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KNOWLEDGE AND ACCEPTANCE OF RFID TRACEABILITY SOLUTIONS

Empirical studies

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Abstract

In recent years the food market has become highly dynamic. Food crises in the early 90's, or those of the recent years, such as avian flu pandemic, swine flu, the cucumber or horse meat crises all had a negative impact on the Romanian food industry. Food deficiencies have led not only to contamination but also to the illness or death of some consumers.
The products traceability is a prerequisite for success in the food industry. As a modern solution, RFID technology can be useful for traceability applications made with rewritable passive RFID tags.
This paper aims to examine how RFID technology can be useful for traceability applications and will submit a diligent search regarding the degree of knowledge of RFID technology and the acceptance of an empirical model by the employees of Romanian companies.

Introduction

The introduction of well thought out and carefully applied information technologies in logistics can increase the profitability of companies. Through the Internet, companies interact with customers, collecting an impressive volume of data that they process in a variety of ways. Companies successfully using these technologies are able to reduce costs, simplify information sharing, improve business processes between supply chain partners and add measurable value to their business.

Initially food traceability was correlated with the origin or geographical region from where these products came (Mozzarella, Cognac, Tokaly). Later the concept was expanded to embrace food safety, serving the consumer's right to be informed about: country of origin, breeding conditions, the conditions of products harvesting, genetic composition and/or their environmental characteristics etc.

The use of methods for animal identification and ensuring animal traceability plays an important role in the effective management of herds. Over time animal identification methods have evolved from the biblical proof of Jacob, who marked its own animals Genesis 30.37-42 (Good 2011), through using ear tags, notching the ears of animal, until the biometric samples and RFID technology used today.

There are well-established modern technological innovations that can be applied to develop and implement an integrated traceability system for food products. Such an innovation is the RFID technology.

1. Traceability of goods from the perspective of the new electronic technologies

Poirier and Bauer (2000) refer to the term of "electronic supply chain management" as a reference to "combine naturally the supply chain and the e-commerce." Electronic supply chain management (e-SCM) is a new concept introduced by the need for adaptability and flexibility in a highly dynamic business environment that focuses on network integration (Williams et al, 2002). Therefore, introducing information technology implementation has become an absolute necessity for today's businesses. To achieve electronic supply chain management, a wide variety of IT technologies are used in logistics. These are based on: identification technologies, such as advanced versions of speech recognition (voice recognition robots), the digital image recognition, radio frequency identification systems (RFID), real-time location systems (RTLS), optical scanning / barcode, GPS communication, transmission and processing technologies for real-time (electronic diaries), Enterprise Resource Planning (ERP), Electronic Data Interchange (EDI) etc, and multiple software tools that will improve processes and will save companies time and money in the pursuit of the materials flows, the monetary flows and informational flows (Schönsleben, 2004).

To be successful, the innovative models in logistics should have two key components. Firstly, it should be regarded as a set of processes which generates ideas based on relationships. Secondly, it offers insights into potential improvements in many (possibly all) activities throughout the supply chain and sales. Progress in information technology brings opportunities and challenges for agricultural engineers to develop technological innovations to ensure food traceability from farm to fork.

There are already modern technological innovations that can be applied to develop and implement an integrated food products traceability system. A significant innovation in food management is RFID technology. Already it is possible to ensure the quality and the safety food processing of these products using current technologies:

- sustainable packaging materials
- implementing and standardising flexible technologies

To these can be added recent advances in the field of smart materials and packaging, including the application of nanosciences and nanotechnologies and the automation of the management principles and improvement of the production.

2. The RFID technology in the traceability solutions

RFID is a wireless automatic identification and data collection technology (RFID Journal 2014).

An RFID system consists of four components: the antenna reader (each consisting of transceiver, the decoder and the antenna), the RF tags that are electronically programmed with unique information and the computer network, which connects the readers.

The antenna emits radio signals to activate the tag, reads and writes data to it. Antennas control the data transmission and reception system.

The readers may be portable or fixed, or they can be mounted on a device. The reader emits radio waves within a radius of one inch to 100 feet or more, depending on the used radio frequency and its power. When an RFID tag passes through the electromagnetic area, it detects the reader's activation signal. The reader decrypts the encrypted data in the integrated circuit of tag and data are passed for processing to the host computer.

RFID tags (Fig. 1) are available in a wide variety of shapes and sizes. Identification tags can be: active, passive and semi-passive. **Active RFID tags** are powered by an internal battery and generally can be read/write also, namely the labels data can be rewritten and/or modified. **Passive RFID tags** operate without a separate external power source, but obtain operating power from the

reader. Passive tags are consequently much lighter than active tags, less expensive, and offer a virtually unlimited operational lifetime. **Semi passive RFID tags** are similar to active tags, but the battery is used to run the microchip's circuits, but not sending radio waves to the reader. Some of these RFID tags conserve the battery life in a state of "hibernation" until they are awakened by reader's signal.

Using RFID technology the supply chain members may choose to enable the automation of manual tasks, to reduce human errors, and to improve traceability and availability of products (goods, boxes, pallets, etc.). Thereby generates savings for all members of the supply chain. This is possible because RFID is a non-invasive methodology for data capture. That means it is a process that does not require human intervention, achieved by using automated readers that gather information from the RFID tags attached to articles. It is also known to be an "invisible" technology, and so may have both the reading and the writing capability in the same piece of equipment. The radio waves are used to make this technology invisible, meaning that the labels can be read even if they are not visible to the reader.

RFID tags have proved to be incredibly resistant becoming indispensable for a wide range of automated data collection operations and identification applications that would not otherwise be possible.

RFID solutions can be used by manufacturers across all kinds of industries, as well as distributors or retailers offering them significant benefits. RFID systems also operate in modern armed forces. For example, during the war in Iraq, they were used to oversee the logistical operations. At companies the RFID technologies are used in automate search of the optimal transport route from A to B, through satellite navigation system, in reverse logistics chains (in backflows) etc. Due to RFID, each product can be identified. Warehouses can be scanned in order to localize the products that are close to expiry date, and which should be dropped or withdrawn from sale, and returned to the manufacturer. In the case of products returned by the customer, the delivery antecedents and history can be traced, where, when and how the product was purchased, identifying and eliminating the source of the problems and possible scams.

RFID technology is used profitably in production processes and in the distribution activity. It can provide a large amount of data collected automatically and wirelessly, and it can work at temperatures up to 200 ° C(Convery 2004). RFID tags can store more information on the products, that in their turn can be obtained into a database. There are possibilities of connecting this technology with other sensors to measure climatic factors of temperature, humidity or even vibration. This information can be used later, to mark the shipment or the production process and automatically target any damaged goods.

These properties and advantages suggest that RFID technologies will become highly recommended for traceability applications.Collecting data with RFID is very accurate, helping to prevent the picking errors, and in shipping orders that affect the agro-food industry (Kelepouris et al, 2007).

The objectives of a traceability system are:

• Improving risk management in tightly interlinking with the requirements for food safety and consumer safety

• Guaranteeing the authenticity of products and information/education of the consumers

• Improving the quality of products and processes

At the European level, traceability is regulated by Directive (EC) 2001/95 concerning the General Product Safety (taken completely by Law no. 150 / 14.05.2004 concerning the food safety requirements governing Romanian agents in this direction) and Regulation (EC) nr. 178/2002, concerning the General Food Law, applied from 15 January 2004, and from 1 January 2005 in all EU countries (Plesea and Purcarea, 2007).

In the food industry the traceability system is designed to document the food, throughout from the raw material to finished product. The purpose of this system is not limited to products which present a risk for health, but also to provide a basis for quality assurance for processes and products. Therefore the traceability can be used as an effective tool in the management of food safety risks and security of the individual, as part of a control process.

A modern solution for food traceability can be implemented on the rewritable RFID tags, which have enough memory and storage capacity to each product, to allocate a unique identification number and other information.

RFID tags can be updated with timestamps and with the transaction registrations to create electronic pedigrees. The RFID tags can also be fitted with sensors to record the main storage conditions. The description such a solution has been used in the empirical research questionnaire concerning knowledge and acceptance of such innovative solutions by the employees of Romanian companies.

3. Level of knowledge and acceptance of RFID solutions

This material presents the results of the research conducted on this topic in our country, a traceability model, for tracking goods tested during June to September 2014.

Respondents were presented a logistic model using RFID technology with rewritable, passive RFID tags. The RFID tags have enough memory to allocate to each product a unique identification

number plus other information, and enough memory to store this information. This model could be a modern and useful solution for food traceability applications. The labels are provided with sensors to record the main storage conditions, updated with timestamps and recording the transactions to create electronic pedigrees.

Via the questionnaires, useful data were collected regarding the logistic model in different stages of the supply chain, The questionnaire also established prior knowledge about RFID technology and the permeability of managers regarding the innovative technologies etc.

As a sampling method the stratified probabilistic method was used. Participants included in the survey population are employees of the Romanian economy. Initially the target group was the management of production, distribution and food trade companies. Thereafter due to the low level of responses we surveyed employees who have responded to the request. The questionnaire was written in Romanian and was sent to approximately 1,900 people.

3.1 Results:

The working field of respondents (Fig. 2):

- production 46.85%,
- distribution 9.91%,
- trading 12.61% and
- others 30.63%.

Level of importance that is given in the respondents' firms regarding traceability of products and goods (Fig. 3):

- not at all important 11.71%
- unimportant 7.21%
- important in a certain extent 9.01%
- important 23.42%
- very important 48.65%.

To the question is there are a traceability system to track the goods in firms where the responders working (Fig. 4):

- 47.75% answered yes,
- 45.05% gave a negative answer,
- at 7.21% is not the case.

Number of employees in the firms where working respondents (Fig. 5):

- 21.62% work in firms between 1 - 9 employees,
- 27.93% work in companies between 10 - 49 employees,
- 13.51% work in firms of 50 - 99 employees,
- 16.22% work in companies between 100 - 249 employees,
- 7.21% work in companies between 250 - 500 employees
- 13.51% work in firms over 500 employees.

45.05% of respondents had a prior knowledge about traceability and 54.95% had not prior knowledge about traceability (Fig. 6).

To the question about the permeability of managers concerning RFID technology (Fig. 7): 36, 04% felt that managers in the company in which they work would be open to the use of these technologies, 22.52% felt that managers in the company in which they work would not be open to the use of these technologies, and 41.44% do not know how the managers would react on this thing.

3.2 Conclusions:

The respondents who work in production, distribution and trade attach great importance or very high importance, concerning the traceability issues. Most of them had prior knowledge about the problem of traceability and they have said that their managers would be open to utilize RFID technology (or other innovative technologies).

We can say that although the level of knowledge of RFID technology is not high, most of the surveyed employees were receptive to learn new information on other traceability systems.

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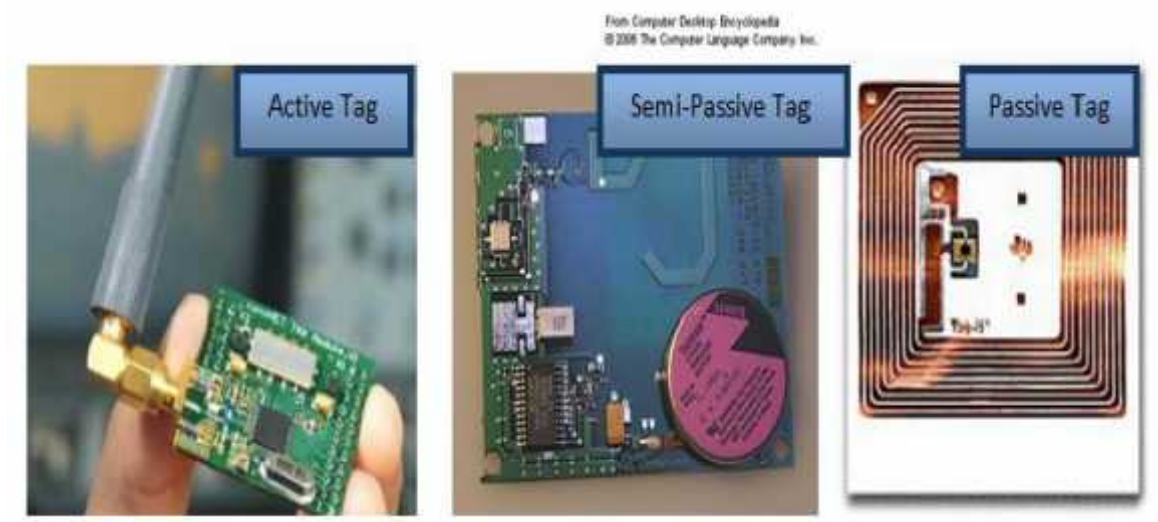
Appendices

Figure 1. Different types of RFID tags



Source*: Computer Desktop Encyclopedia*

FIGURE 2: Business operation area of the employer

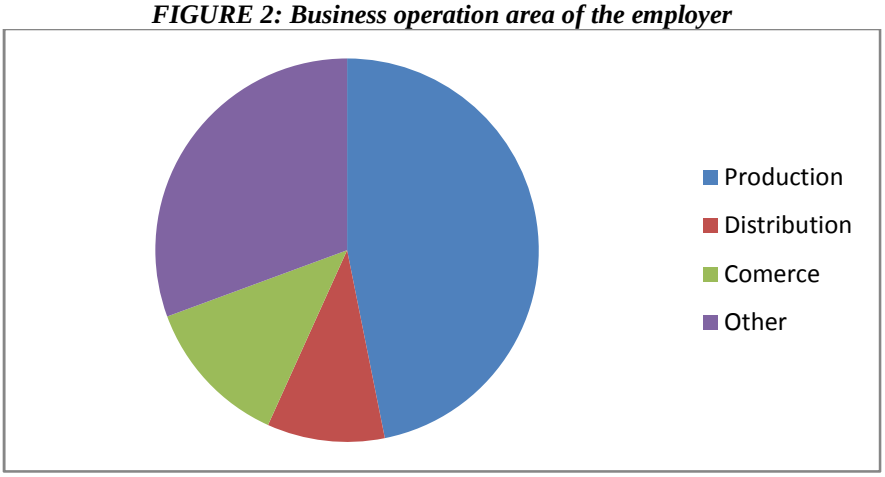


FIGURE 3: The importance granted for traceability

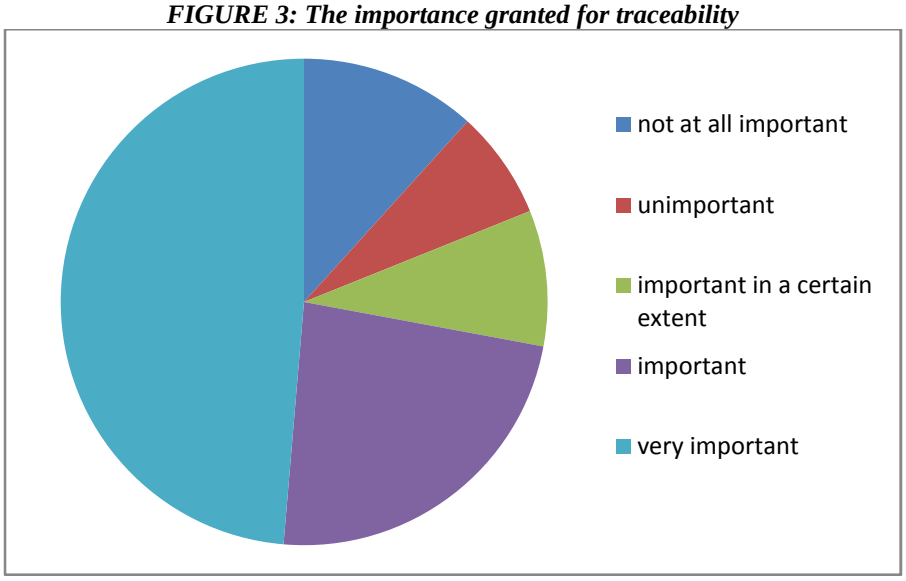


FIGURE 4: Are there a traceability tracking system?

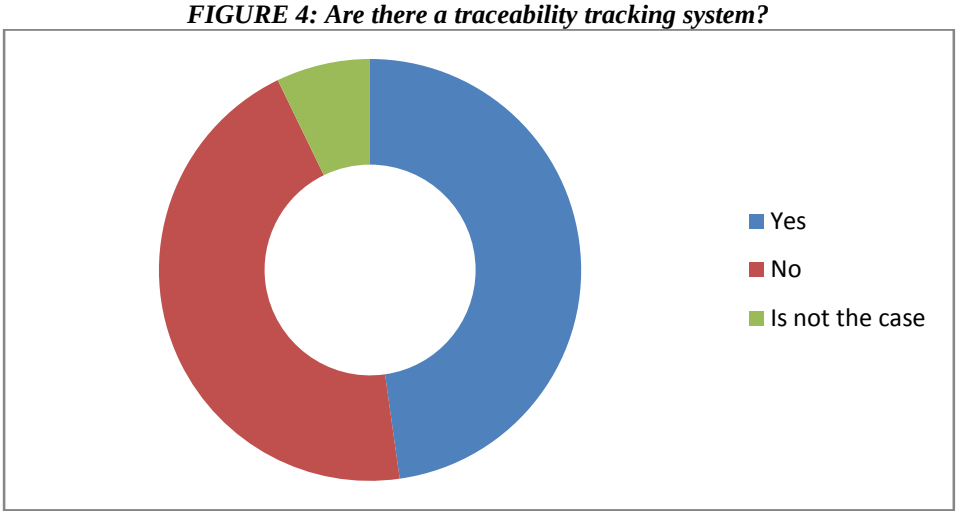


FIGURE 5: Number of employees

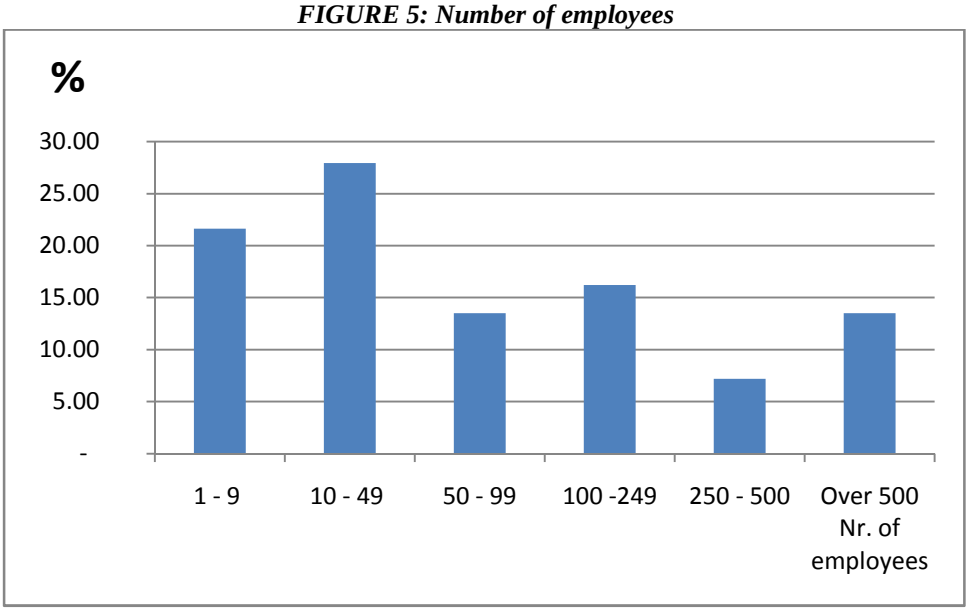


FIGURE 6: Prior knowledge concerning the traceability?

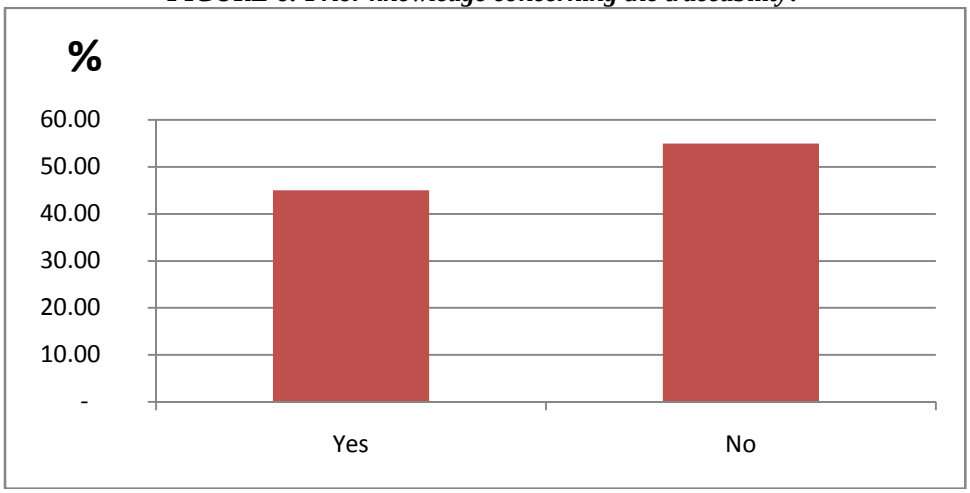


FIGURE 7: Manager's permeability