a documentation of all the procedures that have been taken to achieve the HACCP and provide records for the information that was recorded during the manufacturing phases and to confirm the extent of compliance with the principles of HACCP and its application

#### 2.8.7.1. Record Keeping & Documentation Procedures

All procedures taken to verify that the system works without stopping, and all procedures that followed the manufacturing phases of food products and to ensure that the food manufacturing system is under control, as well as recording any corrective measures that were taken and according to the critical limits, which are used as evidence of Food product manufacturing in a safe way.

## 2.9. The Efficiency of the Organization When Using A Traceability System

When trying to achieve effectiveness when using traceability systems [10] - which means the ability to track and trace food at all phases of manufacturing and distribution to ensure that food products delivered fresh to the consumer - the available and accompanying technologies are reviewed to support traceability systems and at different levels of locating each part The manufacturing system is supported by Active RFID, and secondary data identifiers can be used to support the manufacturing process, such as environmental sensors.

traceability systems supported by Active RFID have become one of the supporting mechanisms for following up [11], watching and controlling the various manufacturing phases to confirm compliance with the regulations and laws binding on food quality and safety and have become one of the basic infrastructures for production, operation and even delivery of food products from entering the production line as raw materials to exiting it as finished products.

There are many other technologies available for tracking other than traceability systems supported by Active RFID, such as barcodes, GPS, and each of these technologies has its different applications and depends on the level at which it is applied. Tracking systems supported by Active RFID have wider uses due to the ease of tracking food products in different phases by relying on them.

## 2.10. Improving Traceability Systems in the Food Industry With RFID Support for Achieving HACCP Requirements

When improving the traceability systems in the supply chain [12], the necessary requirements must be provided to comply with the regulations and laws binding on food production and to abide by the characteristics and specifications of the product authorized by the Ministry of Health, taking into account the appropriateness of equipment and surfaces in contact with food to achieve the purposes of quality and safety for food, and this is achieved by tracking the application.

### 2.10.1. Applying The Seven Principles of HACCP.

Although the quality and safety of food is one of the most important factors that lead to the use of traceability systems, such as determining corrective actions when an error occurs or the risk of losing customers as a result of poor demand for the product, managing product losses, and developing the production process as a whole, which requires defining the characteristics of the system and the required functional needs. To ensure its implementation and to define requirements for an acceptable system of differentiation between the functions available through the traceability systems.

### 2.10.2. The Use of Active RFID-Enabled Traceability Systems for Decision-making in the Food Industry

In order to provide accurate information to help in decision-making, the design of the manufacturing system is based on the design of an information system that is acceptable in terms of its functional components and complies with the required standards and adherence to the caveats in the seven principles of HACCP and the periodic review of the sub-categories that make up the manufacturing system to ensure their suitability for the application of those standards which are designed based on the expertise of experts in food science, nutrition and medicine, the binding laws of the Ministry of Health, as well as the food preferences of consumers.

The need to connect to the information network during the manufacturing phases [13] and to overcome the complications associated with the large and varied number of information obtained from the system and required to follow the traceability process, as well as the need to work on compatibility between the components of the information system based on the traceability system is critical to share the information obtained with decision makers.

## 2.11. Work Life Cycle in Food Manufacturing

The work life cycle in food manufacturing starts from preparing to enter the manufacturing phases [14] to packaging the final product. By following this cycle, the risks and diseases expected to occur in identifying a defect at any phase are studied and prevented, and food products conform to government specifications of health and safety.

### 2.11.1. Food Manufacturing Processes Development

Food manufacturing processes are developed based on chemical, natural, physical and biological technologies [15], and a traceability system based on RFID technology is adapted accordingly, on which the internal arrangement of operations, equipment arrangement, and labor locations are built, and the process of controlling manufacturing processes is integrated with each process.

### 2.11.2. The Use of Data About Food Standards

There is access to data related to chemical, natural, physical and biological standards that affect the specifications of the food product [16], which provided the opportunity to review the set of operations in the supply chain, and this review is then confirmed that the processed food conforms to the required specifications. It can be assured that food is safe by monitoring the manufacturing phases and making sure that good manufacturing practices are carried out, which is done by reviewing every step of the manufacturing process and not just checking the final product.

### 2.11.3. The Use of Data About Raw Materials Supplied to The Factory

The information on the specifications of raw materials is provided to suppliers and is included in the inherent specifications [17] of the food product, such as production date, shelf life and free from impurities, and the safe manufacturing system allows accepting or rejecting these raw materials
In the same way, food safety management systems can be applied, which enables effective support and compatibility with the impact system, whether in the pre-manufacturing phases or in the manufacturing phases, which includes recording the manufacturing movement to support the requirements of achieving HACCP, through which it can:

1. Following-up of waste management processes to ensure food safety and not to be exposed to any danger that affects the products.
2. Providing real information to the consumer about the components of the product to ensure that it conforms to the specifications.
3. Improving the supply side management of raw materials and thus improve product quality.

## 2.12. Sources of Danger in The Place And Environment of Food Processing

Consumer health is affected by food processing in the following ways:

1- Food exposure to spoilage as a result of contamination with microorganisms.
2- The arrival of foreign components on food from the air, such as gaseous, liquid or even solid substances.
3- Inadequate protection of food from changes in temperature or natural environmental factors.
4- Enzymatic changes or metabolic developments in the food itself.

### 2.12.1 Machines Used in Manufacturing

Machines used in manufacturing as one of the sources of danger in the place and environment of food processing. When planning to follow up on the sources of danger resulting from equipment, tools and surfaces in contact with food ingredients and the standards used to measure the operating requirements of those machines are determined before they are operated. Each batch of operation, in order to ensure compliance with the binding standards that reduce the occurrence of risks, one of the methods used to reduce the risk is to measure the natural characteristics of the surrounding environment for manufacturing, which depends on the environmental sensor systems in the factory. The following Figure. 1 shows the phases of food manufacturing.


Figure. 1: Explains the phases of food manufacturing

### 2.12.2 Storage

Storage is one of the Sources of danger in the place and environment of food processing. The method of storing raw materials or ingredients used in food processing, whether by cooling or ventilation, ensures the preservation of the taste of the food component, the percentage of fat, and its freedom from undesirable characteristics, or its exposure to pesticides, insects or rodents.

### 2.12.3 Manufacturing Method

Manufacturing method is one of the Sources of danger in the place and environment of food processing Food processing methods include food preparation and processing, which may include heating or cooling systems, steaming and cooking of food, or drying and smoking using auxiliary equipment.

### 2.12.4 Handling

Handling is one of the Sources of danger in the place and environment [18] of food processing. Risk assessment is in the handling phase and during food processing operations, by identifying potential changes to the characteristics of the food product through a series of processing steps during the food handling chains during the manufacturing process, and this is done based on the available data, which is obtained through traceability systems or Environmental sensors, which includes the movement and handling of materials during the different phases, and the following factors can influence the risks of food safety during handling operations :

1) Raw material handling.
2) Food processing steps, including food handling.
3) Food processing chains.
4) Food processing steps.

The more complex the system and including many phases of handling, the greater the opportunities of exposure to danger and the greater the possibility of errors in the manufacturing phases.

## 3. Research Methodology

The study is based on the descriptive analytical method, where the descriptive aspect deals with the description of health safety and how the HACCP requirements can be achieved , and how to plan for it through the system, and the analytical side deals with the study of the relationships between planning to achieve HACCP requirements It showed both the expected performance of business results and the efforts made to internal operations during the phases of food manufacturing and the factors of innovation and education of employees from training and educational level, and the following were taken into account:

1) The selection of the study sample on the basis of individuals who are able to give correct information in the field of study to ensure the safety of testing the hypotheses.
2) Simulation and comparative evaluation were used for some issues that were difficult to obtain data about in the factories under study.

### 3.1.Research Objectives

1) Determining the need for modification in the food control system supported by RFID technology.
2) Familiarizing with the specifications of the proposed food control system.
3) Studying how to use traceability systems in the food industry with its support to achieve the requirements of HACCP.

4) Studying the effectiveness of the traceability tool based on the RFID technology and used to find the defective in the supply chain.
5) Determining the risks expected from the new system and how to overcome them.
Things that may affect safe food
There are many things that can have direct contact with food and may affect it, such as:

1. pots.
2. Food processing machines.
3. stirring tools.

### 3.2. Field Study

The study is exploring how a safe traceability system can increase the effectiveness and efficiency of the supply chain in the food industry. Moreover, studying how food factories can comply with the requirements of HACCP Throughout the production chain, where the traceability system identifies defective units in the supply chain in an easy and low-cost manner based on RFID technology.
The system is also studied the entire supply chain, as the system is built and applied in the food factories under study to ensure that the HACCP requirements are met By discovering defective finished units, as well as identifying potential defects during the movement of the product during the various phases of food manufacturing by supporting the dynamic movement of the product with RFID technology Where the system needs to be modified in the current traceability system and modified to obtain a final traceability system that helps to track access to defective units during the various phases of manufacturing.

After the survey form was designed according to the objectives and hypotheses of the research and after selecting a sample of industrial organizations working in the field of food industry, the forms were distributed equally to the employees of these organizations, which are ten factories, and sixty forms were distributed to each of the factories in the study sample, the total completed questionnaire forms were 511. Obtaining the entire data, as the sample of each plant was large in size and therefore it was not easy to obtain the complete data and 89 forms were canceled because it was not completed.

#### 3.2.1 Applying Functional Restrictions to Ensure Food Safety

There are many functional limitations that may prevent exposure to food spoilage. Handling of items and tools used in food processing, as well as packaging materials can be:
1- Transport from containers filled with raw materials to the place of food processing.
2- Exposing it to water, gaseous substances or other organic components for washing or preparing foodstuffs before manufacturing them.
3- Transporting foodstuffs after processing, cleaning and preparing them for cooking, and transferring them to utensils used in cooking or food processing.

#### 3.2.2. The Research Sample

The study was conducted on food manufacturing organizations in Egypt, and survey forms were distributed equally to the companies as shown in Table 1.

Table 1: Research sanple companies

| NS | The Company's name | The Company's address |
|---|---|---|
| 1 | Cadbury Adams Egypt Foodstuff Factory | Tenth of Ramadan city |
| 2 | (Green Land) Middle East | Tenth of Ramadan city |
| 3 | The Egyptian Company for Modern Foodstuffs Honey Well | Tenth of Ramadan city |
| 4 | Sweet Source Foodstuff | Tenth of Ramadan city |
| 5 | Taiba Company for the production of crackers, snacks and dry sweets | Tenth of Ramadan city |
| 6 | Al-Horya Food Industries Company | Tenth of Ramadan city |
| 7 | United Company for Oriental Sweets and Juices - Al Rabie Group | Tenth of Ramadan city |
| 8 | Al-Zahar Automatic production for the manufacture of food | Tenth of Ramadan city |
| 9 | Hana company for Italian food and pasta | Tenth of Ramadan city |
| 10 | (Algsr Al Araby) Arab Bridge Company for the manufacture of juices | Tenth of Ramadan city |

A questionnaire form were distributed to a sample of workers in food production factories under study, which includes the previous sample. It took a lot of time to collect accurate and relevant data for the proposed system. Therefore, estimates of some issues related to the system were based on different simulation systems and comparative evaluation of similar systems in which the proposed system is implemented in order to reduce the time required to estimate system requirements. After determining the data requirements, the data collection should start immediately after the simulation of the proposed system. Then a survey was conducted through a set of questions to discover what kind of data is available. In many cases, the user does not know what type of data they have.

### 3.3. Research Hypotheses

1) There is no relationship between the use of traceability systems In the food industry supported by RFID technology And the expected performance of workers' skills to deal with the traceability system of workers in food manufacturing organizations.
2) There is no relationship between the use of traceability systems In the food industry supported by RFID technology And efforts for internal operations to achieve the HACCP requirements for maintaining food safety in food manufacturing organizations.

### 3.4. Questionnaire Design

A sample questionnaire was made for workers in food manufacturing organizations to learn about their job experiences in the field of quality assurance and health security. Thus, the questions in the questionnaire were designed according to specific answers in order to test the hypotheses.
Statistical processors

1) SPSS/PC has been used for statistical manipulations.
2) Simple frequency tables and graphs were made using an Excel program.

## 3.5. Hypothesis Test

### 3.5.1. The First Hypothesis

There is no relationship between the use of traceability systems traceability in the food industry supported by RFID technology And the expected performance of workers' skills to deal with the traceability system of workers in food manufacturing organizations

### 3.5.1.1 Null Hypothesis

There is no relationship between the use of traceability systems In the food industry supported by RFID technology And the expected performance of workers' skills to deal with the traceability system of workers in food manufacturing organizations

### 3.5.1.2 Alternative Hypothesis

There is a relationship between the use of traceability systems in the food industry supported by RFID technology and the expected performance of workers' skills to deal with the traceability system of workers in food manufacturing organizations. To test this hypothesis, a simple regression analysis model was used, where the answers of each sample were taken from the factory sample representing the research community, then a questionnaire representing the types of food industries was unloaded, and the data was analyzed in the survey forms using the statistical program spss /PC, with a significant degree of 5% , and the test result was significant, meaning rejecting the null hypothesis and accepting the alternative hypothesis, and the analysis of variance table was ANOVA as follows, simple regression analysis was used, and the results of the analysis can be shown in the following Table 2 to Table 4.

Table 2 Model Summary

| Model 1 | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | | Durbin-Watson |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change | |
| | 928[a] | .861 | .861 | 1.793 | .856 | 3151.966 | 1 | 509 | .000 | .701 |

Table 3 ANOVA[a]

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 10132.474 | 1 | 10132.474 | 3151.966 | .000[b] |
| Residual | 1636.258 | 509 | 3.215 | | |
| Total | 11768.732 | 510 | | | |

Table 4 Residuals Statistics[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 26.28 | 47.78 | 38.73 | 4.457 | 511 |
| Residual | -5.998 | 3.541 | .000 | 1.791 | 511 |
| Std. Predicted Value | -2.794 | 2.030 | .000 | 1.000 | 511 |
| Std. Residual | -3.346 | 1.975 | .000 | .999 | 511 |

We find here that the significance is 0.000, which is considered highly significant due to the fact that planning to achieve food safety requirements depends mainly on the skills of workers in dealing with the traceability system and thus affects the efficiency of the organization as a whole.

### 3.5.2. The Second Hypothesis

There is no relationship between the use of traceability systems In the food industry supported by RFID technology And efforts for internal operations to achieve the HACCP requirements for maintaining food safety in food manufacturing organizations.

Null hypothesis: there is no relationship between the use of traceability systems In the food industry supported by RFID technology And efforts for internal operations to achieve the HACCP requirements for maintaining food safety in food manufacturing organizations.

Alternative hypothesis: there is a relationship between the use of traceability systems In the food industry supported by RFID technology And efforts for internal operations to achieve the HACCP requirements for maintaining food safety in food manufacturing organizations.

To test this hypothesis, a simple regression analysis model was used, where the answers of each sample were taken from the factory sample representing the research community, then a questionnaire representing the types of food industries was unloaded. The data was analyzed in the survey forms using the statistical program spss /PC, with a significant degree of 5% , and the test result was significant, meaning rejecting the null hypothesis and accepting the alternative hypothesis, and the analysis of variance table was ANOVA as follows, simple regression analysis was used, and the results of the analysis can be shown in the following Tables 5 to Table 7.

Table 5 Model Summary

| Model 1 | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | | Durbin-Watson |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change | |
| | .841[a] | .707 | .706 | 2.604 | .707 | 1226.520 | 1 | 509 | .000 | .802 |

Table 6 ANOVA[a]

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| 1 | 10132.474 | 1 | 10132.474 | 3151.966 | .000[b] |
| Regression | 1636.258 | 509 | 3.215 | | |
| Residual | 11768.732 | 510 | | | |
| Total | | | | | |

Table 7 Residuals Statistics[a]

| | Minimum | Maximum | Mean | Std. Deviation | N |
|---|---|---|---|---|---|
| Predicted Value | 24.00 | 46.57 | 38.73 | 4.038 | 511 |
| Residual | -6.603 | 7.688 | .000 | 2.602 | 511 |
| Std. Predicted Value | -3.647 | 1.940 | .000 | 1.000 | 511 |
| Std. Residual | -2.536 | 2.952 | .000 | .999 | 511 |

a. Dependent Variable: Y
b. Predictors: (Constant), X2

We find here that the significance is 0.000, which is considered highly significant due to the fact that planning to achieve food safety requirements depends mainly on the skills of workers in dealing with the traceability system and thus affects the efficiency of the organization as a whole.

### 3.6. The Opportunities Provided By Planning For Health Safety in The Food Product

As it was found through the field study and through the open questions
The opportunities provided by planning for health safety in the food product in the organization are as follows, Table 8 shows the opportunities provided by planning to follow the phases of manufacturing using a traceability system to maintain the fulfillment of HACCP requirements of food production organization and the repeated answer to the open question (1) in the questionnaire.

## 4. Results

The main objective of the study was to identify the methods and concepts of planning to achieve the HACCP requirements Using the traceability system in food manufacturing organizations, as well as ensuring the safety of food specifications, as well as recognizing the role of the traceability system in maintaining safe food specifications and maintaining the health safety of food products.

## 5. Recommendations

In light of the results of the study, the researcher recommends that the production system in food manufacturing organizations should be based on the following:
1- Monitor needs and HACCP requirements and how to link it to the traceability system.
2- Studying the needs of workers in terms of training or vocational education, in order to identify the requirements for dealing with traceability systems.
3- Familiarizing with the regulations and laws binding on the food industry and exported from the Ministry of Health and their compatibility with the requirements of HACCP Which must be adhered to when exporting food products.
4- Determining the material facilities required to support the production system with traceability systems and environmental sensors
5- Observe the application of the binding rules in HACCP In order to maintain food safety.

Table 8: The opportunities provided by planning for health safety

| NS | the opportunity | Repetition |
|---|---|---|
| 1 | The system Provides an effective food safety system | 11 |
| 2 | The system allows tracking of every type of product from entering the production line as raw materials to its manufacture | 8 |
| 3 | The system facilitates identification of components causing natural, chemical and microbial hazards | 7 |
| 4 | It is easy to identify the allergens of some types of food for some individuals through the system | 6 |
| 5 | The system enables setting specific standards for food safety control. | 5 |
| 6 | The quality of the food product can be improved by tracking its components during the manufacturing phases. | 3 |
| 7 | The system facilitates the management of the purchased materials, which are raw materials, chemicals, and packaging materials | 1 |
| 8 | Maintaining the health of workers and consumers by following up on the phases of manufacturing using the traceability system to maintain the fulfillment of HACCP requirements is achieved. | 1 |
| 9 | The quality of the product increases whenever it is safe, healthy and committed to following up the manufacturing phases using a traceability system to maintain the fulfillment of HACCP requirements and therefore the demand for it from consumers increases. | 1 |
| 10 | Reducing costs resulting from correcting possible errors that may occur during the manufacturing phases. | 1 |
| 11 | Improving working methods to avoid exposure to danger. | 1 |
| 12 | Avoid losses resulting from non-compliance with HACCP requirements. | 1 |
| 13 | Anticipate the risk before it occurs by following the manufacturing phases using a traceability system to maintain the fulfillment of HACCP requirements Reduces the possibility of danger in the field of health security. | 1 |
| 14 | The speed of applying the practical solution when there is any danger when tracking the food product by following up on the manufacturing phases using the traceability system to maintain the fulfillment of the HACCP requirements. | 1 |
| 15 | It is easy to prepare the equipment for the working environment, such as water, air and steam entering the manufacturing environment | 1 |
| 16 | It is easy to track the disposal of waste, whether solid, liquid or gaseous. | 1 |
| 17 | Work and movement can be traced between the phases of manufacturing and up to the stage of transportation and storage of the final product. | 1 |

## 6. Discussion

Through the research, matters related to food safety and review were reviewed using the traceability system during the supply chain. A questionnaire was employed as a tool to assess the impact of the application of the system on food factories and system specifications and its impact on the completion of activities in the supply chain. in the end, the challenges and opportunities available in the proposed system were identified. To achieve the quality and safety of food products, a set of rules must be followed in accordance with the regulations and standards binding on the food industry. Therefore, compliance with them must be verified at every phase of the supply chain by tracking the manufacturing phases with RFID-based tracing systems to achieve HACCP requirements.

The results showed that this technology has a positive effect on both

1) The expected performance of workers' skills to deal with the traceability system of workers in food manufacturing organizations.
2) Efforts for internal operations to achieve the HACCP requirements for maintaining food safety in food manufacturing organizations.

The results of the survey analysis included that there are many factories that use this technology and have succeeded in not exposing the food components to spoilage or spoilage as a result of an error during the manufacturing processes, and therefore the highest levels of benefiting from this technology can be reached. Figure 2 shows the phases of food monitoring and control.


Figure.2. Explains the phases of food monitoring and control

There are some things that have emerged through the study. Food producing companies are keen to provide fresh and healthy products, which calls for follow-up and review of information on the components of food products during the manufacturing processes, which facilitates the follow-up of the movement of raw materials during the manufacturing processes and noting any errors that may occur during the supply movement and during Manufacturing processes.

Producers need to focus on achieving a balance between achieving HACCP requirements and the inputs into the production system, which will then be reflected in consumer satisfaction. In general, there are many factors that must be taken into account when evaluating the communication system of the manufacturing system, including providing easy access to information and providing the ability to store information after processing it. Future research must take into account the importance of studying all means of digital transformation in the food industry, not just RFID technology such as sensors and the Internet of Things.

## 7. Research Contribution

Consumers demand high quality, healthy and safe food. The producers focus on providing fresh food to the consumer and ready to eat, and there is a diversity in food products, as the food sector witnesses

several features such as changing the characteristics of products, manufacturing processes, characteristics of continuous production batches and the need for requirements compatible with terms and specifications Accordingly, the study contributed to the treatment of several specific problems that appear in the food manufacturing sector.

The phenomena of the research problem are represented in the problem of food control supported by RFID technology and the problems that are expected to occur when non-compliance with the requirements of HACCP (Hazard Analysis Critical Control Point), as well as the need to examine the different methods of developing the systems used to reach the defective in the supply chain in the food industry through this study.

Food processing can be affected by several geographical, environmental, social and economic factors, and it is difficult to predict the variables that may affect the contents of food processing.

1) Public health threat, which may lead to negative effects on the economy.
2) It needs to follow up and direct resources accurately in the different phases of manufacturing for an easy-to-use system that is convenient for workers and end users.
3) Difficulty planning for crises resulting from failure to meet requirements of HACCP.
4) The lack of time available to manage each crisis resulting from the lack of fulfillment of requirements HACCP In the event of any crisis.
5) The need for a system to accurately predict the variables of food processing.
6) Achieving speed in providing system components.
7) Balance between management and supply and demand for raw materials.
8) Focus on direct raw materials currently available.

The goal of reaching global markets in the food industry is one of the primary goals pursued by organizations working in the manufacturing of food, and the need to comply with the requirements of HACCP (Hazard Analysis Critical Control Point). It tracks the impact of raw materials used in the manufacture of foodstuffs, as well as food packaging materials, as well as environmental requirements to provide an appropriate storage and transportation environment to preserve food and the security of the food product and not endanger it.

"There are several problems related to the food control system supported by technology RFID, to fulfill the requirements of HACCP Food control in the supply chain"

It can also support the current industry efforts and study the integration between the components of supply chains in food manufacturing, and accordingly the main objective of the research was to study the possibility of employing RFID technology in achieving HACCP requirements , and the research also reflects recent developments in the application of RFID technology in monitoring Manufacturing processes, and the research variables were tested through the statistical study, which contributed to supporting the different levels in the manufacturing process.

The importance of the research stems from studying the problems related to traditional food control systems and how to develop them by designing new systems based on the technology of RFID according to:

1) The need to fulfill HACCP requirements of Food control in the supply chain.
2) The need to identify the problems associated with the lack of certainty of the food product specifications with the standards set by the Ministry of Health.
3) The need to identify areas for developing automatic food control methods.

## 8. Methods/Experimental

The aim of the research was to study the effectiveness of the traceability system to achieve the HACCP requirements for food control, 511 questionnaires were distributed to workers in food factories. Officials in food factories participated in the research by distributing a survey to factory workers and analyzing the resulting data to analyze the research variables. The results of the analysis showed that there is an effect of using these systems on ensuring food safety and health.

## 9. Conclusions

Through the research, the feasibility of using a traceability system supported by RFID was evaluated to maintain the fulfillment of HACCP requirements. Officials and leaders in food factories participated in the research by distributing a survey to factory workers and analyzing the resulting data to analyze the research variables. The results of the analysis showed that there are a relationship between the traceability system supported by RFID and achieving the requirements of HACCP for food control . In the end, we find that it has become necessary for those in charge of the food industry to identify changes in food production and the way it is consumed, and food manufacturing control systems can be provided through tracking systems supported by RFID Which is considered one of the production control tools to ensure food safety and security.These systems include many aspects that are included when applied, including technological and administrative dimensions or general professional practices, which may represent an important role in the field of food safety and security control, which helps in:

1) Improving and developing food control systems.
2) Responding to the technological changes currently available that rely on traceability systems supported by RFID
3) Employment of traceability systems supported by RFID In the field of food control during its handling through the phases of the supply chain.

There are many challenges that may face manufacturing practices based on traceability supported by RFID In order to achieve quality assurance.

## 10. Acknowledgments

The author would like to Acknowledge everyone who contributed to making the research appear in the appropriate manner including anyone who provided any data about food production.

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