Development of Information Digital Warehouse Accounting System through the Introduction of Radio-Frequency Identification Technology

Mihail Nikolaevich Dudin, Elena Anatolievna Reznik, Julia Alexandrovna Romanova, Irina Leonidovna Smirnova

Abstract: Taking into account the labor intensity of inventory, a methodology of organizing a permanent automated inventory of material values requires further improvement.The article examines the procedure for products tagging by radio identification tags by manufacturers (packers), logistical and materially liable persons of the enterprise at the time of the receipt of the goods, and reveals the advantages and disadvantages of inventory items identification technology by using radio-frequency identification and barcoding.The article is designed to study the functional capabilities of radio-frequency identification technology for identification of inventory items for the purposes of their automated inventory.The object of the research is the warehouse automation technologies.The subject of the research is the process of automating a warehouse through the implementation of radio-frequency identification technology.Methods. Methods of analysis and synthesis were used for structuring the subject field of the research based on identification and formalization of the automated inventory procedures at the enterprise.Based on the results of the research, it has been suggested to use the technology of tagging and reading the data on radio-frequency identification tags for the organization of perpetual automated inventory. To this end, it is necessary to equip the entire territory of the enterprise with wireless scanners, which are able to identify the location of the inventory item. Premises of the enterprise should be conditionally classified by functionality for warehouse, commercial, industrial, administrative, sales and other zones for inventory tracking.

Index Terms: radio identification tags, radio-frequency identification technology,radio-frequency identification,warehouse automation.

I. INTRODUCTION

Warehouse automation is a mandatory condition for the business growth of the modern commercial enterprise, which fully determines the amount of profit. Automated inventory control information system is one of the most effective solutions in all matters of its optimization, preferred by most Russian companies now. This is a simple and convenient accounting program in the trade industry. It allows keeping separate accounting for several warehouses of the enterprise within one user account.

II. PROPOSED METHODOLOGY

A. General description

In modern warehouses, a huge amount of logistics operations are carried out, thereby providing customers with a certain opportunity to choose logistics services, such as cargo handling, warehousing, packaging, transportation.

B. Algorithm

Aforementioned stages include a set of operations, which can be represented as a diagram (Fig. 1).

Development of information digital warehouse accounting system through the introduction of radio-frequency identification technology
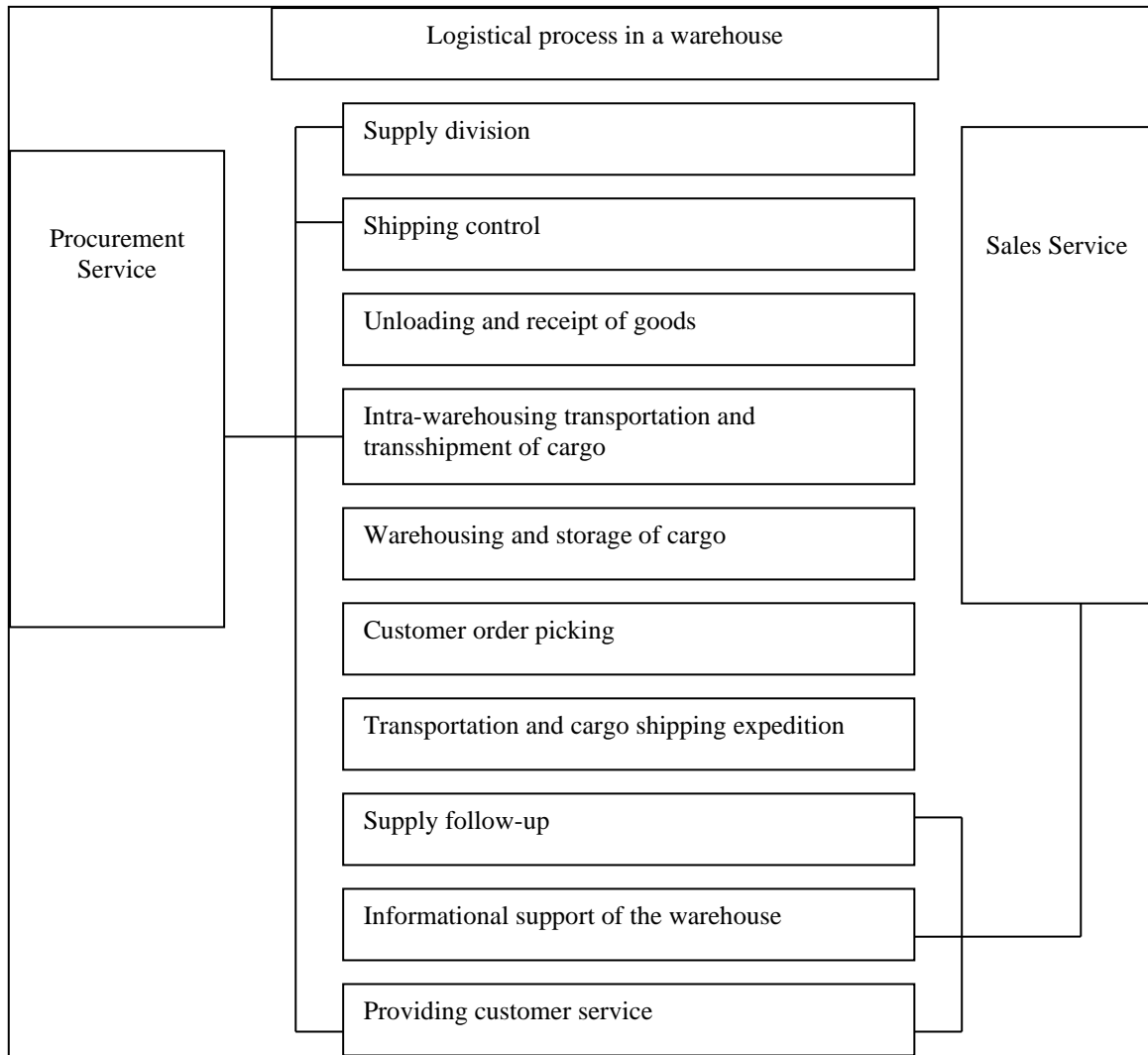

Fig. 1. Logistical process in a warehouse [1, p. 172]

Today, radio-frequency identification (RFID) is a dynamically developing technology due to the wide use of various contactless systems for recording items in commercial and manufacturing processes.

RFID is radio-frequency detection with the help of special tags fixed to the object, that contain identification information and other data, which is used for inventory tracking in manufacturing sector and trade industry, keeping the attendance records (the time worked) and staff movements in the territory of an entity, simulation of optimal transport routes, providing systems security and protection against theft, etc. For the first time, RFID was mentioned in 1946, when Soviet military scientist L. S. Termen invented a device that impressed the audio information on random radio waves.

The next milestone in the development of the RFID technology was implemented by M. Cardullo in his 1969 original business plan for the use of radio-frequency read-on devices for retailers (United States Patent No. 3, 713, 148 dated 1973. Passive transmitter with memory) [2].

However, a large cost of production of engineering components of such accounting system stood in the way to the enhanced use of the RFID technology, unlike barcoding.

Only starting from 2000, with the cheapening of radio identification (RI) technology world trade giants, particularly Wal-Mart, DOD, Target, Tesco, Metro AG, began to study the possibility of using RI-tagging in the realization of the principles of customer self-service and in security systems to prevent theft of material values. In 2002, world trade network Metro AG, which owned 2300 retail establishments in 26 countries, launched the concept of "future store" [2]. In the German city of Rheinberg, a retail establishment, the principle of operation of which was based on fully automated customer service using the RFID technology for identification of goods, was built for partnership with suppliers of hardware and software for retail automation. The founding of Metro "future store" implied a significant increase in the efficiency of trade operations, eradicating queues and improving other aspects of the trade. The aim of founding an experimental retail establishment was not reached [2]. According to the founders, one of the reasons for poor test performance indicators of "future store" was the lack of developed methodology of inventory and accounting of goods.

1678

III. RESULT ANALYSIS

The RFID technology can be classified as a subgroup of technologies for automatic identification and data capture (AIDC). The large-scale commercialization of machine-to-machine (M2M) link recently sparked the fourth industrial revolution, and RFID tags are vital for Siemens Industry 4.0 and General Electric Internet of Things. In the field of intellectual infrastructure, such items as clothing, cash or pharmaceuticals could be identified and tracked in real-time mode using RFID tags. As a result of this supply chains may become more effective. Today, RFID is a dynamically developing technology. Forecast size of the world market for RFID tags from 2016 to 2020 (in billions of US dollars) is presented in Fig. 2.
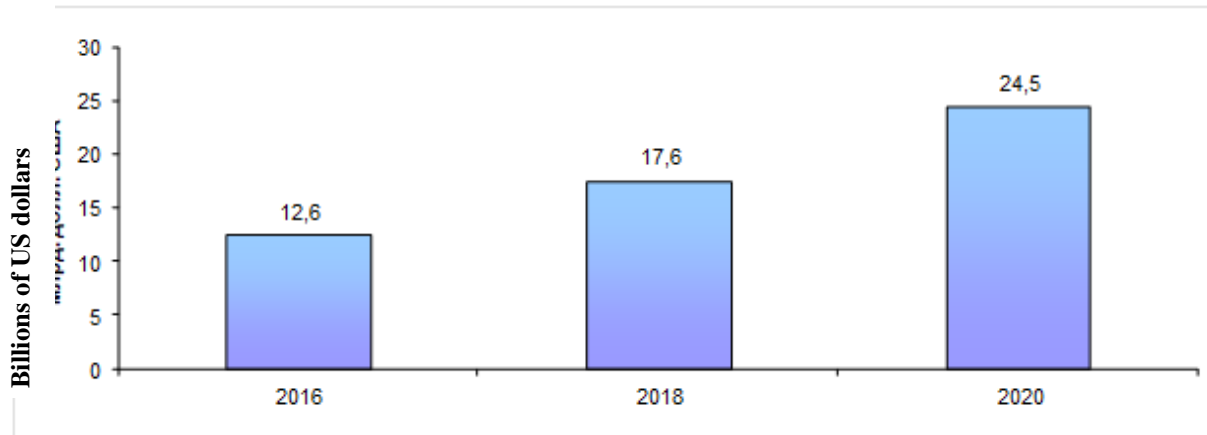

Fig. 2. Forecast size of the world market for RFID tags until 2020 (in billions of US dollars)

However, about 99% of the available RFID tag market remains untapped today due to the high cost and application only in large warehouses. In addition, most enterprises are reluctant to use RFID tags, because their use holds certain risks. RFID tags combined with Integrated Manufacturing Execution System (IMES) may threaten information security of companies and contribute to the evolvement of cybercrime.

Taking into account the labor intensity of inventory, a methodology of organizing a permanent automated inventory of material values requires further improvement.

When using the RFID technology, objects are automatically identified by reading radio signals or data records stored in transponders or RFID tags [3, p. 130].

A basic RFID system consists of three main components:
1) Reader (scanner):
- Antenna;
- Transceiver (two-way radio transmission device);
- Microprocessor;
- Memory block;
2) Transponder (tag) where information is stored:
- Transceiver (two-way radio transmission device);
- Memory;
- Antenna;
3) Data processing computer software.

The main tasks of the use of the RFID technology in warehouses are as follows:
- Organization of effective inventory record;
- Product tracking within the territory of the warehouse;
- Significant reduction of staff errors during order picking;
- Reduction in staff costs and other costs for the maintenance of the warehouse.

The RFID technology has the following advantages:
1. Provides the ability to read in difficult conditions such as dust, frost, etc.;
2. Allows the storage of much more information about the product, in addition, the data can be changed in real-time;

3. Improves storage of goods, which require special conditions of storage (tags can control the humidity and temperature);
4. Impedes theft of warehouse products;
5. Provides an opportunity for remote scanning, as well as a multi-threaded scanning [4, p. 5].

When using the RFID technology goods are marked by special RFID tags, which can then be read remotely (1.5-5 m) by RFID-readers (hand-held or stationary). All information is forwarded to the accounting system and can be checked at any moment [5].

The RFID technology is widely used in foreign countries. Specialists of the International Department of the First BIT suggested using the advanced RFID technology enabling to automate stock recording Keysight Technologies warehouse without an operator while minimizing errors caused by "human element"[6].

Tracking of material values by RFID tags is relevant not only for warehouse distribution centers but also for enterprises of various sectors of the economy. The RFID technology is intensively used in the area of trade (wholesale and retail sale of tangible assets), transport (identification of self-propelled machines, automatic payment system (tolling system), electronic license plate numbers, e-payroll files, driving, monitoring of vehicles), banking (e-check books, e-credit cards), security (personal identification, automatic gate, surveillance) and in medicine (patient identification, medical history) [7].

The use of the RFID technology for warehouses is justified from an economic and practical point of view, especially if it concerns terminals with a large turnover. Purchasing equipment for large companies pays off quite quickly.

1679

Development of information digital warehouse accounting system through the introduction of radio-frequency identification technology

According to a study conducted with the use of Cleverens software, calculating inventory balances using RFID runs 40 times faster as compared to barcodes and 100-200 times faster than doing it manually. People and equipment are used muchless and the efficiency of data increases many times [4, p.6].

Identification by RFID tags makes significant changes to the process of inventory tracking. Compared to the barcode identification, there are substantial differences that can be used for efficient automated inventory (Table I).

Table I. Advantages and disadvantages of inventory items identification technologies: radio-frequency identification and barcoding

Subitem No.	Characteristic features of technologies ("+" – advantage, "-" – disadvantage)	RFID	Barcoding
1	Direct visibility for the scanner of the tag placed on the inventory item	No +	Yes -
2	Inventory tracking in space and time	Yes +	No -
3	Identification of a significant amount of inventory items at the same time	Yes +	No -
4	Detection of each inventory item separately (and not just the butches, articles)	Yes +	No -
5	The use of a significant number of different devices for identification	No +	Yes -
6	Involvement of enterprise personnel in the identification of inventory items	No +	Yes -
7	Application to enter raw data into the database	Yes +	Yes +
8	A significant amount of tag memory, into which one can add various characteristics of the inventory item	Yes +	No -
9	Significant useful life of ID tag	Yes +	No -
10	Multiple uses of ID tags	Yes +	No -
11	Impact of environmental conditions on tags	No +	Yes -
12	Possibility of fraud and manipulation with the ID tags by personnel of the enterprise	No +	Yes -
13	Use in the system of protection and control of unauthorized carry inventory items outside the enterprise	Yes +	No -
14	Production of the enterprise's own ID tags	No -	Yes +
15	Insignificant cost of implementing and maintaining the technology	No -	Yes +

Source: developed by the authors

All premises of the enterprise, in which inventory items are stored or moved, are recommended to be equipped with wireless scanners. To read RFID tags, unlike barcodes, there is no need in the arrangement of direct visibility between the source of information and the receiver. At the moment of entering of the marked product in the radio field, it is identified with the relevant recording in the accounting system. Tagging of material values can be done in two ways. First of all, it is advisable for manufacturers of products to apply RFID tags at the time of product packaging. At a production company, it is necessary to assign and record a unique product identifier code, its name, article number, date of manufacture and other information on the RFID tag.

Information on the transfer of goods with RFID tags is the basis for recording in the financial accounts of the inventory items disposal operations from the manufacturer (seller) and their receipt by the buyer.Based on marked inventory item tracking within the territory of the enterprise, one can automate warehouse accounting. The entire territory of the enterprise must be conditionally classified into various zones by functionality: warehouse, commercial, industrial, administrative, sales and other premises.

Identification of the fact that a product crosses the boundaries of certain premises is the basis for the automatic generation of accounting entries. Inventory items are written off from the financial accounts with simultaneous recording as part of the production, administrative, sales or other operating expenses. Inventory items transferred to retail premises can be automatically identified as products in trade. Wireless inventory items identification technology provides information on the exact place of their location. All information about the availability of inventory items per minute enters the automated accounting system. Constant control over the storage of goods that can be put in the base of the permanent automated inventory is ensured.

Constant comparison of the credentials with the actual data is performed automatically. In case of any deviations detected inventory shortage write-off and capitalization of overages records of transactions are formed. At the same time, it is advisable to send signaling messages to responsible persons, with a view to identifying the causes and perpetrators of the deviations.

With the rapid development of the RFID technology, security system provided by various manufacturers of electronic RFID tags, is also becoming more sophisticated. First of all, the serial number of each tag is unique; it is formed in the production process and cannot be changed. In the field of communications security, to verify the legitimacy of electronic tags and readers of RFID tags, they apply three mutual verification technologies, conforming to international standard ISO 9798; DSA algorithms are used for data encryption in the transmission of data to ensure that data is not blocked [8].

The following ways are recommended to improve the sustainability of RFID systems to the aforementioned threats: minimization of sensitive data on the tag; password protection of radiofrequency tags; data encryption [5]; sign data; physical protection of RFID systems.

IV. CONCLUSION

Using computer and communications technologies, it is possible to optimize the labor intensity effectiveness of the inventory through automation of control procedures. An effective method of automated inventory is the identification of commodities and materials using barcodes. The main disadvantages of barcoding inventory are the inability to identify each item and the need for a clear line of sight between the scanner and the bar codes. The imperfection of the traditional material values identification technology can be solved through the use of the RFID technology – wireless scanning of RFID tags.

RFID tags are more durable than barcodes and cannot be blurred if they get wet. They can help track a product from the stage of its production to its sale and are especially useful in a warehouse.

Currently, RFID is used mainly for the control over fraud and theft of inventory items. Tagging technology and reading of information using RFID tags can be used to organize perpetual automated inventory. There is a need to equip the entire territory of the enterprise with wireless scanners, which are able to identify the location of the inventory item. Premises of the enterprise should be conditionally classified by functionality for warehouse, commercial, industrial, administrative, sales and other zones for inventory tracking.

The process of tagging should be performed by manufacturers (packers) of products or materially responsible persons of the enterprise at the time of the arrival of goods. Automatic identification of material values may occur every minute, which is the basis for the organization of perpetual automated inventory of items, to which one can fix RFID tags.

The implementation of the RFID system is inextricably linked to the risks and threats to information security. To reduce the risk of unauthorized access to the data one is forced to follow recommendations for enhancing the protection of information of the radio-frequency system as a whole, including minimizing confidential data on the tag, RFID tag password protection, data encryption, data signing, physical protection of RFID systems.

REFERENCES

1. A.V. Khramov, and R.A. Danilov,"Logistics process in a warehouse and the basics of its modeling".*Bulletin of young scientists of the Samara State University of Economics*, *vol. 1*, 2017,pp. 172-174.
2. "The World's Leading Source of RFID News and Information – RFID Journal". Available:http://www.rfidjournal.com
3. E.V. Beletsky,"The use of innovative technologies as a basis for the effective functioning of the warehouse". *Innovation science, vol. 1*(3), 2017, pp. 129-132.
4. N.S. Kisteneneeva, and Yu.V. Gorshkova,"Automation of a warehouse through the introduction of radio-frequency identification technology".*Scientific Forum: Economics and Management. Collected papers on materials of the VIII International Virtual Research and Practice Conference*. Moscow, 2017,pp. 5-9.
5. "RFID system for automation of warehouse processes".Available:http://www.itproject.ru/otraslevye_resheniya/sklady_logistichiskie_centry/rfid_warehouse
6. "Warehouse automation with The RFID technology".Available:http://en.1solution.ru/o-kompanii/nashi-klienty/proekty/warehouse-automation-with-The RFID technology.html
7. "Once again about automation of the inventory". Available: https://habrahabr.ru/post/151306
8. "RFID Automated Warehouse Management System Solution".Available: https://www.hopelandrfid.com/blog/rfid-otomatik-depo-y-netim-sistemi-z-m_b110