Warehouse logistics information system using RFID tags as an effective way of automating business processes

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Abstract. This article presents an information system project based on warehouse logistics using RFID tags. RFID tags are the last word in automating business processes related to the identification of various items. Now this technology is becoming attractive and relevant. The main goals of creating an information system are as follows: reducing the time spent on searching for goods, through the use of modern technology of RFID tags; increase search quality, due to non-contact remote detection and recognition of goods; improving the efficiency of the organization, due to the formation of reporting and statistical information.

1 Introduction

The information system being designed is designed to automate warehouse activities through the introduction of RFID tags. The main activity of the warehouse is warehousing, storage, inventory management, as well as their placement on shelves and removal from them.
The object of automation is the warehouse of a large trading company, and in particular the processes:

- collection and storage of information about the location of goods in the warehouse;
- tracking and accumulation of statistics on the supply, placement and removal of goods located on "smart shelves";
- providing tools for analyzing product data;
- providing a quick opportunity to detect goods in the warehouse using RFID tags;
- maintaining statistics, in the course of this process, information on goods is provided to warehouse employees;
- creating reports, in the course of this process, data is selected for the report, the report is generated and printed;

RFID-system (Radio Frequency IDentification, radio frequency identification) is a technology for automatic non-contact remote detection, recognition and operational tracking

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of stationary and moving spatially distributed objects [1-3]. Details about the application and the technology itself are described below.

A label is a thin label with an antenna and a chip applied to it, with the possibility of contactless reading and writing information, and the label can be hidden inside the product or package. It is impossible to fake a label [4-6].

Depending on the location of the power source, passive and active RFID tags are distinguished.

Passive tags are called tags that are not equipped with their own power source. They receive the charge of energy necessary for information processing from the electromagnetic signal emanating from the scanning device. Therefore, the reading range of passive RFID tags is determined solely by the parameters of the reader. Their advantages include relatively low cost and a long operating period.

Active RFID tags contain a power source in their own design. Their reading distance does not depend on the energy parameters of the scanning device. Thus, the scanning range of active tags is approximately 2-3 times greater than that of passive tags. Another important advantage is the high permissible speed with which the RFID tag moves next to the reader. This is especially true for anti-theft systems. However, active tags are much more expensive and larger than passive tags [7-9].

To solve the task, you must do the following:

- conduct a pre-project analysis of the warehouse;
- develop the structure of the information system;
- describe the procedures that take place during the operation of the warehouse using RFID tags;
- develop information system models.

2 Functional and organizational structure of the warehouse

The organizational structure of the warehouse is a management apparatus, in which each department reports to its manager (head of the sector), each manager, in turn, reports directly to the director. The organizational structure of this enterprise includes the following structural units:

- director: the head of the enterprise, whose duties include control and planning of actions in the warehouse;
- head of the personnel department: this is the head of the department, whose duties include managing the recruitment of the enterprise with new personnel;
- chief accountant: this is an official who heads the accounting service of the organization when it is established as a structural unit of the organization;
- Head of IT Department: This is the official who heads the IT department of an organization when it is established as a structural unit of the organization;
- head of the analytics department: this is the official who heads the analytical service of the organization when it is established as a structural unit of the organization;
- head of the warehousing department: this is an official who heads the warehousing department of the organization when it is established as a structural unit of the organization;
- personnel department: the department dealing with the reception of employees;
- financial department: department dealing with the financial activities of the company;
- IT department: a department that maintains the IT infrastructure and information system of the enterprise;

- analytics department: a department that analyzes the course of the enterprise, operational planning and management.
- warehousing department that optimizes the storage of goods using RFID tags.
- The functional structure of the enterprise includes a set of functions implemented within the subject area. The functional structure of the warehouse includes the following functions:
- acceptance of goods: this procedure is the process of transferring goods by the carrier directly to the warehouse;
- collection and storage of information about goods: this procedure is a set of measures for searching, collecting, checking, storing data about a product;
- collection and storage of information about RFID tags and places in the warehouse: this procedure is the process of collecting and storing information about the rows, racks and places of the warehouse that have their own RFID tag, the so-called "smart shelves";
- assigning an RFID tag and a place in a warehouse to a product: this procedure is the process of placing a product on a certain place (“smart shelf”) with assigning its RFID tag for further accounting;
- search for goods: this procedure is the process of trying to find the desired product;
- reading an RFID tag: this procedure is the process of reading a tag entered into the database in order to find a particular product on it;
- search for data by label: this procedure is a search for a subset of goods in the warehouse in accordance with a given label;
- determining the location in the warehouse: this procedure is the process of presenting data on the location of the goods in a form that provides the most optimal path to the goods;
- reporting: this procedure is the process of creating a document containing information about the analysis and search for goods by RFID tag;
- selecting data for a report: this procedure is the process of selecting data for creating a report.

3 Description of business processes

IDEF0 diagrams are used to describe business processes. A model in IDEF0 is represented by a set of hierarchically ordered and logically related diagrams. Each diagram is located on a separate sheet and consists of flows and works, flows are certain objects that interact with the system in a certain way, works are operations on these flows, during which input flows are converted into output flows under the action of mechanisms, taking into account the recommendations of control flows. flows. The following diagrams can be distinguished:

- context diagram A0 (each model can have only one context diagram);
- decomposition diagrams (including the diagram of the first level of decomposition A0, which reveals the context diagram). The context diagram of the RFID-based warehouse logistics business process describes its general functional structure. This context diagram is shown in Figure 1.
- This diagram uses the following data flows:
- arrival of goods at the warehouse: this input stream represents the goods received at the warehouse of the enterprise;

- algorithms for assigning an RFID tag to a place in a warehouse: this control flow is a method for assigning a tag containing information about a row, a rack, a floor of a rack, and a specific place;
- enterprise personnel: this mechanism represents the employees of the enterprise;
- product with an RFID tag: this output stream is a product assigned to a specific location and fully controlled by the system;
- data after analysis: this output stream represents the aggregated and filtered data obtained during the analysis of the product;
- report: this output stream is a generated report.

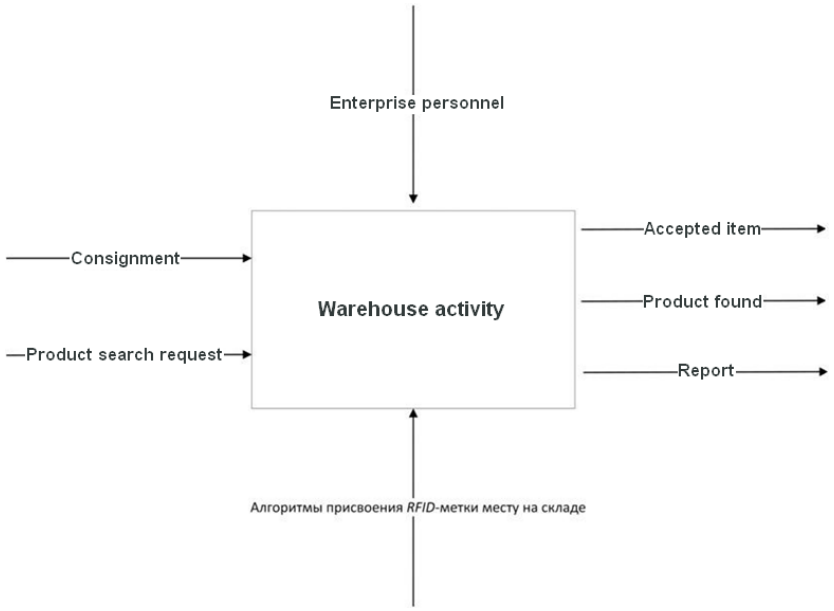

Fig. 1. Context diagram of the activity "Warehouse activity based on RFID tags".

After describing the system as a whole, it is divided into large fragments. This process is called functional decomposition, and the diagrams that describe each fragment and the interaction of fragments are called decomposition diagrams. After decomposition of the context diagram, each block of the diagram is decomposed into smaller fragments, and so on, until the desired level of description detail is reached. This ensures that the model matches real business processes at any and every level of the model.

During the decomposition of the context diagram, according to [10], the main functions and work performed by the warehouse should be obtained. The decomposition of the main business function is shown in Figure 2.

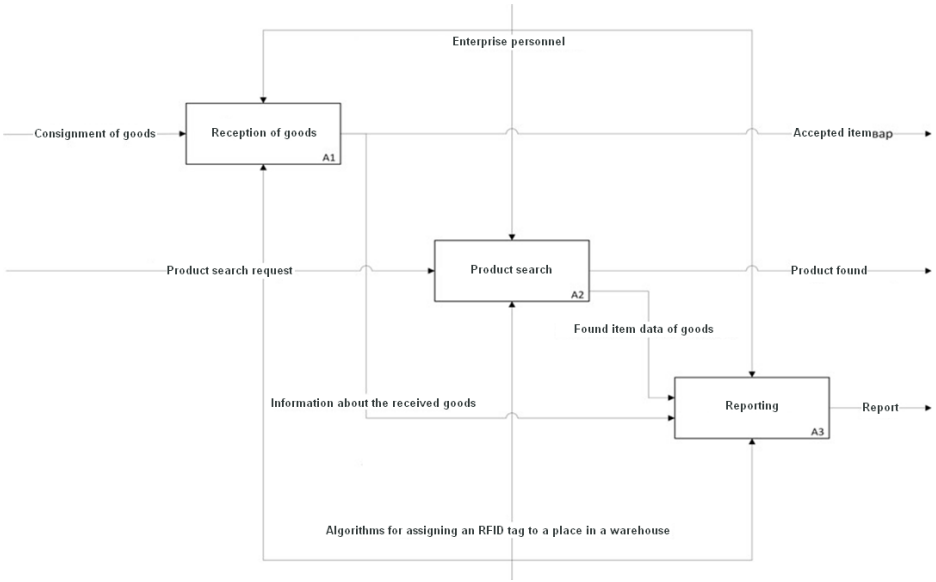

Fig. 2. Decomposition diagram of the main business function.

4 Software implementation of the warehouse logistics information system based on RFID tags

To implement an information system for warehouse logistics based on RFID tags, the NodeJS platform based on the JavaScript programming language was used.

Express.js, or simply Express, is a web application framework for Node.js implemented as free and open source software under the MIT license. It is designed for building web applications and APIs. It is the de facto standard framework for Node.js. The author of the framework, TJ Holowaychuk, describes it as being based on the Sinatra framework written in Ruby, implying that it is minimalistic and includes a large number of plug-ins. Express can be the backend for the MEAN software stack, along with a MongoDB database and a Vue.js, React, or AngularJS framework for the frontend.

When designing the system, the following hardware components were used:

- client employee warehouse: automated working place of the warehouse employee;
- accountant's client: accountant workstation;
- local network: local area network built on Ethernet technology;
- Chrome: web browser;
- DeductorSrudio: analytical platform for data processing;
- Node.js: used as a web server;
- MySQL: free relational database management system;
- *linux*: The operating system used on the server.

Based on the data obtained, a diagram of the information system deployment was constructed. The deployment diagram (Figure 3) is a diagram that describes the hardware and software configuration of the system being developed.

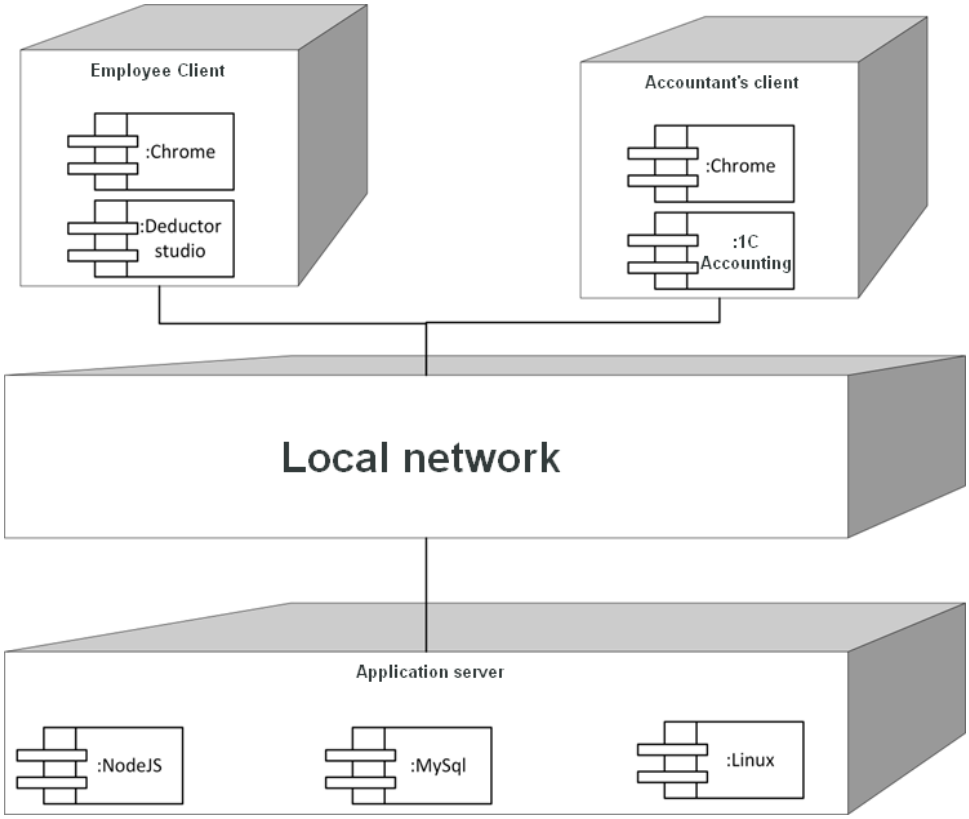

Fig. 3. Information system deployment diagram.

5 Conclusion

As a result of the research work, the following results were obtained:

- carried out a pre-project analysis of the warehouse activity based on RFID tags;
- the structure of the information system was developed;
- describes the procedures that occur during the operation of the warehouse based on RFID tags;
- information system models are developed and described;
- a warehouse information system based on an RFID tag has been developed.

The implementation of the information system project will reduce the likelihood of loss of profits by controlling goods and analyzing their demand by sector leaders, increasing the efficiency of goods analysis, and increasing the overall efficiency of staff work. In the future, this product can be upgraded by introducing more advanced means of transporting goods using RFID tags, as well as creating an improved report designer.

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