



ORGANIZATION AND TECHNOLOGY OF RELEASING GOODS FROM THE WAREHOUSE

Khudoyberdiyeva Marifat Umarovna

*assistant at Samarkand state university of veterinary medicine,
animal husbandry and biotechnologies,
E-mail: godirovanozanin2@gmail.com*

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This article investigates the effective organization of the goods release process in warehousing, as well as the technologies for order picking, sorting, assembly, packaging, and preparation for shipment. The removal of goods from the warehouse is a vital link in the logistics system, the efficiency of which directly affects the enterprise's service speed, labor productivity, warehouse costs, and the accuracy of customer orders. The study analyzes the characteristics of traditional manual assembly, as well as zonal, batch, wave, and automated order assembly methods.

Introduction.

In a market economy, the competitiveness of enterprises depends not only on the volume and quality of product production but also on their ability to deliver it to the consumer on time and with minimal costs. In this process, the warehouse is an important logistical link that coordinates material flows between the producer and the consumer. The main tasks of the warehouse include receiving, placing, storing, inventorying, collecting orders, sorting, packaging, and shipping goods. Among these operations, the collection of orders and the preparation of goods for release are of particular importance. In the studies of De Koster, Le-Duc, and Roodbergen, order picking was assessed as one of the most labor-intensive and costly operations in many warehouses. The development of e-commerce, increasing customer demand for delivery times, a decrease in the order structure, and the expansion of the SKU (Stock Keeping Unit) nomenclature require warehouses to operate more efficiently and accurately. For this reason, digitalization, automation, and robotization processes are rapidly developing in



modern warehouses. An analysis of systematic literature for 2020 shows that throughput, delivery time, and operational efficiency are the most studied result indicators in automated order collection systems. From this perspective, the scientific organization of warehouse release, the selection of optimal technology, and the implementation of modern information technologies are among the most important practical tasks for enterprises.

Literature review on the topic.

Issues regarding the organization of warehouse operations have been studied in numerous scientific works on logistics and operational research. Gu, Goetschalckx, and McGinnis classified warehouse operations by key functions such as receiving, storing, collecting orders, and shipping, analyzing planning and management issues for each of them. A comprehensive literature review conducted by De Koster, Le-Duc, and Roodbergen examines areas such as location planning, product placement, zoning, order grouping, and routing of the warehouse order collection process. The authors emphasize that order collection efficiency significantly affects the overall performance of the warehouse.

Recent research also pays great attention to the use of artificial intelligence. A study by Rad et al. in 2025 showed that an AI-based order collection system can help reduce movement distance and order fulfillment time, but it is necessary to consider technological, organizational, and human factors to use such systems effectively.

Another study published in 2025 indicates the need to classify automated order picking systems by various technological solutions and select the technology that best fits the enterprise's conditions. Thus, the literature analysis shows that the efficiency of the warehouse removal process depends not only on a single technology, but also on:

warehouse location + product placement + order grouping + routing + information system + staff performance

depends on mutual compatibility.

Research methodology.

A systematic approach was used in the study to evaluate the organization and technology of the warehouse release process. The research methodology includes the following stages:

1. Literature review. Scientific research on warehouse operations, order collection, and automation was studied.

2. Process approach. The product release process was reviewed in the following sequence:
order acceptance → order verification → task creation → product search → assembly → control → assembly → packaging → documentation → shipment

3. Comparative analysis. Manual, semi-automated, and automated order collection technologies were compared.

4. Analysis of performance indicators. When evaluating system efficiency, it is proposed to use the following indicators:

❖ one order execution time;



- ❖ the number of orders or positions collected per employee hour;
- ❖ accuracy of order collection;
- ❖ employee's walking distance per shift;
- ❖ number of errors in order fulfillment;
- ❖ the level of warehouse space utilization;
- ❖ labor costs;
- ❖ operating expenses per order.

The order collection performance can be expressed by the following formula:

$$U = QT$$

here:

U — order collection productivity;

Q — the number of orders or product items collected within a specific period of time;

T — labor time spent.

And the accuracy of order collection:

$$A = N_{\text{correct}} / N_{\text{total}} \times 100\%$$

can be determined in the form.

Where N_{true} is the number of orders executed correctly, N_{total} is the total number of completed orders.

Analysis and results.

Organization of the goods release process from the warehouse. The goods release process from the warehouse begins upon receipt of an order from the customer or an internal division. After receiving the order, its composition, quantity, product code, and other parameters are checked. At the next stage, the warehouse worker or the automated system is instructed to assemble the products.

In a traditional warehouse, the employee independently searches for the necessary products based on the order sheet. Although this method is simple for small warehouses, travel distance, time, and errors can increase as the number of orders increases.

Therefore, the correct placement of products in the warehouse is of great importance. Placing frequently sold products close to the departure and collection zone reduces the unnecessary effort of employees.

Order collection technologies

In practice, the following main technologies can be distinguished:

Technology	Key feature	Scope of application
Single-order assembly	Each order is collected separately	Small warehouses
Party assembly	Multiple similar orders will be collected together	Large number of small orders



Zonal assembly	The warehouse is divided into zones for employees.	Large warehouses
Wave assembly	Orders are grouped by time or shipping schedule	Distribution centers
"Pick-by-light"	An instruction is given to the employee via a light indicator	Rapid acquisition
Single-order assembly	Each order is collected separately	Small warehouses
Party assembly	Multiple similar orders will be collected together	Large number of small orders

Scientific literature separately examines "picker-to-goods," "goods-to-picker," and fully automated collection strategies. In the "goods-to-picker" system, the product is delivered to the employee automatically, resulting in a reduction in the employee's time spent walking around the warehouse.

The importance of the WMS system. The Warehouse Management System (WMS) is a digital management tool for warehouse operations, using which the location of goods, balance, orders, and assignments to employees are managed within a single information environment.

Using WMS:

- determine the exact storage location of the product;
- automatic order generation;
- determining the optimal assembly route;
- distribution of employees' work;
- real-time balance monitoring;
- simplification of the inventory process;
- opportunities will be created to monitor the order status.

Research on smart warehouses characterizes modern warehouse systems through areas such as information interconnection, equipment automation, process integration, and stability.

Automation of product release

There are several levels of automation for warehouse processes. At the first level, barcodes and mobile terminals are used. At the next stage, conveyors, automatic storage and unloading systems (AS/RS), automatically controlled vehicles, and robots will be introduced.

RFID technology allows for the identification of products via radio frequency. Unlike barcodes, RFID technology in some cases reduces the need for a direct view of the object and facilitates the control of large volumes of goods.

When selecting automated systems, it is necessary to consider not only technical capabilities but also order volume, product size and weight, number of SKUs, demand volatility, existing building infrastructure, and investment costs. The literature on automated order collection



systems indicates the need to consider the relationship between the design of the technology and its actual operational results.

Using artificial intelligence. Artificial intelligence can be used in warehouses to group orders, forecast demand, and optimize product placement and collection routes.

For example, an AI system can analyze historical ordering data to determine which products are most commonly ordered together. As a result, it becomes possible to reduce the employee's walking distance by placing interconnected products close to each other.

One study in 2025 showed that an AI-based order collection system helped reduce travel distance and time, while considering factors related to personnel, organization, and technological infrastructure when implementing the technology.

Proposed model for increasing efficiency. To improve the release of goods from the warehouse, the following integrated model can be proposed:

Step 1 - Digitize the order.

The order is automatically transferred from the ERP or e-commerce system to the WMS.

Step 2 - Order optimization.

The system groups orders by zones, product types, and shipping times.

Step 3 - Determining the optimal location.

Products in high demand will be placed near the collection zone.

Step 4 - Formulation of the assembly task.

The WMS determines the optimal route for the worker or robot.

Stage 5 - Identification and control.

The type and quantity of the product are verified using a barcode or RFID.

Stage 6 - Completion and packaging.

The order composition is re-checked, and the products are prepared for shipment.

Step 7 - Shipping.

The finished order is uploaded to the vehicle, and its status is recorded in the WMS as "shipped."

The main goal of such an approach is to reduce unnecessary human effort, accelerate information exchange, reduce errors, and reduce order fulfillment time.

Discussion of results. The analysis results show that the efficiency of removing goods from the warehouse depends on three main groups of factors:

The first group is organizational factors. This includes the proper organization of warehouse zones, clear distribution of staff duties, grouping of orders, and scheduling of work shifts.

The second group is technological factors. These include WMS, barcode, RFID, voice and light-controlled assembly technologies, conveyors, automatic storage systems, and robots.

The third group is the human factor. No matter how advanced technology becomes, issues of employee training, occupational safety, ergonomics, and the proper use of technology remain important. The 2026 systematic reviews also noted the need to consider factors such as fatigue,



cognitive load, the learning process, and human-robot interaction alongside technological optimization when collecting warehouse orders.

Thus, choosing the highest level of automation for an enterprise is not always the only solution. The technology must be selected in accordance with the size of the warehouse, the order structure, product characteristics, and economic capabilities.

Conclusions and suggestions.

The study determined that the process of unloading goods from the warehouse is of strategic importance in the enterprise's logistical activities. Delays or errors in the order collection process not only increase warehouse costs but also affect the quality of customer service.

To increase the efficiency of goods removal from the warehouse, the following proposals were developed:

1. Real-time management and monitoring of goods movement through the implementation of a WMS system.
2. Product placement based on ABC analysis. Placement of high-demand products near the collection and dispatch zone.
3. Reducing errors in product identification through the use of barcode and RFID technologies.
4. Selection of batch, zonal, or wave order collection based on order composition and warehouse conditions.
5. Optimizing collection routes. Increasing labor productivity by reducing the excessive walking distance of employees.
6. Implementation of automation in stages. Initially, it is advisable to introduce information systems and identification tools, followed by mechanization and robotization technologies.
7. Improving demand forecasting, optimal product placement, and order grouping processes through the use of artificial intelligence.
8. Regular staff training. Developing skills for working with new technologies and complying with occupational safety requirements.
9. Implementation of the KPI system. Order collection time, order accuracy, number of items collected per hour, error rate, and per-order costs must be regularly monitored.

In general, the process of unloading goods in a modern warehouse is not merely an operation to remove products from storage, but a complex of information, labor, transport, and technological processes integrated into a single system. Although modern literature notes the expansion of capabilities in automation, digitalization, and artificial intelligence, adapting technology to the real operating conditions of an enterprise remains a crucial requirement.



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