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Intelligent Items Traceability System – RFID vs QR

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Nowadays traceability systems are an inseparable part of international business and are essential in manufacturing and supply chain management systems. The advantages of the traceability system are more obvious for products that are exported and those imported from overseas. Traceability is highly important in food management and for products with short expiry. In recent years there have been several investigations and publications on traceability systems criteria especially in the food industry in the US, Europe and Southeast Asia. Figure 1 illustrates the general idea of a tracking system.

Based on the International Standard Organisation (ISO), traceability is defined as the "ability to trace the history, application, or location of that which is under consideration". In more detail, traceability is the capability to authenticate the production history, pricing structure, positioning and location, application and all the other information of an object, by means of documented data. In the other words, traceability refers to the ability to track the object through the supply chain management from raw materials supplier to the end user, and also tracking the product after it has been used through the recycling process.

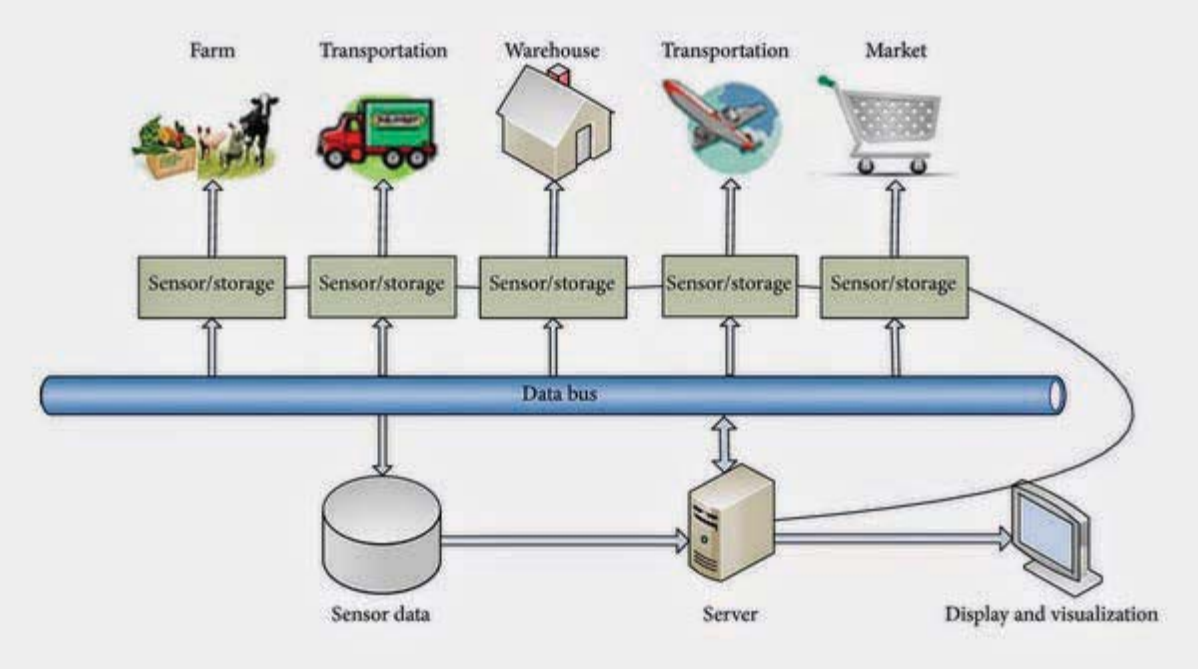


Figure1. General Idea of Tracking System (Source: ISO 22000 Resource Center)

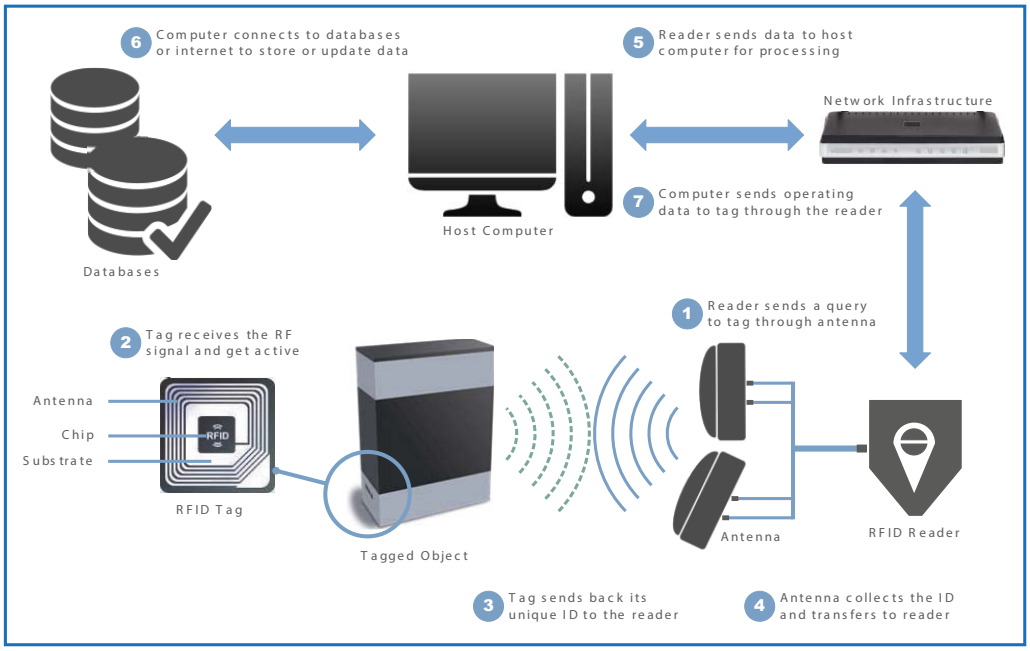


Figure 2: RFID Operation System

To achieve the objectives of the traceability system, we need to provide the product with a unique identification number and some required information. We need also a system to capture the information from the object, identify the object uniquely and manage the whole system. In this article, we investigate the two most popular technologies in traceability systems. Radio Frequency Identification (RFID) and Quick Response (QR) code are separately investigated as identification technologies. Their advantages in the traceability system and a comprehensive comparison between the RFID and QR are provided.

OVERVIEW OF RFID TECHNOLOGY

RFID provides a unique identification for tagged objects by transmitting radio signals. Tags, reader, antenna and the host computer are the four essential components of an RFID system. RFID technology provides a fast, reliable and flexible identification process for all tagged objects. Objects emit their unique ID trough the radio signals by utilizing the tag antenna. Transmitted signals are collecte, interpreted by the reader and transferred to the computer application, where the database or any specific applications that manage all the identification process. RFID technology is widely utilized in different scientific and industrial projects such as: tracking systems, supply chain management, warehouse and inventory management, manufacturing, construction, transportation, toll collections and so on.

How Does an RFID System Work?

In RFID systems the reader initiates the identification process. First the reader broadcasts the query to the tags through the antennas. The tags receive the RF signals; where, the RF signals induct the electric current through the coil antenna inside the tags. Next, a RFID chip utilizes the induced current to send back its unique ID to the reader through the antennas. Reader antenna collects the emitted data and transfer to the reader. The Reader sends all the data to the host computer for processing. Then the host computer connects to several databases or Internet at the same time, and sends the event based data to be stored on the tag. Figure 2 demonstrates the whole operation process of RFID systems.

OVERVIEW OF QR TECHNOLOGY

QR code is also known as a two dimensional barcode. It was developed in 1994 by DENSO Corporation of Japan to provide fast identification and track objects by scanning a tag optically. The general idea of the QR and barcode are the same.

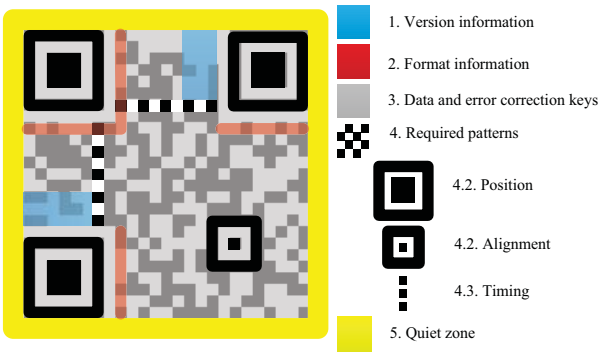


Figure 3: QR System Structure

However, QR enjoys several advantages over the barcode such as: more information storage capacity, information in a smaller space, more flexible design, more security and stronger data checking system.

How Does a QR System Work?

As we can see in Figure 3, a QR code is made up of several squares in black and white. Each square is known as a module. In each QR code, some modules are critical and cannot be covered or changed, otherwise the identification would fail. The critical modules of QR are:-

The modules in **blue** are representing the QR version information. Since there are several different versions of QR structures, this presents the version of the QR.

The **red** sections present the format information. The scanner based on this section will know the QR refers to the text, numbers, website, Chinese symbols or any mixed models.

The all **gray** part involves the whole data and error correction keys, which provide the identification process and specific structure to avoid potential errors.

The **black** and white squares are the required patterns. Where the three big squares in the three corners represent the position of the code and shows where the edges of the code are. The smaller square is alignment marker. Acts as a reference point and guarantee the position of the code for the reader to make sure all the vertical and horizontal lines are in the correct position.

The **yellow** line is the boundary of the code and is the quiet zone.

RFID vs QR

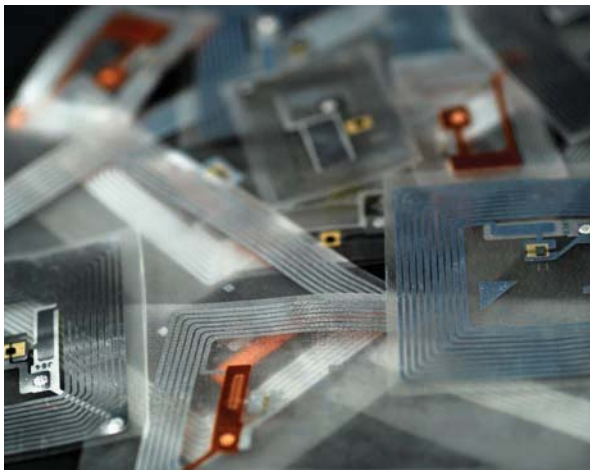
The RFID technology and QR code are compared through their functionality and capabilities. Table 1 presents a comparison of the two technologies.

Attribute	RFID	QR Code
Line of Sight	Not required	Required
Read Range	Passive tags up to 30 feet Active tags up to 100s feet	Several inches up to a foot
Read Rate	1000s tags simultaneously	Only one at a time
Read Speed	Microsecond	Second
Identification	Uniquely identify each item	Limited up to certain value
Read/write	Read and write capability	Read only
Operating Technology	Radio frequency	Optical
Effect of Degradation/ Wear	No effect	Susceptible
Dirt Influence	No effect	Susceptible
Metal Vicinity	Susceptible	No effect
Automation	No human operation (fixed reader)	Need human operation
Updating	Tag information can be updated	Cannot be updated
Tracking	No need for tracking	Manual tracking
Information Capacity	More than QR	Less
Ruggedness	Yes	No
Reliability	Nearly flawless read rate	Wrinkled tags may work 30% data recoverable
Unauthorized Copy	Ciphering	Susceptible
Memory Capacity	Active tags: 16 Bytes – 128 KB Passive tags: few Bytes – 2 KB	Up to 7089 characters
Orientation Dependent	No	No
Marginal Cost	0.05 US$	0.05-1 US$

Table 1. Comprehensive Comparison between RFID and QR (Adapted from Lotlikar et al. 2013)

RECOMMENDATION

Based on the comprehensive comparison between the RFID and QR technologies, and their features and capabilities, we need to consider several issues before implementation in industrial projects. Both technologies have their own advantages and disadvantages. For example, QR codes are easier and cheaper to use, and also do not need specific requirements and installations. Therefore, QR codes are preferable in small businesses; and in the industries with lower priced products or products with short expiry such as food. On the other hand, RFID technology is more flexible, has more memory capacity and fully automatic. But being more costly, it is preferable in industries with long production line and/or distribution chain; or in the industries with valuable products. ■



RFID technology is more flexible, has more memory capacity and fully automatic.

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