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LOGISTIC CONCEPTS AND MICROLOGISTIC SYSTEMS USED IN THE PRACTICE OF LARGE MANUFACTURING ENTERPRISES

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Abstract: This article describes logistics concepts and micrologistics systems employed by many successful foreign companies in business. In particular, it highlights the JIT (Just-In-Time), Kanban micrologistics system, MRP (Material Requirements Planning), and MRP II (Manufacturing Resource Planning) concepts used initially by Japan’s Toyota Motors company and later adopted by other Japanese automotive firms.

Keywords: procurement, warehousing, inventory, transportation, information services supporting production, distribution, macro and micro logistics systems.

INTRODUCTION

Global economic changes necessitate changes in the content, direction, and methods of managing the activities of manufacturing enterprises, as well as addressing the issue of delivering goods produced by manufacturers to the final consumer. Increasing competition forces enterprises to seek additional sources of competitive advantage to succeed in the market.

In this situation, the implementation of a logistics approach to managing production processes becomes an important factor in increasing the economic efficiency of manufacturing enterprises. By introducing a logistics approach in production processes, it is possible to reduce costs from the purchase of raw materials and supplies to the production and sale of finished goods, improve the quality of customer service, and ensure the competitiveness of the enterprise.

Most manufacturing enterprises are organizing logistics departments within their organizational structures. The main reason for this is the need to regularly work with sources of procurement and supply chains under changing market conditions, plan the purchase of raw materials and spare parts, and ensure the continuity of finished goods production. Therefore, manufacturing enterprises pay special attention to the organization of logistics services.

LITERATURE REVIEW

Foreign experts have deeply studied the theoretical foundations of logistics and supply chain management. Martin Christopher (2016) proposed a systematic approach to managing material flows. In his research, Martin Christopher focused primarily on cost reduction, warehouse management, procurement, and the integration of transportation systems [7].

Ballou, in his scientific studies, examined classical models of logistics systems, their economic efficiency, and implementation mechanisms. Ballou paid special attention to planning, forecasting, and evaluation methods of material flows. His research serves as an important source for making economic and organizational decisions in manufacturing enterprises [4].

Alan Rushton, Phil Croucher, and Peter Baker (2010) emphasized in their studies that the organization and management of logistics services in manufacturing enterprises depend on the organizational structure. According to them, clearly distributed tasks and responsibilities among internal departments of a manufacturing enterprise are the main factors in improving the efficiency of logistics services [2].

K. Oliver and M. Webber developed the business logistics concept as an integral instrument of business management for organizing the movement of material resources. They also highlighted significant fundamental differences between marketing and logistics functions in distribution

channels [5].
In manufacturing enterprises, material flow management is directly related to interconnected areas such as procurement, warehousing, inventory, transportation, information services supporting production, and distribution. Therefore, in the economic and organizational mechanism for developing logistics services in manufacturing enterprises, it is necessary to consider procurement, warehousing, inventory, transportation, information services supporting production, and distribution.

MAIN PART

Many successful foreign companies in business utilize logistics concepts based on a completely new philosophy in managing the delivery of material resources. These concepts include JIT (Just In Time), MRP (Material Requirements Planning), and MRP II (Manufacturing Resource Planning). The essence of the JIT concept is that in a continuous production process, raw materials, components, and other supplies are delivered to the place of use only when they are needed. The goal of this concept is to ensure that only the necessary amount of raw materials, components, or parts is delivered just in time to the required workplace or point of consumption. This concept was first implemented in the late 1950s by the Japanese company Toyota Motors and later adopted by other Japanese automobile manufacturers. The term JIT literally means “as needed” or “just in time”

The operating micrologistic systems are built upon this concept and are characterized by the following key features:

– Minimal levels of raw materials, material resources, work-in-progress, and finished goods inventories;
– Short production (logistic) cycles;
– Small volumes of finished goods production and replenished inventories;
– Strict adherence by logistics partners to quality, quantity, and timing criteria during the delivery process, along with an optimal number and placement of these partners.

According to this concept, the required material flow must be delivered just moments before the actual need arises.

In the “Just in Time” (JIT) concept, the flow of material resources begins with the customer’s order for the finished product. The demand or order triggers the movement of raw materials, parts, and components through the logistics system stages, ultimately ensuring the creation of the finished product.

The short cycle of the production logistics system necessitates that the logistics nodes supplying raw materials, materials, parts, components, and semi-finished products be located close to the assembly workshop. The enterprise should select a small number of highly reliable suppliers and strive to maintain close cooperation with them. This is because any disruption in deliveries can cause interruptions in the production schedule. The importance placed on supplier reliability can be illustrated by the fact that many manufacturing companies in the United States and Europe were able to implement the "Just in Time" (JIT) concept only 10 to 15 years later than their Japanese counterparts. The main reason for this delay was that in these countries, relationships and operations with suppliers were not organized at the level required by the JIT concept. According to this concept, suppliers must become partners in the manufacturers' business operations, which is both essential and necessary.

In practical application of the "Just in Time" concept, the quality of the delivered product or component plays a crucial role. Therefore, the micrologistic system must prioritize significantly improving the quality management and control system at every stage of the production process.

Toyota Motors implemented the JIT concept in practice by developing the Kanban micrologistic system. "Kanban" means "card" in Japanese. Designing the Kanban micrologistic system and applying it at Toyota Motors took ten years of dedicated effort.

In the Kanban micrologistic system, all production workshops and units of the enterprise, including the final assembly workshop, are required to supply the necessary material resources in the quantities ordered by the subsequent consumer unit. This means that the logistics nodes must optimize their operations within the limits of the given demand. To facilitate the transfer of material resources to consumer units, special plastic cards are used as a means of information exchange between the nodes. These plastic cards are called Kanban cards.

The effective organization of the movement of Kanban cards within the enterprise solves the problem of delivering material resources to consumers in an optimal manner. The technology of Kanban card movement within the micrologistic system can be described as follows. For simplicity, consider a two-node production micrologistic system. Node A uses component s to manufacture semi-finished product a, and node B uses semi-finished product a to produce finished product b.

Before implementing the Kanban micrologistic system at nodes A and B, special containers are designed and developed, taking into account the size, technical characteristics, handling operations, and delivery specifics of component s, semi-finished product a, and finished product b. In such a system, warehouses are not used, and warehouse operations are not performed. Components produced at each node (parts, semi-finished products, finished products) are stored in containers that also serve as technological transport units. When demand arises at the consumer node, these containers are immediately delivered to it.

Each container includes an envelope for inserting Kanban cards, which carry the following information:

- Component code;
- Name and description of the component;
- Name or workstation code of the logistics node where the component should be used;
- Code of the workstation where the component was produced;
- Name or code of the product (finished, semi-finished, or intermediate) in which the component is used;
- Quantity of components in the container;
- Number of containers.

In the Kanban micrologistic system, two colors of cards are used: white and black. White cards are placed in the envelopes of “inbound” containers at nodes A and V. An empty container with a white card serves as a signal for transportation. Black cards are placed in the envelopes of “outbound” containers from the nodes. An empty container with a black card signals a production order for that node.

In this system, containers and cards move according to the following sequence. Node V produces finished product b based on an order by using the semi-finished product from the inbound container with a white card. As a result, the container with the white card becomes empty. This empty white-card container serves as the basis for transporting the semi-finished product from node A to the input of node V.

The transporter at node V arrives at node A’s area carrying the empty white-card container and replaces the card in the container holding the semi-finished product with a black card. In other words, the transporter swaps the white card they brought with the black card in the container and takes the container back to node V's input. The black card placed in the empty container envelope serves as a production order for node A to manufacture semi-finished product a.

To fulfill this order, node A uses component s, which comes in containers with white cards. As a result, the container holding the white-carded components at node A becomes empty. This signals the preceding node to transport component s to node A.

Even when there are many logistics nodes and components involved, the movement of cards and containers within the system follows the sequence described above.

CONCLUSION

Thus, as a result of the movement of containers and the cards attached to them, when an empty container with a black card appears at the output of a certain node, this indicates a production order for that node. Conversely, when an empty container with a white card appears at the input of a node, it signals a reduction in inventory at that node and serves as an instruction for transportation.

The use of two types of cards in the Kanban micrologistic system requires strict adherence to the following rules:

1) No components (finished, semi-finished, or intermediate) should be produced at a logistics node if there is no empty black card available. During such periods, workers may focus on other tasks as specified in regulations, for example, projects aimed at improving quality.

2) Only standard containers should be used, and they must be fully loaded when dispatched.

3) Each container must correspond to exactly one white or one black card.

To further develop the use of logistics concepts and micrologistics systems employed in the practice of large manufacturing enterprises, it is advisable to implement the following measures:

1) Implement Integrated Logistics Systems: Manufacturing enterprises should adopt integrated logistics management systems that unify procurement, production, inventory, and distribution processes. This will help streamline material flows, reduce costs, and improve overall operational efficiency.

2) Develop Strong Supplier Partnerships: Establish close and reliable relationships with a limited number of trusted suppliers to ensure timely and quality delivery of raw materials and components. Supplier collaboration is crucial for the successful implementation of just-in-time (JIT) and Kanban systems.

3) Invest in Information Technologies: Utilize advanced IT solutions such as ERP (Enterprise Resource Planning) and SCM (Supply Chain Management) software to enhance visibility and coordination across all logistics stages. Real-time data exchange between suppliers, production units, and distributors is essential for responsive logistics operations.

4) Optimize Inventory Levels: Focus on minimizing inventory at all stages—raw materials, work-in-progress, and finished goods—by applying JIT principles. Reducing inventory not only lowers holding costs but also improves cash flow and reduces waste.

5) Enhance Quality Control: Integrate quality management into every stage of the logistics and production process. Continuous monitoring and improvement of quality will reduce defects and delays, which are critical for maintaining an efficient supply chain.

6) Train and Engage Employees: Provide regular training to employees on logistics principles, JIT, and Kanban methodologies. Engaged and knowledgeable staff are vital for sustaining logistics improvements and adapting to changes quickly.

7) Conduct Continuous Process Improvement: Regularly analyze logistics performance using key metrics and adopt lean management practices to identify and eliminate inefficiencies in the material flow and logistics operations.

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