

# Increasing the Efficiency of Warehouse Operations Applying the RFID Technology

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**Abstract** – Many companies use sophisticated systems to manage goods in the warehouse, integrated with supply chain systems, enterprise systems and electronic data interchange. The main objective of Radio Frequency Identification (RFID) is to enable automatic identification of products regardless of their origin and purpose, and the free circulation and free movement in all links in the supply chain. The use of this technology for automatic identification of goods in the warehouse and updating status has the positive influence on the parameters of the logistic processes such as: speed performance, the validity of recorded data, the efficiency of the flow of goods, increasing of reliability, operational flexibility, etc.

**Keywords** – Automatic Identification, RFID, Supply Chain, Warehouse.

## I. INTRODUCTION

Supply chain can be defined as a synchronized and isochronous implementation of the transport, handling and storage operations to ensure the flow of goods from the sender to the receiver [1]. A storage operation is an essential link in the supply chain. This paper will demonstrate one of the ways to increase the storage efficiency, and therefore the supply chain performance.

RFID technology is a technology for automatic identification that has a very wide application in management of flows of goods in the warehouses. It represents the Automated Data Collection (ADC) system that enables businesses to wirelessly capture and move data using radio waves [2]. The main objective of application of this technology is to enable automatic identification of products regardless of their origin and purpose, and free circulation and free movement in all links in the supply chain. According to previous researches, cost savings of 8 to 30% out of the total logistics costs can be realized in the supply chain through the use of RFID technology [3].

There are some individual examples of using this

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technology with the aim of increasing the efficiency of storage. HP logistic centre in Memphis has been monitored. Applying RFID technology eliminates the need to work with bar codes [4]. Time for planning logistics processes has been significantly reduced from several minutes to a few seconds, which reduced storage costs. Study of Auto-ID Center [5] showed that the implementation of RFID technology can reduce inventory loss by 10%.

## II. RFID SYSTEM

Radio frequency identification is an automatic, wireless identification technology capable of gathering data without human intervention and line of sight requirement [6].

The basic elements of the RFID system are: antenna, tag, reader and data processing system (Fig. 1) [7]. Communication between the tag and reader in the product is done wirelessly, at exactly the right frequency. Reading speed and data transfer speed are associated with the frequency. As the frequency is higher, the data transfer is faster. A very important factor in planning the RFID system is the amount of data transferred, especially when tag passes quickly through the readings zone. Other important factors in planning the system are the reader power and interference generated by the facilities and equipment around (especially metal).



Fig. 1. RFID system

## III. ASSUMED SYSTEM

Each store has its unique layout, organization and structure. RFID technology meets these challenges with its modular and flexible architecture, on the basis of which it can be adapted to any storage structure [8]. Application of RFID technology in warehouse operations include the following:

1. *Reception* - It is possible to set a stationary RFID reader in a stock to control the entry of goods. Each passage of goods through the entrance activates the reader that reads the goods (Fig. 2). This allows the automatic reading of the products movement and updating the database of the warehouse.

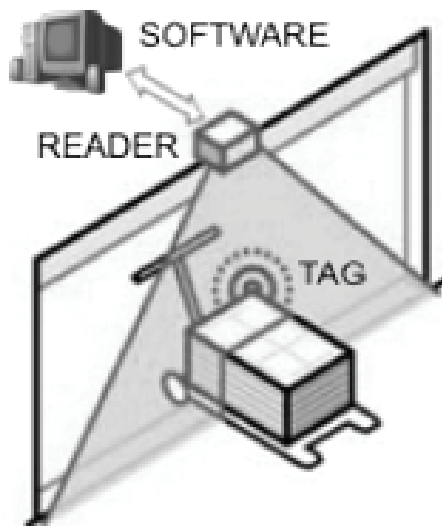


Fig. 2. Reading of goods at the entrance

2. *Disposal* - The correct identification of the stored goods is essential for efficient storage management. If the user has not selected a location for storing, the software selects the best possible location based on the criteria.
3. *Picking* - Takes place according to the orders issued directly from the system or the accounts taken from the system for ordering. Different principles are used: First In - First Out (FIFO), Last In - First Out (LIFO), First Ended - First Out (FEFO), according to shelf life, the quantity and others.
4. *Wave picking* - Efficient determination of the location of collection of goods is caused by a high degree of optimization process based on: the selection of routes, the planning time required for the process of collecting, different types of orders and the realization order priorities.
5. *Packing / dispatch* - The system proposes the most effective form of packaging for any item, calculates the optimal weight and pack size for the selected transmission method. Places for packing / dispatching equipped with RFID readers increase security and speed up the verification of orders. When the loading is finished, the system may exchange information with courier services, transport operators and shipping companies, to make supply chain more efficient (Fig. 3).
6. *Control interface* - Graphical management interface based on the "web" technology makes all relevant information be available in real time. There is a possibility of finding a bottleneck before it becomes a critical problem in the warehouse. All key logistic parameters for measuring logistics performance and parameters defined by users can be tracked and compared with the planned values.
7. *Task & resource management* - Is especially important in combination with a networked computer system. Task & resource management ensure appropriate action to be executed and the adequate resources to be allocated at the right time.

Using RFID technology at the entrance and exit, the process of collecting data on input and output flows in the warehouse is completely automated. All data on the quantity and type of a product as well as the time of entry and exit from the warehouse is automatically read from the tag. Also, any movement of goods within the warehouse is automatically registered and loaded into the system for data processing.

#### A. Advantages

The benefits of using RFID technology in relation to other information technologies in the identification of products in stock are [9]:

- contactless data transmission,
- relatively large distance between the tag and reader,
- high speed and accuracy in data reading,
- storing more information on the tag,
- the possibility of subsequent writing data,
- simultaneously reading of multiple tags and
- fewer errors in identification and data entry.

Packages are read regardless of orientation and without direct visibility between the product and a reader. Tags can be exposed to dirt, heat, humidity and pollution that other technologies (e.g. bar code) make useless.

RFID technology is very fast. Tag can be read and feedback is available in milliseconds [10]. Readers read multiple tags at once, which is much faster and more efficient than other technologies.

One of the great advantages is the reading distance and low energy consumption. Reading distance is affected by many growth factors, such as: type of tag, electromagnetic noise, the orientation of tag, type of antenna and legislation. The current reading distance ranges (for some types of tags) from a few tens of centimeters to several hundred meters.

There are tags with different memory capacity. They are selected according to the desired application and the necessary amount of information that is stored in them.

The participants in the supply chain can use RFID systems for applications of different purposes and carefully planned systems can use the same tags in order to reduce costs of implementation.

RFID technology is designed as a simple replacement of bar codes [11]. However, replacement of bar codes is not going at a satisfactory pace and that process is not simple. There are still few companies that use RFID technology and those are mainly the biggest ones. The main reason for the relatively slow proliferation of RFID technology in modern storage systems is that the bar code technology is in mass use in product identification since the late 60s of the last century. During this time, it is widely implemented in all business information systems, particularly systems for production management, warehousing, distribution, transportation and trade. Therefore, the entire philosophy of storage and other systems designing, which was based on the possibilities and advantages of bar code technology for years, needs to be changed now.

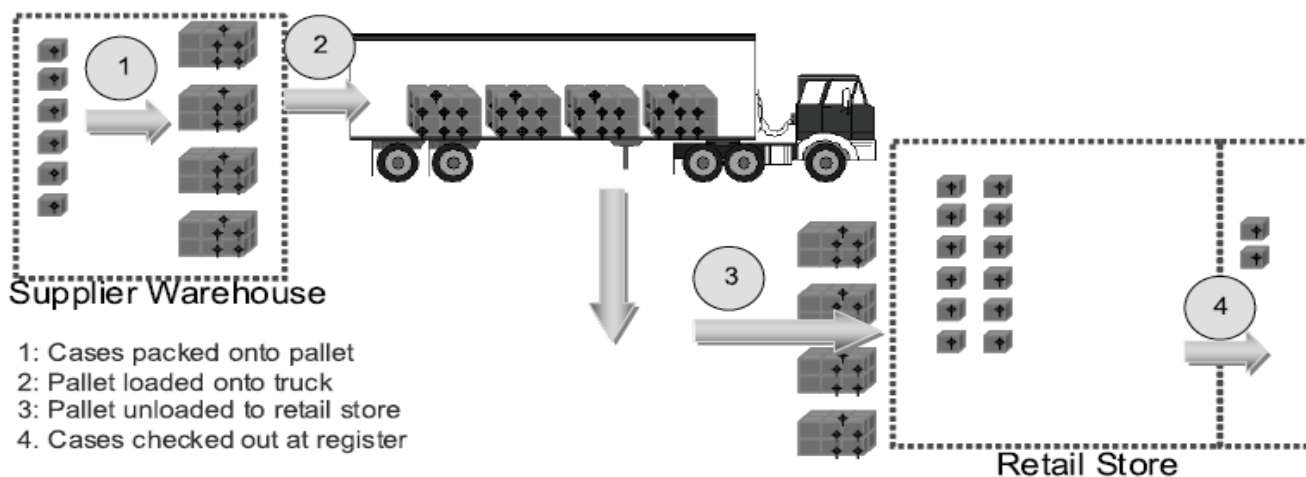


Fig. 3. Application of RFID technology in the warehouse as part of the supply chain [12]

### B. Disadvantages

Currently the biggest disadvantages of RFID technology in relation to other information technologies for automatic identification of products are:

- high price,
- lack of desired tags,
- radio interference,
- undeveloped awareness of users,
- lack of privacy and
- data security.

The cost of tags, the cost of integrating RFID technology into existing storage systems, readers and software maintenance costs, and the costs of employees training make the introduction of this technology a significant investment. Prices of tags that are embedded in products range from a few tens of cents to several hundreds of euros, depending on the type of the tag you wish to use [2]. Also, the cost of supporting infrastructure is still very big.

The principle of reading tags is not based on optics, as with bar codes, but it requires a clean environment in order to make contact and read the tag. Radio signals from the aspect of the environment in which they work and the applied frequency, can be disturbed by generating or absorbing in the obstacles [13].

It is clear that a higher degree of automation and efficiency of storage is achieved applying RFID technology, but there are dangers related to data security [14]. Great possibilities open a number of potential abuses, too, especially if more information is stored in the tags.

In addition to these shortcomings, the expansion of RFID technology is still expected in the automatic identification market in the future. There is an evident increase in its application not only to the storage systems and supply chains, but in other industries as well.

### C. The Expected Effects of the Warehouses Operations

The advantages of using RFID technology in warehouse include: total visibility and complete history of the stock, reducing the amount of inventory in the warehouse, facilitating the delivery of “just in time”, the complete process of products control, reduced preparation and loading time, improved sorting and selecting products, reducing storage space, increased security, reduced number of errors and lower overall operating costs. [15]

Applying technology for the automatic identification and updating the situation in the warehouse, has the positive influence on parameters of processes such as the speed of implementation, the validity of recorded data, the efficiency of cargo flows, increased reliability, operational flexibility, etc.

High reliability of storage of goods, excellent control and tracking system increase the quality of any logistics operations and contribute to the delivery of products from the warehouse without any errors. Time and cost counting on entering the store are reduced, by extracting the data automatically which eliminates the need for manual intervention [16].

Readers, covering storage shelves and other storage places, can automatically record the removal of the unit and update the database. If a unit was placed in the wrong place or is it necessary to complete the order urgently, fixed readers or workers with mobile readers can automatically find the product [17]. Products are ensured against theft by readers which have an alarm or they send a notice if the unit is moved without permission.

In the warehouse operations the following effects are achieved:

- more efficient flow control in the warehouse according to the principle of storage: FIFO, LIFO, FEFO, shelf life and quantity,
- formation of a unified system of coding, marking and identification products,
- business automation,
- processing of orders and dispatch,

- efficient communication between different business partners in all links of the supply chain,
- increased productivity,
- complete products control and monitoring from the entrance to the exit of the warehouse,
- costs reducing,
- saving time,
- improving production,
- increased reliability and
- improving services and meeting customer requirements.

#### IV. CONCLUSION

Application of RFID technology can be imagined in any area of human activity where the results are present. Currently it is the most widely used in transportation and logistics, manufacturing and control. More and more companies integrate RFID technology into the warehouse management system. These systems are equipped with specially designed equipment. It's a big initial investment, but in the long period of time the efficiency of storage is greatly increased and costs are reduced.

Application of the proposed RFID system a high level of automation in the selected points is achieved. Entering and updating information on admission and shipping from the warehouse is fully automated. In all these processes in the warehouse, the level of human interaction is kept to a minimum. This method enables significant acceleration of procedures of collecting and processing data related to the storage process.

RFID technology provides completely new possibilities and benefits. In order to use them properly and to get the expected effects, it is necessary to change the way of the information systems design in logistics-distributive and commercial centers. The above activities require the adequate expertise and available resources.

The next step towards improving the automation of all supply chains would be connecting storage systems for data processing with the other participants systems in the supply chain by a corresponding information system. Such integrated compact system would enable fast and qualitative data and information exchange necessary for achieving a high level of service quality.

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