

DEVELOPMENT OF INFORMATION SYSTEM OF STORAGE ACCOUNTING RADIO ELECTRONIC COMPONENTS

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Abstract:

In warehouse facilities, material flows are converted from dynamic to static and Vice versa. In addition, the storage and processing material flows are included with some parameters, and go with others. The parameters should be understood as the intensity, power, rhythm, structure of material flows, as well as the type and method of packaging products, arrival and departure time of transport batches, etc. The General concept of the warehouse system solution in the first place should be economical. Economic success is ensured if the planning and implementation of the warehouse system are considered from the point of view of the interests of the whole company, being only part of the overall concept of the warehouse. And the profitability of the warehouse will be, in the end, the main criterion for the chosen General concept. The aim of this paper is to develop an information system of warehouse accounting of electronic components.

Keywords:

Storage, information system, electronic components.

ACM Computing Classification System:

Enterprise computing, operations research, planning and scheduling, software system structures.

■ Introduction

Currently, no production, trading company, service enterprise can not be imagined without a warehouse. A warehouse is one of the "strategic objects" of any enterprise. On how much actual and reliable information is about the quantity and quality of products, raw materials stored in the warehouse of the enterprise, directly depends on production planning. Proper production planning is the key to the success of any enterprise, one of the methods to reduce the costs of an enterprise.

A modern warehouse is not only a storage room, shelves and staff, but also specialized software. The task of this software is the continuous collection of data on the presence and movement of material values, the fastest possible provision of the collected data for analysis [1].

On the market of modern automated warehouse accounting systems, companies such as Oracle, EME, 1C-ASTOR, Business Systems Engineering, BUKhta, KOMPAS, SOFT RETAIL, AXELOT and other well-known developers represent their software.

Given the significant cost of such systems, many companies decide to develop their own automated warehouse accounting system.

All warehouse accounting programs, without exception, use certain databases in their work. This is a convenient way of structured storage of information and access to it.

The functionality of most modern warehouse accounting systems is already close to the capabilities of modern ERP-systems. However, there are cases when these systems are redundant and their use in certain areas of production is inappropriate because of the significant costs of acquiring a ready-made solution and refining it for the needs of the enterprise [1].

The purpose of this work is the development of an information system for inventory accounting of electronic components. To achieve this goal it is necessary to solve the following main tasks:

1. Review of the market leaders in modern warehouse accounting systems, comparison of the cost of their acquisition, refinement and operation.
2. The choice of architecture of the developed system.
3. The choice of storage system and data management system.
4. Software implementation of data entry and processing by users of the system.

■ 1 The Concept of the Warehouse Management System

Warehouse management system - a management system that provides automation and optimization of warehouse processes. The architecture of an automated information warehouse management system is built, as a rule, on a three-level principle:

- the client application, through which the user enters, modifies and deletes data, gives requests for operations and queries for selecting data,
- database server that stores data,
- business logic - a module that performs user-initiated data processing and returns the processed data to the database, informing the user via the client application screen about the completion of the requested operation.

The main objectives of the implementation of automated warehouse management systems are:

- warehouse management,
- increase the speed of processing orders,
- obtaining accurate information about the location of the goods in the warehouse,
- effective management of goods with a limited shelf life,
- optimization of the use of storage space.

For efficient use of storage space and for automation, the warehouse area is divided into zones according to the types of operations for receiving, placing, storing, processing and shipping goods. This allows you to optimize the work of staff in different areas and effectively distribute areas of responsibility [3].

At the stage of introducing an automated warehouse accounting system, the system records the physical characteristics of the warehouse, loading equipment, the parameters of all the equipment used and the rules for working with it [4].

In modern warehouses, all incoming goods are marked with bar codes. The technological warehouse operations under the control of the system are carried out on the basis of the data of bar codes, the location of the place where the goods are stored and the location of the loading equipment. Loading equipment and warehouse workers are equipped with a data collection terminal, which is a portable computer with special software installed. The data collection terminal constantly sends and receives information from the server system.

During the inventory, specialists use data collection terminals to read barcodes that are automatically entered into the instrument databases.

The automated warehouse accounting information system takes into account all the requirements for storage conditions when distributing storage locations for goods entering the warehouse. For example, humidity, temperature, product shelf life, manufacturer, sales date, supplier, compatibility rules, and any other parameters may be considered. The automated system automatically selects storage locations for received cargo and generates tasks for warehouse workers. Tasks come to the terminal screen in the form of elementary step-by-step teams individually for each employee.

When forming teams, the system develops optimal routes for moving vehicles around the warehouse, which reduces the total idle mileage of the loaders. The system assigns the loading equipment to the operations, the use of which most fully meets the set task and it is closer, free or free in the near future. The execution of tasks is confirmed by scanning a bar code. Thus, the system controls all actions of the employee and makes it possible to almost completely eliminate the possibility of erroneous placement of cargo or incorrect picking of the order. When reading a bar code, the system instantly updates all information about the location of goods, the availability of goods in stock, the actions of employees and the operations performed. For convenience, as a rule, it is possible to monitor the warehouse in the two-dimensional graphical display mode [5].

Tasks that are solved by modern automated warehouse accounting systems:

- acceptance of goods and materials,
- warehousing - automatic or under the control of staff,
- maximize storage space utilization and/or performance of warehouse operations,
- comprehensive criteria for the construction of storage cells,
- custom creation of warehousing tasks,
- preparation of bulk goods from various suppliers for storage,
- automation of one-time acceptance and shipment of goods,
- overload of the received goods to be sent to customers,
- transit shipment of products through the warehouse,
- comprehensive grouping of orders,
- processing and issuing orders by groups with optimization of processes and resources,
- consolidation and separation of lots of goods,
- customizable parameters need replenishment,
- automatic generation and sending of replenishment tasks,
- customized replenishment strategies,
- automatic generation and sending of tasks to employees for order picking,
- a complete set directly in the pallet taking into account requirements of ergonomics and also the sizes, weight and other parameters of goods,
- complete set on a conveyor belt,
- completion in lots of goods,
- packaging,
- personalization of orders during assembly,
- generation of identification numbers of shipped containers and their tracking, scheduling shipment of goods, taking into account priorities,
- ordering and combining goods during loading, depending on the sequence of delivery,
- check and close the send operation,
- creation of accompanying documents,
- container tracking,

- flexibility in moving and adjusting stocks,
- intermediate partial inventory,
- complete physical inventory with weight fix on entry and exit,
- monitoring the status and obtaining information on warehouse stocks in real time,
- localization of stocks and configuration of areas and warehouse zoning,
- record dates and track the timing of the sale of goods,
- scheduling tasks with their rearrangement in accordance with the priorities,
- dispatching and alternating tasks,
- bookmark in the container several different products,
- identification of goods by packaging for shipment and return,
- definition of restrictions on joint storage of goods,
- inspection of warehouse equipment and refueling planning.

Despite the huge functionality for automating warehouse processes, no warehouse can be done without people. Warehouse workers are the key to the effective functioning of the enterprise.

There are several classes of automated information systems for warehouse accounting:

- entry level systems, designed for warehouses of small companies, shops with a small nomenclature,
- boxed warehouse management systems, where the target consumer is a warehouse with an area of 1000 - 10 000 m² with a large range, but a low turnover,
- adaptable systems, they are implemented by large logistics companies, distribution centers, warehouses over 5000 m²,
- configurable systems which are designed for warehouses over 5000 m² with a large range and high turnover.

2 Designing the System of Storage Accounting of Radio Electronic Components

2.1 Formation of Requirements for the Developed System

Let's consider a model problem. At the time of collecting and analyzing data on the processes of warehouse accounting and control of the movement of material resources, the information flows of the company related to the work of warehouses have the following scheme (Fig.1). This diagram shows the interaction of the warehouses with each other and the controlling authority - the accounting department.

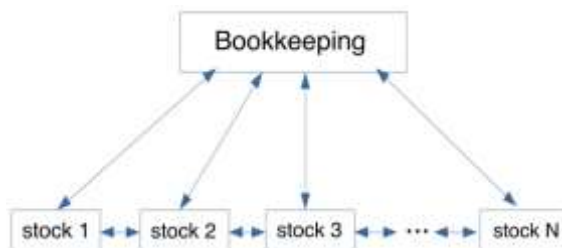


Fig.1. Diagram of information flows of the warehouse before the introduction of IP.

The total number of links in the presented scheme is $(N^2 - N) / 2$, where N is the number of nodes in the scheme. Due to the low computerization of the enterprise and the lack of an electronic document management system, the exchange of data between elements of the scheme runs as a transfer of paper invoices, requirements and acts of inventory. In a modern market economy, this scheme of work is unacceptable and requires optimization.

The following requirements were formed for the developed information system:

1. The information system should increase the speed of interaction of the warehouse with counterparties. Counterparties are storerooms of assembly shops and assembly lines.
2. Due to the implementation of the information system, the time for obtaining information on the quantity and availability of electronic components of one or another counterparty should be reduced.
3. In the information system should be implemented a system of double accounting between counterparties.
4. The information system must be implemented using transactions.
5. It is necessary to provide for the possibility of supporting and updating the software with the involvement of third-party developers. The code should be as readable as possible.
6. Minimum software requirements for the hardware resources of the operator's workstation.
7. Software should not be tied to any platform. Requires the ability to run and work in operating system environments other than Microsoft OS.

On the basis of the requirements for the developed information system, a general scheme of information flows of the developed information system is drawn up (Fig.2).

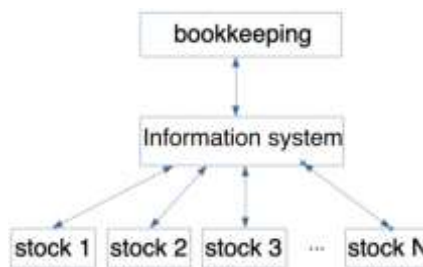


Fig.2. Scheme of information flow after the introduction of IP

By adding information flows to the scheme, an additional link, the Information System, eliminates the exchange of information directly between warehouses. In addition, the load on the accounting element is reduced by reducing the number of links from N , equal to the number of warehouses, to 1. The total number of links in the information system will be N , where N is the total number of nodes. By reducing the number of information flows from $(N^2 - N) / 2$ to N , paragraph 1 of the requirements for the developed information system is achieved.

Additionally, due to a single point of collection and storage of information, paragraph 2 of the requirements is fulfilled - reducing the time to access information.

2.2 Selection of the Architecture of the Developed System

During the analysis of the enterprise's information infrastructure, the study of the computer park and the structured cable network (SCS) of the enterprise, the following were revealed:

1. Outdated computer hardware and software.
2. Multiple user violations of computer security rules. As a result, infection with various computer viruses in the park of user workstations is more than 80%.
3. Low qualification and computer literacy of users. The average age of future users of the information system is 49 years.
4. Due to the work of the enterprise with government orders of the Ministry of Defense of the Russian Federation, access to the Internet is strictly limited. The bandwidth of the external channel is 5 megabits/s. No reservations.
5. The SCS is in a satisfactory condition but does not have sufficient reliability to ensure uninterrupted access to the network elements.
6. The management of the company requires maximum results with minimal investment and in a short time.

Based on the above, it was concluded that it is impossible to use web-based information systems. It was decided to develop a classic desktop client-server architecture application using a two-tier scheme. The implementation of the three-tier information system will require additional time and financial costs for the implementation of the application server API. Let a client be an application running on the workstations of operators. A server is a relational database management system (RDBMS). The business logic of the information system is implemented in the client application. The server serves as a data warehouse.

2.3 Development of the User Interface of the Application

Main requirements for the user interface should be divided in two main topics.

1. The user interface of the developed information system should provide quick access to the functions used.
2. The interface should not be overloaded with elements, as this will slow down the user experience with the application.

In accordance with the requirements above, a multi-window graphic interface was developed based on the Swing graphic elements library.

Swing is a library for creating a graphical interface for Java programs. Swing was developed by Sun Microsystems. It contains a number of graphic components (English Swing widgets), such as buttons, input fields, tables, etc. Swing refers to the JFC class library, which is a set of libraries for developing graphical skins. Related to these libraries there are Java 2D, Accessibility-API, Drag & Drop-API и AWT [6].

When the application is launched, the main application window is created (Fig.3). Using the application involves working with material values, which is why the application has a login and password authentication mechanism that is issued to the system user by the administrator. Until the user passes the authorization, the work with the program will be blocked.

After launching the application, the existence of the file for setting up the connection to the database server is checked [7].

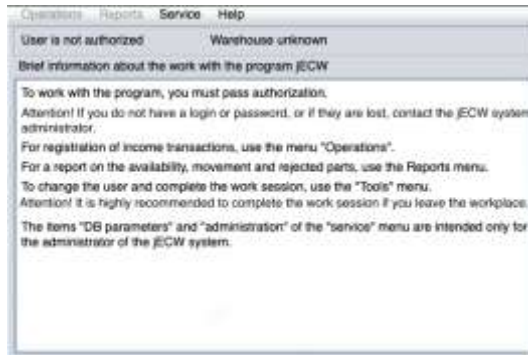


Fig.3. The main application window.

The connection configuration file must be located in the application launch directory. If a configuration file is found, the program will prompt the user to log in (Fig.4).

The screenshot shows a form with five input fields: 'Host' (value: osadmin.ru), 'Port' (value: 15432), 'DB name' (value: warehousebase), 'DB user' (value: wbuser), and 'DB password' (value: masked with asterisks). A 'Save' button is located at the bottom right of the form.

Fig.4. Authorization form.

If the configuration file is not found, the program will offer to configure a new connection to the database server (Fig.5).

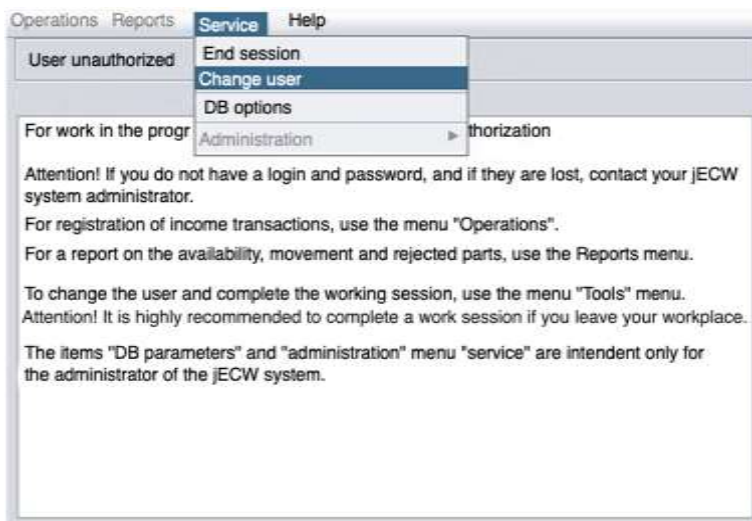


Fig.5. Form for setting up connection to the database server.

In the form fields, you must enter the appropriate information - the server address (the address is supported in the form of a domain name), the connection port, the name of the database being used, and the username and password of the database server. Clicking on the "Save" button will write a new file with connection parameters to the database server.

If the authorization window was closed by the user, select the Tools - Change user menu item (Fig.6). The authorization window (Fig.5) will become available again.

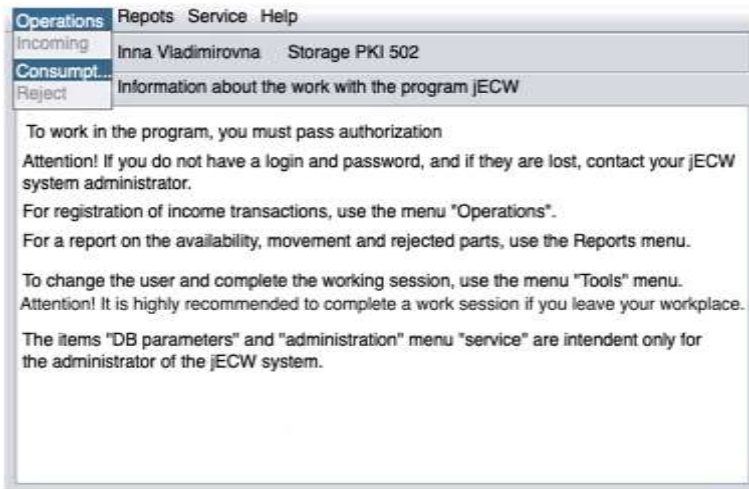


Fig.6. Call the authorization window.

After successful authorization, the program checks the role of the registered user. In the case of authorization of a user who is not a part of the administrator group, the program locks menu items related to entering new instances of the “details” into the system and taking out defective instances from circulation (Fig.7). Additionally, the program administration menu is blocked (Fig.6). If a user is a member of the Administrators group, all program menu items become available to him (Fig.8, Fig.9).

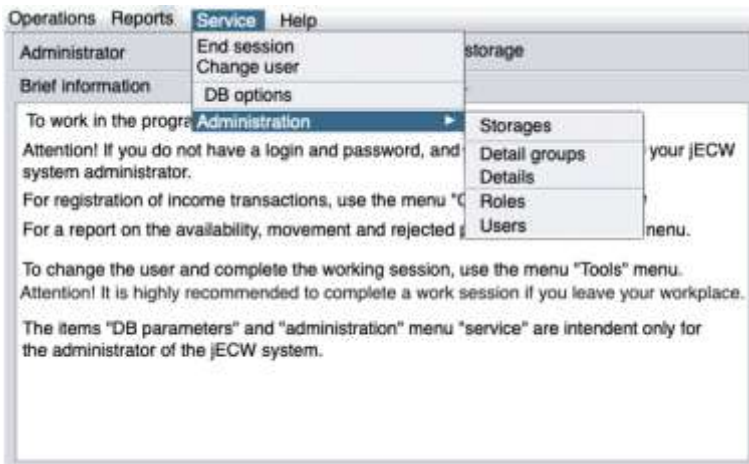


Fig.7. Operations menu after login is not administrator.

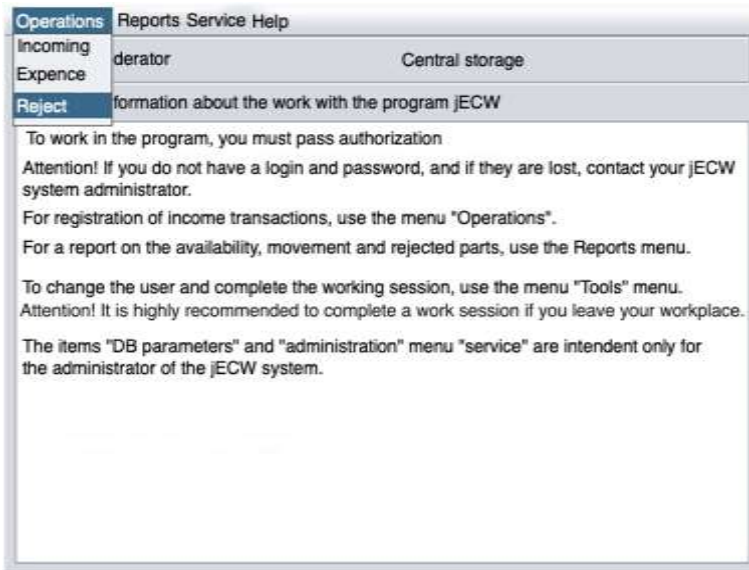


Fig.8. Administrative menu.

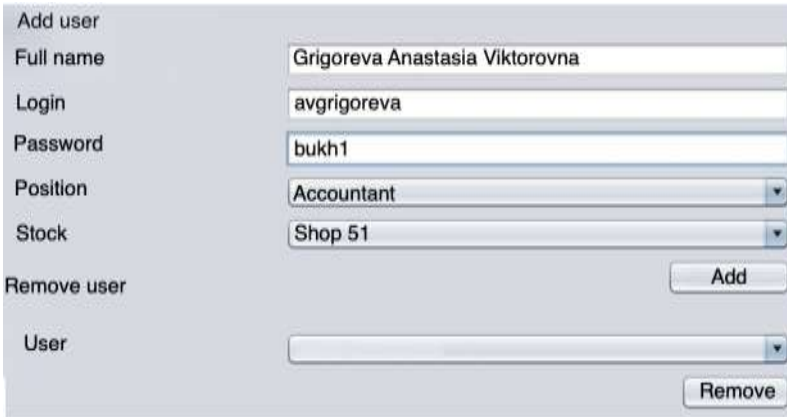


Fig.9. Operations menu unlocked.

In the case of the initial setup of the information system, you must perform the following sequence of actions:

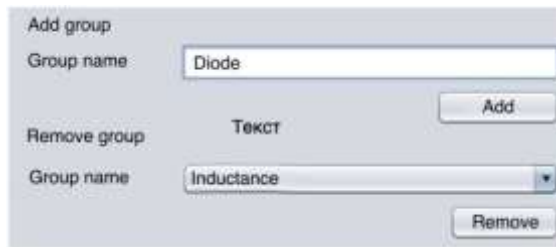
1. Add warehouses to the system. Administration menu - Warehouses. Using the form, you must register in the system all the warehouses of the enterprise.
2. Add user groups to the system using the Administration - Roles menu item (Fig.10).
3. Add users to the system, distributing them into roles and warehouses. The user operation form is invoked by selecting the Administrative Tools - Users menu item.
4. Create new groups of "parts" in the system. The forms for handling groups of "details" (Fig.11) are available in the Administration - Details Groups menu.
5. After creating the groups of "details" you need to create the "details" themselves. This operation is performed by filling in the required fields of the form with "details" (Fig.12).
6. All newly created "parts" go to the "Central Warehouse" and their number is zero. To move parts between warehouses, the number of instances of a "detail" must be greater than zero. To replenish the stock of copies of a particular "part", use the form called from the Operations - Income menu.

- When working with this form, the system moves the specified number of copies of the “part” from the internal warehouse “Purchasing” to the “Central warehouse”.
7. After replenishing the stock of a “part” in the “Central warehouse”, it becomes possible to transfer a certain number of copies of this “part” between the warehouses of the enterprise. This operation is performed in the form called by selecting the menu item Operations - Flow. Also the main work of users occurs in this window.



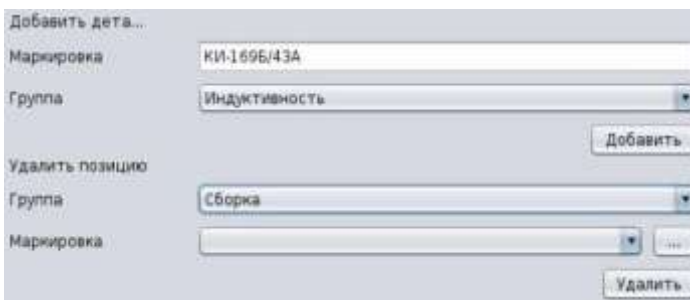
The screenshot shows a web form for managing users. It is divided into two main sections: 'Add user' and 'Remove user'. The 'Add user' section contains several input fields: 'Full name' with the value 'Grigoreva Anastasia Viktorovna', 'Login' with 'avgrigoreva', 'Password' with 'bukh1', 'Position' with a dropdown menu set to 'Accountant', and 'Stock' with a dropdown menu set to 'Shop 51'. Below these fields is an 'Add' button. The 'Remove user' section consists of a 'User' dropdown menu and a 'Remove' button.

Fig.10. Managing user roles.



The screenshot shows a web form for managing groups. It has two main sections: 'Add group' and 'Remove group'. The 'Add group' section has a 'Group name' input field containing 'Diode' and an 'Add' button. The 'Remove group' section has a 'Group name' dropdown menu set to 'Inductance' and a 'Remove' button. There is also a 'Текст' label next to the 'Remove group' section.

Fig.11. Handling groups of "details".



The screenshot shows a web form for operating 'details'. It is divided into two main sections: 'Добавить дета...' and 'Удалить позицию'. The 'Добавить дета...' section has a 'Маркировка' input field with 'KI-1696/43A', a 'Группа' dropdown menu set to 'Индуктивность', and a 'Добавить' button. The 'Удалить позицию' section has a 'Группа' dropdown menu set to 'Сборка', a 'Маркировка' dropdown menu, and a 'Удалить' button.

Fig.12. The form of operating "details": insert part (code, group) / delete part.

3. Installing an Application on a System Operator Workstation

The client application of the developed information system is supplied as a single file in the form of a zip archive.

To install the application, you need to unpack the archive into the user's home directory. The software comes with java - application launchers.

The scope of delivery includes the oracle-jre-1.8.0 execution environment. Additional installation of the java application runtime is also not required.

The application is launched using command line scripts - start.bat for Windows operating systems, start.sh - for UNIX-like operating systems.

Conclusion

In the course of this work, an analysis was made of information flows between the warehouses of the existing enterprise. Inefficient working methods were identified in the existing architecture of interaction between participants in the warehouse accounting process and the movement of tangible assets within the enterprise. Based on the data obtained for enterprise management a new algorithm can be offered for the interaction of participants in the warehouse accounting process.

Within the framework of the proposed information flow scheme, highly specialized warehouse accounting software was developed in a high-level Java language using the PostgreSQL database management system as a data warehouse.

The developed software meets the requirements - performs the assigned functions in full, it is a cross-platform, not demanding on resources and it has a low cost of implementation and operation.

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