

Logistics to increase efficiency and reduce losses in agriculture

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Abstract. This article discusses modern approaches to optimizing logistics in the agronomic sector using digital technologies. In the context of growing demand for high-quality agricultural products and increasing global competition, agricultural enterprises are faced with the need to introduce innovative solutions for managing transportation and storage of products. Special attention is paid to the design of a system aimed at reducing losses and increasing the efficiency of logistics processes. The use of information technologies such as transportation management systems (TMS), the Internet of Things (IoT) and machine learning can improve the accuracy and speed of operations, minimize costs and improve product quality. The article discusses in detail modelling methods using UML diagrams, which allows you to create a clear and complete picture of the structure and behaviour of the system. These results demonstrate a significant improvement in logistics processes, which contributes to increasing the sustainability and competitiveness of agricultural enterprises in the global market.

1 Introduction

Modern agriculture faces many challenges related to optimizing logistics processes and minimizing losses during transportation and storage of products. In the context of global competition and growing demands on product quality, effective logistics management is becoming a critical aspect for agricultural enterprises [1-5].

Traditional methods of logistics chain management often fail to cope with dynamically changing market conditions and requirements for transparency and traceability of products. The use of digital technologies such as transportation management systems (TMS), the Internet of Things (IoT) and machine learning provides new opportunities to optimize processes and increase the sustainability of agricultural production [5-9].

In agronomy, where the success of crop cultivation often depends on many factors such as weather conditions, soil quality and the timeliness of agrotechnical measures, logistics plays a key role in ensuring the efficiency and sustainability of the production process. For example, timely delivery of fertilizers and plant protection products can significantly increase

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yields and product quality. It is also important to ensure fast and reliable transportation of finished products to the market, minimizing storage time and losses due to spoilage [10-15].

This article discusses approaches to system design to optimize logistics and reduce losses during transportation and storage of products in an agronomic context. The key components of such a system will be analyzed, including inventory management, optimization of delivery routes, monitoring of storage conditions and interaction with external services. Special attention is paid to the use of UML diagrams to model and visualize the structure and behavior of the system, which allows you to create a clearer and more complete picture of the designed system and its interaction with users and external systems.

The purpose of the article is to show how modern information technologies can be integrated into the logistics management processes of agricultural products to achieve maximum efficiency and minimize losses. As a result, agricultural enterprises will be able to manage their resources more effectively, reduce costs and ensure high quality of their products, which will ultimately lead to increased competitiveness in the global market.

2 Materials and methods

This section describes the materials and methods used to design a logistics optimization system and reduce losses during transportation and storage of products in agronomy. The main focus is on the application of digital technologies and modeling using UML diagrams [16-19].

The system design process began with a requirements analysis, which included interviews with key stakeholders such as logisticians, warehouse workers, drivers and agronomy managers. This allowed us to identify the main needs and expectations of the system. Based on the collected data, various types of UML diagrams have been developed to create a clear understanding of the structure and behavior of the system [20-22]. The diagrams included use case diagrams to identify the main actors and their interactions with the system, class diagrams to identify the key entities of the system, sequence diagrams to display interactions between process participants, activity diagrams to describe workflows, component diagrams to describe the main components of the system and their interactions, deployment diagrams to demonstrate the physical deployment of the system and state diagrams to describe the life cycle of shipments [23-30].

3 Results

This section presents various UML diagrams that have been developed to model a logistics optimization system and reduce losses during transportation and storage of products in agronomy. These diagrams help to visualize the key components of the system, their interactions and behavior, which provides a better understanding and effective system design.

The logistics manager interacts with the system to manage inventory, track shipments and monitor storage conditions. Warehouse workers, in turn, use the system to perform their duties related to inventory management and monitoring of storage conditions. Drivers work with the system to track shipments and get information about delivery routes. The system administrator is responsible for maintaining and configuring the system, ensuring its proper functioning.

This diagram serves as a basis for further modeling and detailing of the system, helping to identify key interactions and functions that must be implemented to achieve optimal operation of logistics processes. Figure 1 shows a Use Case Diagram.

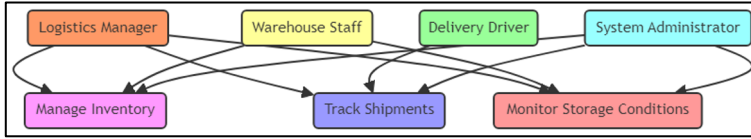


Fig. 1. Use case diagram for an automated millet acceptance system.

Here is a class diagram that illustrates the main objects and their relationships in the system, shown in Figure 2. This diagram provides a detailed view of the structure of the system, defining the main classes, their attributes, methods, and how they interact with each other.

The «StorageUnit» class represents the storages where products are stored. It includes attributes such as «UnitID», location, and capacity, as well as the «monitorConditions()» method, which provides an optimal storage environment. The product class includes attributes such as ID, name, weight and category, as well as the «getPrice()» method for calculating the price of the product. Each product is associated with the storage unit in which it is stored.

The deliveryRoute class defines the routes used to transport products, with attributes such as «routeId», «startPoint», and «endpoint». The «calculateOptimalRoute()» method is used to determine the best delivery path. The shipment class is central to the system, representing the actual delivery process. It includes the shipment ID, the shipment date, the source and destination, and the shipment status tracking method() to track the shipment status. Shipments include the delivery of products along certain delivery routes.

The User class includes attributes such as «userId», name and role, as well as the «login()» authentication method. Users interact with the system based on their roles, which may include inventory management, supply tracking, or monitoring storage conditions.

This class diagram helps to visualize the system components and their interrelationships, providing a solid foundation for further development and implementation.

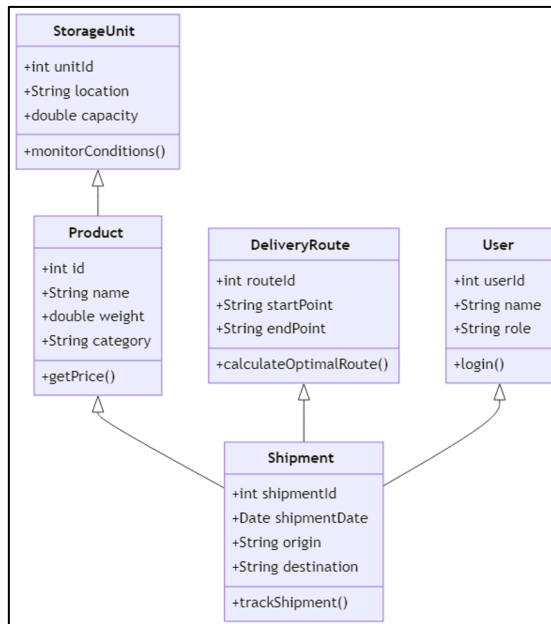


Fig. 2. Class diagram illustrating the structure of the automated millet reception system.

Here is a sequence diagram that shows the interaction between the various participants and the system during the creation and completion of the submission, Figure 3. This diagram illustrates the sequence of events that occur from the initiation of a dispatch request to the confirmation of its delivery.

The process begins with the logistics manager creating a shipment request, which is sent to the warehouse staff. After receiving the request, the warehouse staff prepares the shipment and updates the inventory in the system. The system then confirms the inventory update to the warehouse staff.

The freight forwarder is then responsible for updating the delivery status. As soon as the delivery status is updated in the system, the system confirms this update to the Forwarding Driver. After the shipment is completed, the warehouse staff notifies the logistics manager about the completion of the shipment.

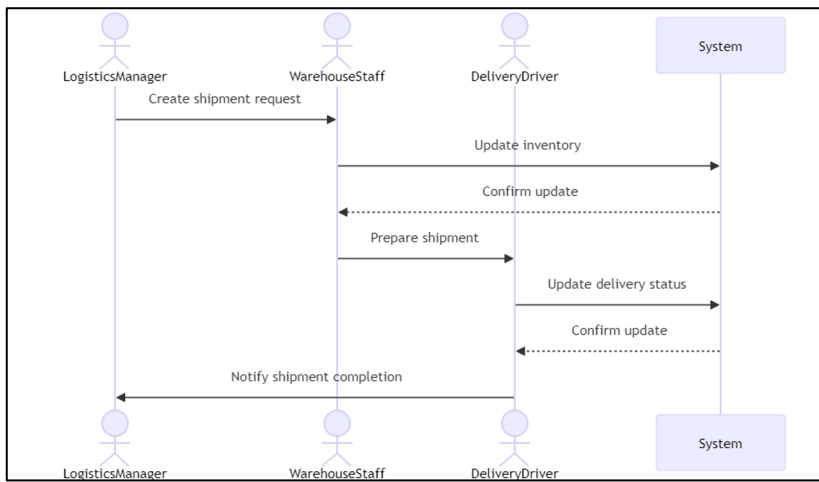


Fig. 3. The sequence diagram.

This Sequence Diagram helps in visualizing the flow of interactions between different actors and the system, ensuring that all necessary steps are clearly defined and understood for the effective management of shipments within the logistics optimization system.

Figure 4 shows the components of the high-level user interface and their hierarchical relationships in the logistics optimization system.

The interface starts with a login screen where users authenticate to access the system. After successfully logging in, users will be redirected to the dashboard, which serves as a central node for navigating through the system's functionality.

From the dashboard, users can access various key modules. The Inventory management module allows users to manage and update inventory data. The shipment tracking module allows users to track the status and progress of shipments in real time. The Storage monitoring module provides tools for monitoring storage conditions, ensuring optimal conditions for storing products. Finally, the User profile module allows users to view and update their personal information and system settings.

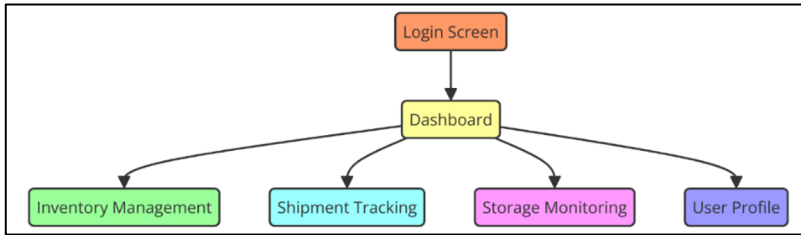


Fig. 4. Diagram illustrating the system interface.

This diagram helps in visualizing the user interface structure and flow, ensuring that the system is user-friendly and that all critical functionalities are easily accessible from the Dashboard.

4 Conclusion

In the modern agronomic sector, effective logistics management is a key factor for ensuring competitiveness and sustainable development. In conditions of constant growth in demand for high-quality agricultural products and increasing global competition, agricultural enterprises need to introduce innovative technologies to optimize their processes. Designing a system to optimize logistics and reduce losses during transportation and storage of products plays an important role in achieving these goals.

The use of digital technologies, such as transportation management systems, the Internet of Things and machine learning, can significantly improve the accuracy and speed of operations related to the movement and storage of products. In agronomy, where the timeliness and accuracy of actions directly affect the quality and quantity of the crop, these technologies are becoming indispensable. Storage monitoring systems help to maintain optimal conditions for products, which prevents spoilage and reduces losses. Optimization of delivery routes and improved tracking of shipments ensure faster and more reliable deliveries, which is especially important for fresh products that require quick access to markets.

The system design described in this article involves the use of UML diagrams to model the structure and behavior of the system. This helps to create a clear and detailed view of all aspects of the system, from user interaction with key functions to the physical deployment of components. This approach ensures the reliability and scalability of the system, which allows agricultural enterprises to adapt to changing market conditions and customer needs. Thus, the introduction of integrated information systems in the agronomic sector contributes not only to improving the efficiency of logistics processes, but also to the overall sustainability of production. This leads to lower costs, reduced losses and improved product quality, which ultimately strengthens the position of agricultural enterprises in the global market. The technological development of agronomy, supported by well-thought-out logistics systems, opens up new horizons for increasing productivity and ensuring food security.

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