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Warehouse Operations of Passenger Service Car Depot with Logistics Elements

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WAREHOUSE OPERATIONS OF PASSENGER SERVICE CAR DEPOT WITH LOGISTICS ELEMENTS

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The article discusses the issues of rational organization of the warehouse process of storing inventory, the sequential implementation of warehouse operations, the improvement of labor organization and technological solutions, the effective use of various equipment involved in the performance of technological operations at the warehouse of the carriage depot of the Joint Stock Company "Uztemiryulyulovchi" ("Uzpasstrans"). The issues of creating a database for storing goods, an effective system for organizing their account are considered. The ER-diagram of the database of warehouse inventory of spare parts and components has been developed. The functions and procedures for working with database data on components and spare parts located in the warehouse of the carriage depot have been determined.

The organization of passenger traffic on the newly organized railway sections of JSC "Uzbekiston Temir Yullari" increased the load on the wagon depot, in which the corresponding repair and equipment work is being carried out. The main element in the logistics chain is the warehouse of the carriage depot providing storage of inventory, spare and component parts (hereinafter, inventory) of mobile units [1]. At the same time, considering the depot warehouse, it should be noted that certain logistic operations are performed in its various sections [2, 3, 9, 12]. Unloading section - mechanized and manual unloading of goods and materials from vehicles is performed; acceptance expedition - the cargo is accepted according to the number of places and its short-term storage before transfer to the main warehouse; acceptance area - acceptance of goods in terms of quantity and quality (goods to the acceptance area can come from the unloading area and from the acceptance expedition); the storage area is the main part of the main warehouse in which the cargo is placed for storage, as well as the selection of the cargo; picking area (located in the main warehouse) - the formation of cargo units containing an assortment of goods and materials selected in accordance with the needs for issuing to employees of the car depot involved in repair and equipment work; dispatching expedition - short-term storage of cargo units prepared for delivery, organization of their delivery; loading area - loading of goods onto vehicles (manual and mechanized) [4-11, 13]. Taking into account this

structure of the organization of warehouse activities of the wagon depot, below in Fig. 1, a general diagram of the technological process of the warehouse with the automation of the corresponding operations is presented.

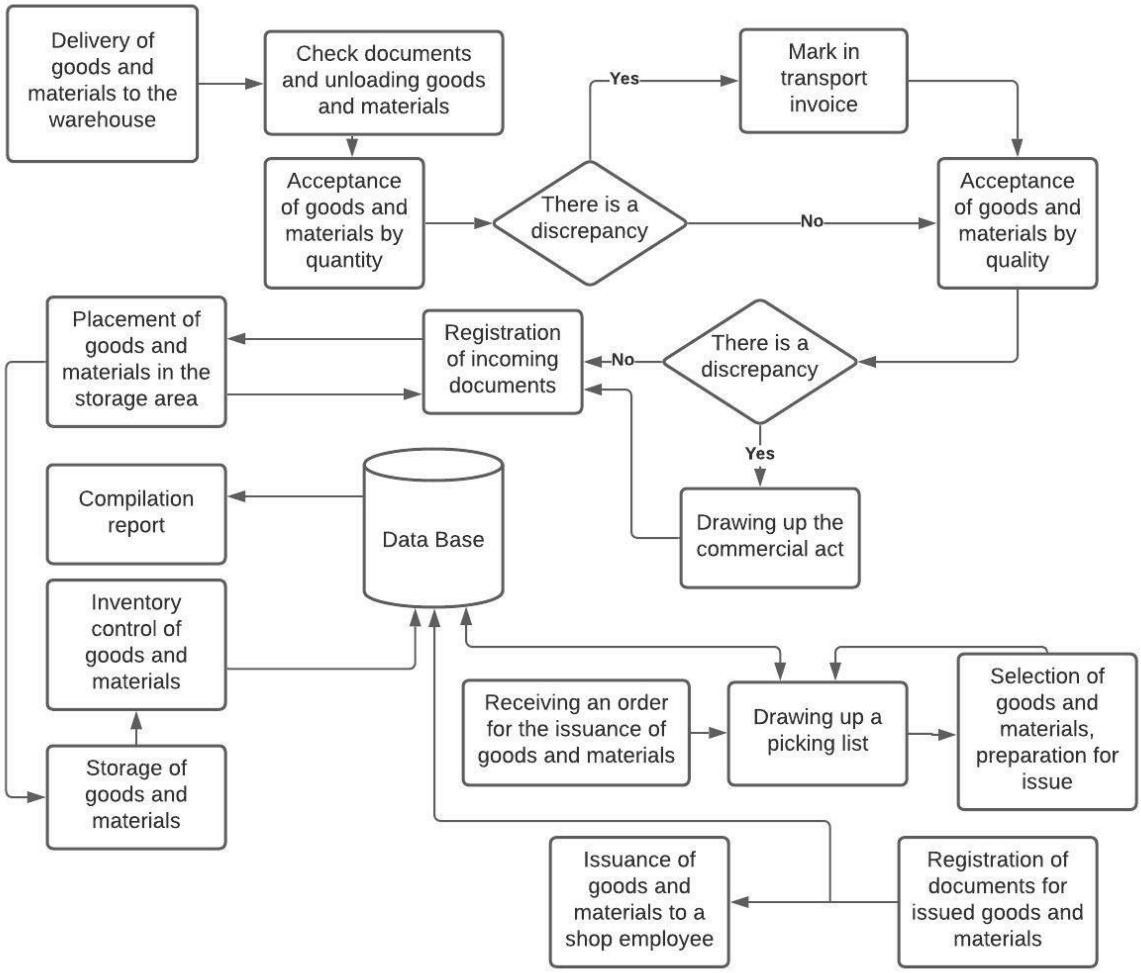

Fig. 1 General diagram of the technological process of warehouse operations during their automation.

The technology of the warehouse process is based on rational construction, clear and consistent implementation of warehouse operations, continuous improvement of labor organization and technological solutions, effective use of various equipment involved in the performance of technological operations [14, 15, 19].

A properly organized technological process of the wagon depot warehouse should ensure:

- timely acceptance of goods and materials, taking into account the quantity and quality of incoming goods;
- competently use loading and unloading facilities when organizing transport and storage operations;
- rationally use warehouse space and properly store goods and materials, which will ensure the safety of goods and material values;

- centralized delivery of goods and materials to employees of the carriage depot involved in repair and equipment work (if necessary) orrectly organize warehouse operations, ensure the planned workload of warehouse workers, favorable working conditions

Placement of goods in the warehouse. The warehouse is an important and most common element of the logistics chain, which is necessary when performing repair and equipment work in a wagon depot. Accordingly, the rational organization of material flows in the warehouse will increase the efficiency of performing the necessary work with moving units.

Determination of the option for placing goods and materials in a warehouse with minimal costs for their purchase and storage of stocks is the main one for railway warehouses. For this purpose, various algorithms and programs for solving the determination of optimal inventories and their placement in the warehouse are used [21, 22]. The solution lies in determining the optimal storage locations for each product group One of the methods for determining the optimal placement of goods and materials is the Pareto method. The essence of the method is to minimize the number of movements in the warehouse by dividing the entire assortment of goods and materials into groups that require a large number of movements and groups that are rarely accessed. In the warehouse of the carriage depot, goods and materials often issued for repair and equipment work make up only a small part of the assortment, and they must be located in convenient places as close as possible to the delivery zones, along the so-called "hot" lines. In this case, goods and materials, which are used less often, are placed in the background, i.e. along the "cold" lines. It is efficient to place large-sized goods and materials and goods stored without containers along "hot" lines, since their movement is associated with significant difficulties

Main part: development of an automated system for managing warehouse operations of a wagon depot warehouse.

Providing cars with the necessary spare parts during repair and equipment work at the depot is ultimately aimed at the timely delivery of passengers to their destination, improving their service and the rhythmic organization of passenger traffic [16].

The current stage of development of information and communication technologies is characterized by the digitalization of management processes, including the introduction of digital methods for calculating inventories of goods and materials located in the warehouses of the carriage depot [18]. The collection of information on the availability of goods and materials in the warehouse is carried out by various technical devices, their processing and the sequential formation of arrays of information placed on the database (DB). The main

advantages of organizing a warehouse management automation system based on a database are [18, 20]:

- improvement of the quality of service of the wagon depot shops, preventing interruptions in the supply of spare parts;
- reducing the likelihood of errors, reducing the influence of the human factor, as well as the risks of loss or damage to material assets;
- the service of supplying goods and materials of depot warehouses works without interruptions, the ability to make managerial decisions increases when performing automated management and logistics tasks;
- the efficiency of warehouse accounting is increased by monitoring the status of material goods placed in the warehouse in real time.

One of the conditions for creating a database is the development of a system for organizing an inventory of warehouse inventory. The account of components and spare parts placed in the warehouse in the database requires the following operations [1]:

- development of an ER-diagram of a database for inventory control of spare parts and components;
- creation of a physical model of a warehouse inventory database;
- creating appropriate operations with requests and performing actions to find the necessary information;
- development of functions and procedures for working with data placed in the database regarding components and spare parts in the warehouse of the carriage depot.

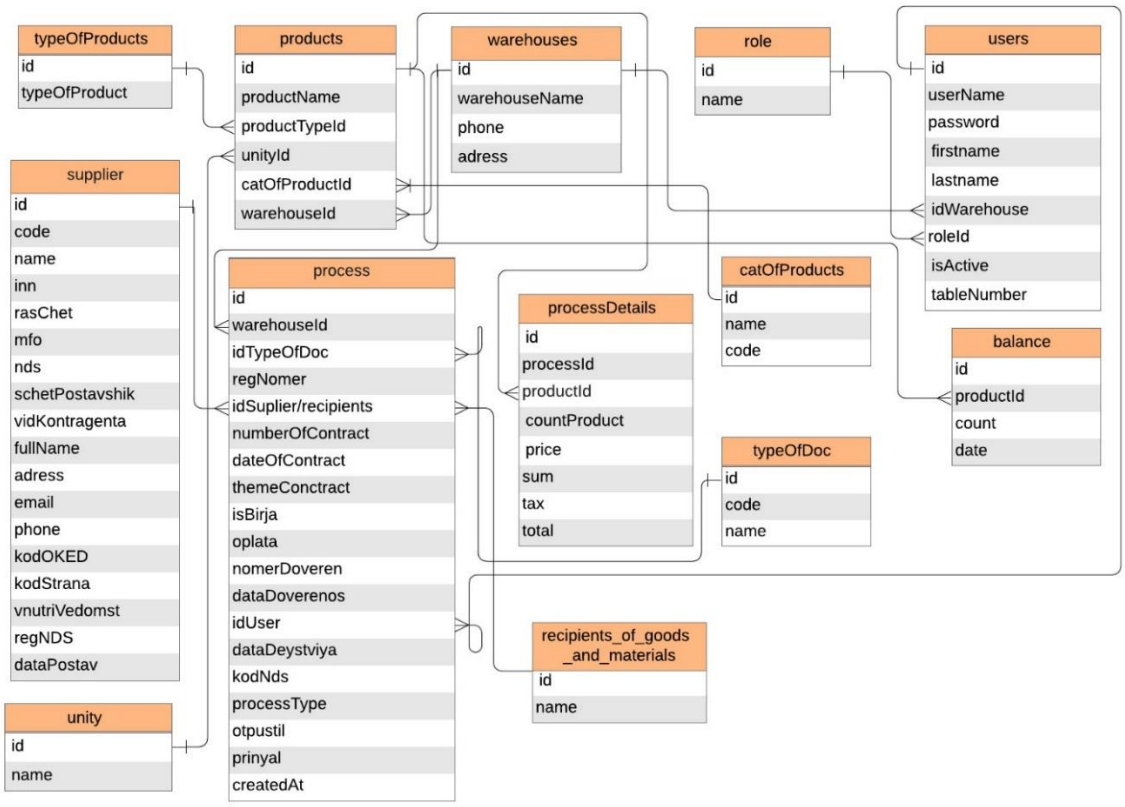

Fig. 2. ER-diagram of the database of the warehouse of the carriage depot VChD-2 of JSC "Uztemiryulyulovchi".

At the first stage, based on the formulation of the task of automating warehouse accounting operations, we developed an ER-diagram of the database (Fig. 2).

DATABASE RELATIVE SCHEME

The analysis of the infological model entities, their attributes and relationships allows us to conclude: each entity can be represented by a separate table, and all of them are already in the third normal form. Below in table. 1-12 show the elements of the relational models of the database "Warehouse accounting", developed for the warehouse of the carriage depot VChD-2, which reflect the primary and foreign keys of relations, the necessary constraints to ensure its (DB) integrity.

Table 1

Relational model **«typeOfProducts»**

Field	Field Name	Key	Type	Domain
Product_type_code	id	PK	NUMBER(5)	Unique
Name_ product_type	typeOfProduct		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -

Table 2

Relational model **«products»**

Field	Field Name	Key	Type	Domain
Product_code	Id	PK	NUMBER(4)	Unique
Name_ product	productName		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Product_type_code	productTypeId		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Unit_code_ measurements	unityId	FK	NUMBER(2)	1-9 A set of values from the id of the unity table
Category_code goods	catOfProductId	FK	NUMBER(2)	1-9 A set of values from a table id typeOfProducts
Warehouse_code	warehouseId	FK	NUMBER(2)	1-9 A set of values from a table id warehouse

Table 3

Relational model **«warehouses»**

Field	Field Name	Key	Type	Domain

Warehouse_code	Id	PK	NUMBER(6)	Unique
Name	warehouseName		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Telephone	Phone		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Address	Address		VARCHAR(20)	a-z, A-Z, A-Я, a-я, -

Table 4

Relational model **«role»**

Field	Field Name	Key	Type	Domain
Role_code	Id	PK	NUMBER(6)	Unique
Name	name		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -

Table 5

Relational model **«suppliers»**

Field	Field Name	Key	Type	Domain
Vendor_code	Id	PK	NUMBER(4)	Unique
Code	code		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Name_	name		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Supplier	inn		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
INN	rasChet		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Checking account	mfo		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
IFIs	nds		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
VAT	schetPostavshik		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Check_	vidKontragenta		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Supplier	fullName		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
View_	address		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Counterparty	email		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Full_Name	phone		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Address	kodOKED		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Email	kodStrana		NUMBER(2)	1-9
Telephone	vnutriVedomost		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Code_OKED	regNDS		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Country_code	dataPostav		Date	Дата время

Table 6

Relational model **«users»**

Field	Field Name	Key	Type	Domain
User id	id	PK	NUMBER(4)	Unique
Name	name		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Password	password		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
firstName	firstName		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
lastName	lastName		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
warehouseId	warehouseId	FK	NUMBER(2)	1-9
roleId	roleId	FK	NUMBER(2)	1-9
isActive	isActive		Boolean	true, false
tableNumber	tableNumber		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -

Table 7

Relational model **«process»**

Field	Field Name	Key	Type	Domain
Code	id	PK	NUMBER(4)	Unique
Warehouse_code	idWarehouse		NUMBER(4)	1-9
View_code_	typeOfDoc	FK	NUMBER(4)	1-9
Document	regNomer		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Registration number	idSupplier	FK	NUMBER(4)	1-9
Vendor_code	numberOfContract		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Contract number	dateOfContract		Date	Date
Date_contract	themeContract		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
Subject_contract	isBirja		NUMBER(1)	0,1
Stock exchange	nomerDover		NUMBER(4)	1-9
Power of attorney number	dataDover		Date	Date
Date_of attorney	idUser		NUMBER(4)	1-9 A set of values from the users table id
User_code	dataDeystviya		Date	Date
Date of action	kodNds		VARCHAR(50)	a-z, A-Z, A-Я, a-я, -
VAT_code	proccesType		NUMBER(1)	1-9
Process_type	otpustil		NUMBER(2)	1-9 A set of values from the id of the unity table
Took	Prinyal		NUMBER(2)	1-9 A set of values from the id of the unity table
Created time	createdAt		Date	Date

Table 8

Relational model **«processDetails»**

Field	Field Name	Key	Type	Domain
Code	id	PK	NUMBER(4)	Unique
Process_code	idWarehouse		NUMBER(4)	1-9 A set of values from a table id warehouses
Product code	productId		NUMBER(4)	1-9 A set of values from a table id products
Quantity of goods	countProduct		NUMBER(4)	1-9
The price of the product	Price		NUMBER(10)	1-9
Price without VAT	Sum		NUMBER(10)	1-9
VAT_Sum	Tax		NUMBER(10)	1-9
Value with VAT	total		NUMBER(10)	1-9

Table 9

Relational model **«catOfProducts»**

Field	Field Name	Key	Type	Domain
Category_code	id	PK	NUMBER(4)	Unique
Goods	name		VARCHAR(40)	a-z, A-Z, А-Я, а-я, -
Name	code		NUMBER(4)	1-9

Table 10

Relational model **«typeOfDoc»**

Field	Field Name	Key	Type	Domain
Code	id	PK	NUMBER(4)	Unique
Document_type_ code	code		NUMBER(4)	1-9
Name	name		VARCHAR(40)	a-z, A-Z, А-Я, а-я, -

Table 11

Relational model **«unity»**

Field	Field Name	Key	Type	Domain
Unit_code	Id	PK	NUMBER(4)	Unique
Name	Name		VARCHAR(40)	a-z, A-Z, А-Я, а-я, -

Table 12

Relational model **«balance»**

Field	Field Name	Key	Type	Domain
Remainder_code	Id	PK	NUMBER(4)	Unique
Product code	productId	FK	NUMBER(4)	1-9 A set of values from the products table id
Quantity_of_goods	Count		NUMBER(10)	1-9
Date	Date		date	Date

The next stage in the creation of an automated inventory control system of the warehouse of the wagon depot is the creation of its information system. When developing an information system for inventory control of goods and materials at the VChD-2 depot JSC "Uztemiryulyulovchi", the object-oriented modeling language UML [17] was used, on the basis of which diagrams and tables were developed (Fig. 3).

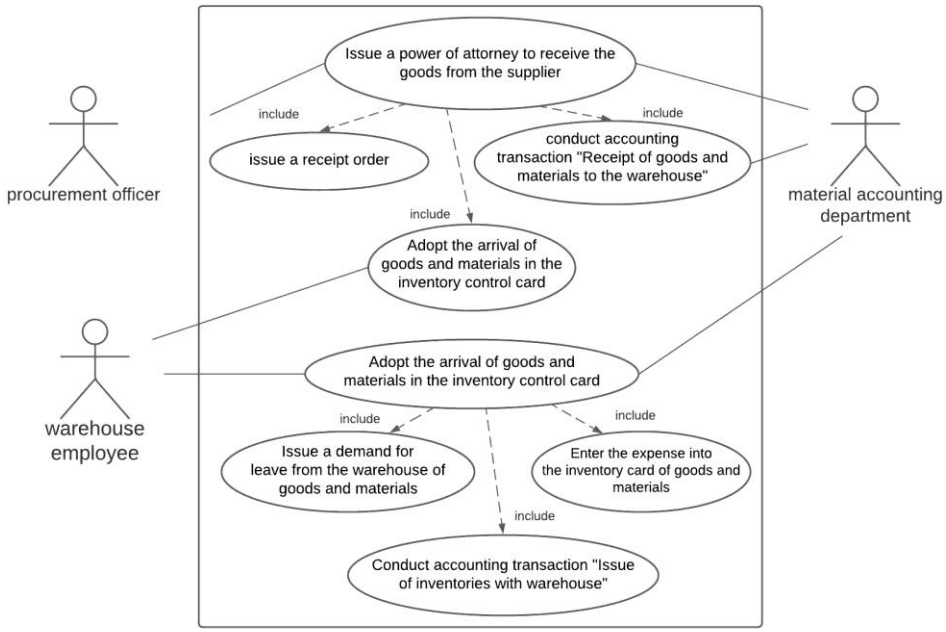

Fig. 3. A variant of the scheme of using the warehouse information system

The proposed information system for accounting for the movement of goods and materials is aimed at efficient management of goods, maintaining the database information of the warehouse of the VChD-2 car depot in an active state.

CONCLUSION

The results of the research performed are the developed automated inventory control system, databases of spare parts and other components located in the warehouse of the VChD-2 wagon depot. The following main results were obtained.

1. The carriage depot of the passenger service of Uztemiryulyulovchi JSC has several warehouses for storing goods and materials. Automation of accounting operations in warehouses is not carried out, which imposes restrictions on the efficiency of placing goods in the warehouse, quickly determine their location and predict the necessary components for the repair of moving units of the carriage depot.

2. Information on the quantity, condition and availability of goods and materials was obtained, analysis and forecasting of the movement of material assets in the warehouse for a certain period of time (quarter, half-year, year).

3. In order to automate accounting operations in the warehouse, an ER diagram of the warehouse accounting database of spare parts and components of the VChD-2 car depot was developed, a study of inventory (goods and materials, spare parts and other components of the rolling stock).

4. The proposed information system will ensure the supply of goods and materials to the warehouse, components, spare parts and other equipment necessary to achieve timely and high-quality service of passenger cars.

5. The scheme of using the information system, its scenarios, as well as classes and their relationships are presented in the form of diagrams. These

diagrams serve as a technical task in the process of programming the accounting of goods and materials, components, spare parts and other equipment of the carriage depot.

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