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DEVELOPMENT OF AN INFORMATION SYSTEM TO SUPPORT LOGISTICS PROCESSES IN THE ORGANIZATION

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Abstract:

Various information flows that circulate within and between the elements of the logistics system, between the logistics system and the external environment, form the logistics information system. It is in a certain way an organized set of interrelated computer equipment, various reference books and the necessary programming tools, while providing the solution of certain functional problems of material flow management. The logistics process in the warehouse is very difficult, as it requires full coordination of the functions of inventory supply, cargo processing and physical distribution of orders. Logistics in warehouses should cover almost all the main functional areas considered at the micro level, so the logistics process in the warehouse is much wider than the technological process.The purpose of this work is to develop a subsystem of logistics analysis of the warehouse of a commercial enterprise. Given the routing of goods in a warehouse, there is a Generalized scheme of the algorithm for product placement.

Keywords:

Information system, logistic, management.

ACM Computing Classification System:

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

Introduction

In the modern world, the role of logistics continues to grow. For the most part, this is due precisely to economic reasons, since increasing production volumes in industry and the deepening of intra-national and global economic relations need more and more attention from spending cuts. Therefore, the creation of a logistic analysis subsystem for a warehouse of a commercial enterprise is a relevant goal.

The purpose of this work is to develop a subsystem of logistic analysis of a warehouse of a commercial enterprise.

To achieve this goal it is necessary to solve the following main tasks:

- learning the basics of improving warehousing activities on a logistic basis;
- development of a scheme for the operation of a subsystem for logistic analysis of a warehouse of a commercial enterprise;
- software implementation of a subsystem for logistic analysis of a warehouse of a commercial enterprise.

1 Logistic Process in the Warehouse as the Basis of Warehousing

The logistic process in the warehouse is very difficult, since it requires full coherence between the functions of supplying stocks, cargo processing and physical distribution of orders. Logistics in warehouses should cover almost all major functional areas considered at the micro level, so the logistics process in the warehouse is much wider than the technological process. It includes the following types of work [1]:

- stocking,
- control over the supply of goods,
- unloading and acceptance of cargo,
- transportation and transshipment of goods within the warehouse,
- warehousing of cargo and its storage,
- formation (commissioning) of customer orders and shipment,
- transportation of orders and their forwarding,
- collection and delivery of empty commodity carriers,
- full control over the implementation of all orders,
- informing the warehouse of orders and the movement of goods,
- customer service and service provision.

The functioning of all components of the logistics process should be considered in interconnection and interdependence.

This approach provides not only a clear coordination of the activities of the warehouse services, but also it will be the basis of planning and will allow you to monitor the movement of goods in the warehouse with minimal cost [2]. Conventionally, the whole process is divided into three parts:

1) operations that coordinate the procurement service;
2) operations that are directly related to the processing of goods and the necessary documentation;
3) operations that coordinate the sales service.

Coordination of the procurement service is carried out in the course of operations on the supply of stocks, as well as through control over the management of supply. The main task of supplying stocks is to provide a warehouse with goods or materials, depending on the possibilities of processing it for a given period, with full satisfaction of customer orders.

Thus, we conclude that the determination of the need for the purchase of stocks must necessarily take place in complete consistency with the sales service, as well as with the available warehouse capacity.

In order to ensure the rhythmic handling of cargo traffic, the maximum and rational use of the existing warehouse volume and the creation of the necessary storage conditions, to reduce the storage times for stocks, which will increase the turnover of the warehouse, it is necessary to keep records and control over the flow of stocks and shipment.

When unloading and accepting goods, you must comply with the terms of delivery, which are specified in the concluded contract.

Accordingly, it is necessary to prepare in advance the places of unloading for the specified vehicle (for example, a trailer, wagon or container), and also it is necessary to agree on the schedule of operations of the loading and unloading equipment. In modern warehouses, unloading is carried out on special unloading road or railway ramps and container platforms.

Specially equipped places for unloading and the correct choice of loading and unloading equipment and equipment will allow unloading in the shortest possible time and with minimal loss of cargo, which, in turn, will reduce vehicle downtime, and therefore, the costs of handling will be lower. This stage includes the following operations [3]:

- unloading of vehicles,
- control of documentation and ensuring physical compliance of delivery orders,
- paperwork for the arrived cargo using the information system,
- formation of a warehouse cargo unit.

Transportation of cargo within the warehouse involves the movement of cargo between different areas of the warehouse.

For example, like this: from the unloading ramp to the reception area, from there to the storage area, picking and loading ramp. These operations are performed with the help of hoisting machines and mechanisms.

All intra-warehouse transportation of goods must be carried out taking into account the minimum length in time and space along the most "direct-flow" routes. With such rational transportation, it is possible to avoid inefficient execution of operations, moreover, to prevent the return to any of the storage areas. The number of movements of goods from one type of equipment to another should be minimal.

Warehousing and storage. The process of warehousing is the placement and placement of cargo for storage. The basic principle of efficient storage is the efficient use of storage space. The optimal choice of storage system and the efficient use of warehouse equipment are the main tasks in this process. Equipment for storage must comply with the specific characteristics of the goods, as well as ensure maximum use of the height and area of the warehouse.

At the same time, the space for working passages should be minimal, and should not create difficulties and inconvenience to normal operating conditions of hoisting-and-transport machines and mechanisms. For orderly storage of goods and its economical placement, an address storage system is used, based on the principle of solid (fixed) or free (the load is placed in any free space) of the choice of storage location.

The process of storage and storage involves the following steps [4]:

- laying the cargo for storage,
- storage of cargo and ensuring the required storage conditions,
- control of stocks in the warehouse, which is carried out using the information system,
- a complete set (commissioning) of orders and their shipment
  which are reduced to preparation of goods according to orders of consumers.

Package and shipping include:

- receiving an order from a client (selection list),
- selection of goods in accordance with the customer's order,
- complete set of selected goods for a specific client in accordance with the order,
- preparation of goods for shipment (packing in a container, on a commodity carrier),
- preparation and execution of documents for each order,
  as well as control over the readiness of the order,
- consolidation of customer orders in the consignment of sending
  and registration of bills of lading,
- shipment of goods by vehicles.

The commissioning of customer orders is carried out in the picking area, and the preparation and execution of documentation is carried out using an information system. Address storage system organizes the place of the selected goods in the selection list, thus, the selection time is significantly reduced, besides it allows you to track the release of goods from the warehouse.

When using an information system, the bundling of shipments and the performance of cargo consolidation into an economical consignment of shipment is greatly simplified, which makes it possible to use the vehicle as efficiently as possible. In this case, you can choose the most optimal route for delivery of orders. Shipment is made on the loading ramp.

Transportation and expedition of orders can be carried out both at the warehouse itself and directly by the customer. The last option will be rational only in the case when the order is carried out in batches equal to the capacity of the vehicle, thus, the consumer stocks will not increase. The most common and cost-effective centralized delivery of orders by the warehouse. In this case, a significant reduction in transportation costs is achieved due to cargo consolidation and optimization of delivery routes, and it also provides a real opportunity to make deliveries in smaller and frequent shipments, which, in turn, will lead to a reduction in unnecessary insurance stocks with the consumer.

Collection and delivery of empty commodity carriers are of great importance in the item of expenditure.

Commodity carriers, such as pallets, containers, tare-equipment, for transportation within the city can most often be used several times, so they will need to be returned to the sender. The effective exchange of commodity carriers can be carried out only in cases when it is possible to reliably determine their optimal quantity and subject to the schedule of exchanging them with consumers.

2 Optimization Criteria and Performance Indicators

Indicators of efficiency of storage systems can be divided into the following groups [5]:

1. Indicators characterizing the degree of customer satisfaction.
2. Indicators reflecting the quality of the warehouse.
3. Indicators of quantity and time.
4. Cost indicators.
5. Indicators of financial and economic results.

The first group includes the assessment of the level of order fulfillment by consumers, the return of goods by consumers due to incorrect picking, packaging failures, etc., the number of delays in shipment of goods, complaints from consumers, service level indicators, and others.

The second group of indicators partially complements the first, but mainly contains indicators that directly characterize the quality of the warehouse. These indicators are conventionally divided into indicators that reflect the accuracy of the order parameters (that is, meeting deadlines, volume, quality, assortment assortment, etc.), order fulfillment (stock level maintenance accuracy, stock availability, storage conditions, etc.). p.), compliance with the internal warehouse operation (cases of loss, damage, theft, etc.).

The third group of indicators characterizes the time of logistic cycles: the time of replenishment of stocks, processing of consumer orders, preparation, picking and delivery of orders, procurement of goods and others.

Indicators of the fourth group show the costs of inventory management, the cost of transportation in the territory of warehouses, cargo handling and storage, packaging and other logistics costs.

In the fifth group shows the financial and economic results, which are a set of derived indicators leading four groups. These include: inventory turnover (number and turnover period), number of warehouses loaded, warehouse volume used, warehouse capacity, number of daily turnover operations, logistic costs per unit of turnover for a certain amount of time, turnover of invested capital in fixed assets of the warehouse, time payback of fixed assets between inventories, costs of commissioning, packaging and other actions per unit of turnover, and others. In Table 1, these indicators are grouped by factors.

Table 1. indicators of efficiency and effectiveness of the logistics process in stock

Key factors	Performance and Performance Indicators
Warehouse service	- Ensuring the implementation of the order by the deadline; - Completeness of the order; - Accuracy of order parameters; - Accuracy of maintaining inventory levels; - The number of returns orders; - Errors in the execution of orders;
Warehouse service	- Cases of loss, theft, damage, etc .; - Return of goods by buyers; - Consumer claims; - Evaluation by consumers of the quality of service
Use of investment	- Speed and number of stock turns; - Use of working capital; - The average level of stocks in stock; - Return on investments in fixed assets; - Use of investments in technological (lifting and transport) equipment;
Logistic costs	- Inventory management costs; - Expenses for internal warehouse transportation; - Costs associated with the quality of products and services (damage from insufficient quality levels, loss of sales, return of goods, obsolescence of stocks, etc.); - Expenses for warehouse handling and storage; - Total logistic costs; - Total logistic costs per unit of warehouse turnover;
Logistic cycle time	- Customer order processing time; - Order delivery time; - Preparation time and order picking; - Load time;
Performance	- Number of orders processed per unit of time; - Freight shipments per unit of warehouse capacity; and cargo capacity of vehicles; - Use of storage space; - Number of cargo handling operations per hour;

3 Organization of Warehouse Processes With Elements of Logistics

Properly equipped technological process of the work of the warehouse enterprise should provide [6]:

- timely reception by quantity and quality of goods;
- rational explantation of mechanical means of loading and unloading and transport and warehouse operations;
- organized dispatch of goods with maximum use of the warehouse area when storing goods and other material values;
- organization of the trading halls, operations for the selection of commodity values, picking and preparing them for the release;
- regular dispatch work and the organization of timely delivery of goods to the halls of sale;
- consistent implementation of warehouse operations, which provide regular and systematic workload of warehouse workers, and provide favorable working conditions.

To optimize the timing and methods of execution of warehouse operations is applied the modeling using various methods. The modeling of processes in the warehouse is used to determine the routes of commodity flows, the choice of standards for workflow, the formation of the organizational structure and algorithms of functioning.

According to the results of the simulation, they identify the name of operations at each workplace, generate process flow charts, determine job descriptions, and select equipment to equip the warehouse.

Modeling logistics processes in a warehouse should begin with the standardization of warehouse processes. Standardization implies the development and use of standards for technological operations, including loading and unloading, acceptance of goods by quantity and quality, equipment, storage and many other warehousing operations.

High quality of the process is possible to ensure, provided that each participant clearly performs his or her role in it, as well as is trained in the actions that he must perform in various situations.

It follows that a great need arises for the formalization of processes with a clear description of the algorithms of actions in special documents. It is important to compile all the documents in a single structure, give them consistent and clear descriptions that are easy to read and do not allow for different interpretations.

Standardization of technological processes in warehouses can significantly reduce the time spent on training employees, helps in solving problems in the division and cooperation of labor.

Improving the quality of services provided by the warehouse and increasing productivity (that is, reducing downtime, cargo handling time) is the main goal of developing technological standards.

For a working warehouse, standardization must begin with a process analysis. A simple description of the existing procedures and control of their implementation can give a significant reduction in the time to perform operations (from 2 to 5%).

The analysis of the stages of technological operations at the warehouses of trade reveals the approximately identical nature of these operations and has the following steps:

- unloading of transport;
- acceptance of goods, carried out by quantity and quality of goods;
- packing of goods for preservation;

- direct storage of goods;
- sorting of goods;
- packaging of goods in containers for transportation;
- completing delivery lines;
- loading of complete sets of goods on transport for delivery to buyers.

The further path of the goods is determined by a number of factors, the main of which are: the type of the consignee and its location, the method of shipment of goods, the type of packaging of goods, the type and method of work, etc.

In order to clearly organize the work in the warehouse, it is recommended to make flow charts that are developed for specific warehouse conditions and in accordance with the process flow diagram [7].

Technological cards reveal the basic composition of operations and transitions, establish the order of their execution, determine technical conditions and requirements, and also form data on the composition of equipment, devices and mechanisms required in the process of performing the operations provided by the cards.

For example, routing cards for a warehouse of wholesalers should contain a lot of information about the initial conditions for the work; about the place of their performance; about the participants of the process; about the content of work with material and information flows; that is, all the information that is used or formed (which documents are prepared or used) in the course of the work; about the mechanisms and technologies used in the course of work.

Analysis of the enterprise activity allows building a qualitative model for acceptance of goods by quantitative and qualitative criteria. However, there is no perfectly formed model for the release of goods.

The developed technological map is presented in Fig.1.

Routings are designed for the entire process, or for its individual stages, it is advisable to use together with network schedules. As well as the network schedule, the technological map reflects the entire system of the warehouse process, but not in a temporary, but in a technical-technological context.

The description of the technological process presented in the map is supplemented with a detailed description of its individual procedures.

In addition to technological charts, daily work schedules should also be drawn up in the warehouse, which systematize the execution of warehouse operations by time (shift, day, etc.) [8]. For example, in order to efficiently use hoisting equipment, it is necessary to develop schedules that regulate the operation of loading and unloading mechanisms during the work shift.

To organize the rhythm of work in the warehouse, it is necessary to develop schedules for the arrival of customers at the warehouse on certain days, weeks and hours for the selection of goods. Such graphs allow the warehouse to work evenly during the working week, month, etc.

Technological schedules of the expedition are designed to ensure timely delivery of goods to consumers, acceptance of goods that may arrive during off-hours, planned loading of vehicles and timely preparation of goods and transport documents.

4 Algorithm Automated Placement of Goods in the Warehouse

In order for the algorithm of automated placement of goods in the warehouse to work correctly, you need to enter data into it, in particular, the logical structure of the warehouse. It is the logical structure of the warehouse that determines the further method of combined storage.

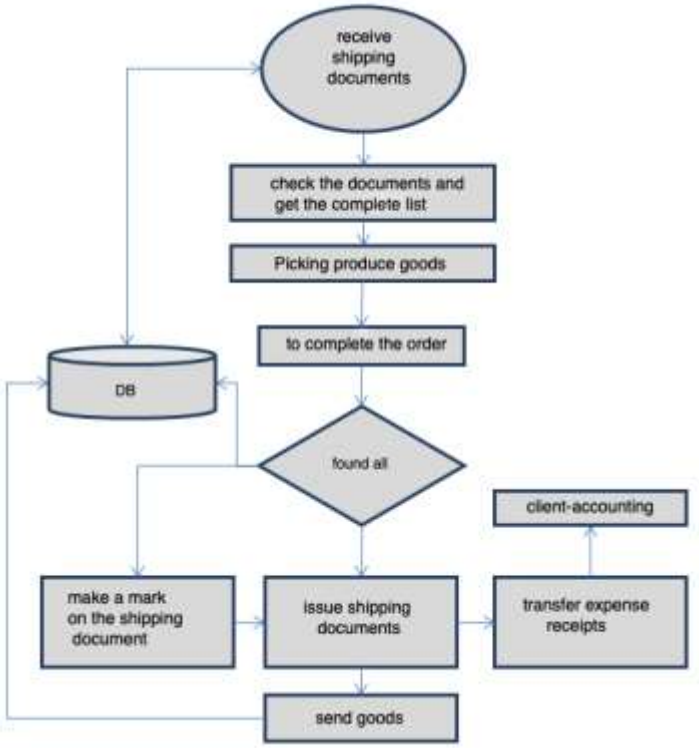

Fig.1. Technological map of the release of goods in stock.

Usually, warehouses are divided in several different ways. One example of such a method is the ABC analysis method - this is a method developed based on the nomenclature turnover rules [5]. A similar warehouse partitioning is performed using the functionality of the storage areas. A warehouse is divided into storage areas - warehouse locations that have similar parameters (for example, how close to the loading and unloading areas, the same temperature, security mode, etc.). Each storage cell is assigned a storage area, and the cell must simultaneously belong exclusively to one storage area. In turn, storage areas can be combined into storage areas. Storage areas are a specially ordered list of storage areas so that the priority of the area within the zone is preserved. A zone can include only one area. At the same time one storage area can consist simultaneously in several storage areas. You need to set several attributes for each area to get to the storage area. You can set the following attributes:

- priority: priority of the area within the zone;
- class ABC: the class can take the values A, B, C, which determines which class of goods (in accordance with ABC analysis) is preferably stored in this area.

The location of the item is set through the storage area. Each commodity-nomenclature group is assigned a zone, which allows the algorithm for determining storage cells to maximize the use of storage space for incoming goods. In the case when the storage area contains several areas, when the algorithm tries to store the cargo in the first area, the system will find that there are no places, then it will attempt to arrange this cargo in the next area. When searching takes into account priorities.

The scheme of the algorithm for automated placement of cargo in the warehouse is shown in Fig.2. The essence of the algorithm is the following: for the cargo arriving at the warehouse, the commodity-nomenclature group is included, into which it belongs [5]. According to the article of the commodity-nomenclature group, the storage area is determined. After that, in order to determine the area in which the load can be placed, one of these steps will be performed:

a) Placement of cargo in free cells

To place the cargo in free cells, you must specify the priority of the area within the zone. The cells are sorted in order of priority in each suitable area and a free cell is searched. The first free cell found is the load.

b) Placement of cargo using the ABC-classification (compatibility is controlled when placing)

To prevent selection errors, you can prohibit finding goods with different batches, expiration dates, or batch numbers in the same cell, if required.

The control of the residuals and the employment of cells is carried out by dividing the N nomenclature into three own inequivalent subsets A, B and C (N = A∩B∩C), or the equivalence class based on some formal algorithm of all consumed material resources, realized values and others.

In a specific case, the division algorithm looks like this: first, the total number of applications that came in over a certain time is highlighted, then the result is divided by the total number of positions in item N, and as a result of these calculations, the average number of applications P is displayed for one position of item N.

In turn, the subsets A, B and C can be considered as ordered sets

$$(A =< a_1, a_2, \dots, a_k >, \quad B =< b_1, b_2, \dots, b_k >, \quad C =< c_1, c_2, \dots, c_k >)$$

All elements are included in the subset A, if they are six or more times greater than P. The subset C includes all the elements that are two or more times smaller than P. All other elements are included in the subset B.

The likelihood of demand for material resources from the subsets A, B and C is subject to various distribution laws. It has been established that in most industrial and trading firms approximately 75% of the value of stocks covers about 10% of item names (subset A), 20% of cost — respectively, 25% of items (subset B), 5% of cost — 65% of items (subset C).

In order for this method to work correctly, you need to set the priority of the area within the zone and the class of ABC for each zone. Area A includes the most easily accessible cells (as a rule, these are lower shelves and closest to the loading / unloading zone), since the goods with the highest turnover (class A goods) will be placed in them. The area of class B will include cells that are less accessible (the second tier of shelving); the goods with average turnover (class B) will be stored in this area. The most difficult-to-reach shelves (upper shelves) will belong to a class C area, the class C goods with the lowest turnover will be stored in this area.

The following actions after the distribution of ABC classes for regions and goods, when accepting goods, determine its class. Based on this information, in the zone are selected the areas most suitable to its class. Then there is a check on the availability of space for placing this cargo in areas of a similar class, in the order that is determined by the priority of areas within the zone. And only after that there is a check of places in areas of other classes. The search order depends on the nomenclature class and is given in Table 2.

There are cases when the placement of goods with different series, expiration dates or batch numbers in one cell.

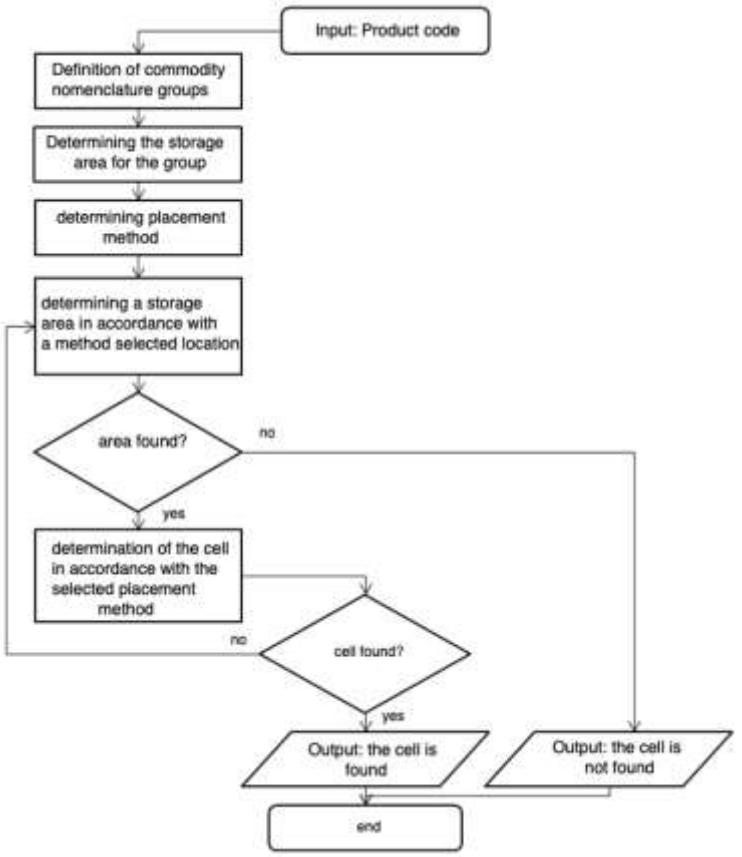

Fig.2. The generalized layout of the product placement algorithm.

This condition is also verified. The load is also placed in the first suitable cell. The classification of the nomenclature when placing in accordance with the ABC classification can be carried out at intervals of a week or a month to account for changes in demand for the goods.

Table 2. Search procedure for a free cell

Nomenclature class	Search order
A	A > B > C
B	B > C > A
C	C > B > A

c) Placement of cargo in occupied cells to an identical or similar cargo (if possible)

When placing to a similar cargo is a compatibility check. To exclude the possibility of selection errors, it is necessary to follow the prohibition of finding a cargo with different batches, expiration dates or batch numbers in one cell, if necessary.

When placing loads in already occupied cells to an identical or similar load, it is necessary that the priority of the area within the zone be determined. In order of priority, in each area, a cell is searched with a load from the same commodity-nomenclature group as the load being placed. If the placement of cargo with different series, expiration dates or batch numbers in one cell is prohibited, this condition is checked and the cargo is placed in the first suitable cell.

d) Placement of cargo in occupied cells to any cargo.

This step can be used when you need to save space in the storage room. In order of priority, in each area, a cell with a load is searched for, all the conditions for placing the load in the given cell are checked, and the load is placed in the first suitable cell.

5 Software Implementation of the Subsystem of Logistic Analysis of a Warehouse of a Trading Enterprise

The program has a separate window for each type of work, between which the user can switch. The program has functions that do not require separate windows and can be performed in the current window. Figure 3 shows the visual structure of the program.

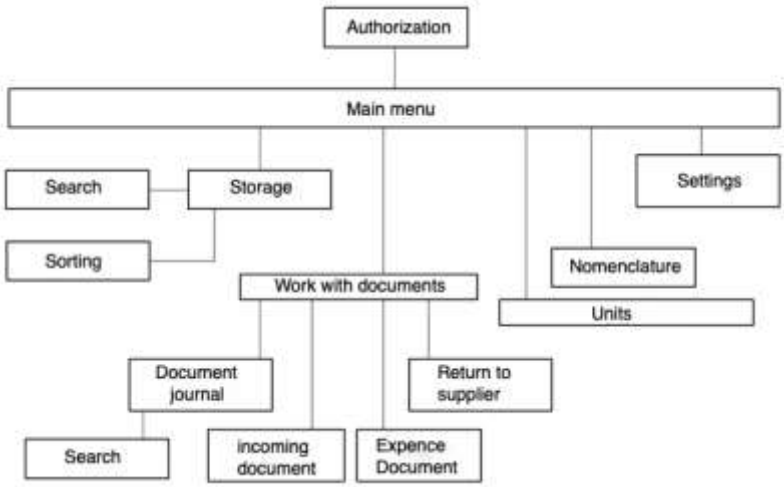

Fig.3. The generalized layout of the product placement algorithm.

Conclusion

During the performance of the paper, the basics of improving warehousing activities on a logistic basis were studied, which allowed us to identify criteria for evaluating the effectiveness of the organization of the warehouse. A scheme was developed for an information system that uses logistics as a tool for organizing efficient warehouse operations.

The developed scheme was successfully implemented in accordance with the technical specifications and tested in the enterprise. This made it possible to simplify the work of ordinary workers, thereby increasing labor productivity and reducing the time for training new warehouse workers without losing the possibility of centralized control and data management. The development does not stop at this stage, the management of the company encourages the further development of the program improvements.

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