Optimization of Enterprise Digital Material Management Based on Supply Chain

Chen Jiahang

Macau University of Science and Technology, Macau, China 999078;

Abstract: With the rapid development of digitalization, enterprise material management gradually changes from traditional static mode to intelligent and collaborative mode. Based on the supply chain view, this paper analyzes three features of enterprise digital material management from the perspective of data-driven process, platform collaboration and flexible response. At the same time, the main problems of system integration failure, information island and supply chain collaboration attenuation are analyzed. According to the above analysis, this paper puts forward three optimization strategies: construct unified data platform, upstream and downstream collaboration and apply intelligent decision-making system. Through theoretical analysis and strategy suggestions, this paper provides a systematic reference for enterprise material management optimization and supply chain enhancement.

Keywords: digital management; supply chain collaboration; material management; intelligent decision-making system

DOI:10.69979/3041-0843.25.02.011

Introduction

In the face of global industrial chain adjustment and technology innovation, enterprise material management requirements are put forward to be higher and higher. Traditional material management mode mainly depends on manual and dispersed process can't meet the development trend of supply chain that is required to be more real-time, dynamic, complex. And then, digitalization as an important method to enhance the management level and adjust the operation mode gradually penetrated into the enterprise material management field. Especially in the supply chain scenario, real-time information sharing, efficient business collaboration and intelligent decision optimization have become the core competitiveness of enterprise. This paper takes the practice of enterprise digital material management as the research object, discusses its evolution characteristics, existing problems and optimization ways, and explores the theoretical and practical basis to build a kind of new intelligent, collaborative and efficient supply chain material management system[1].

1 Characteristics of Enterprise Digital Material Management Based on Supply Chain

1.1 Data-Driven Transparent Processes

In the face of digitalization, material management in enterprise supply chains are gradually moving from reliance on experience to reliance on data. By placing IoT sensing devices and connecting with ERP and WMS, enterprises can record and collect all data collected through the process (from procurement and warehousing to distribution) and make all material flow nodes traceable. This accumulation of data from the entire process not only enhances the enterprise's ability to understand materials, but also enables them to respond quickly to exceptions. For example, warehouse turnover rate and inventory turnover days can be monitored in real time, giving management a scientific basis to make adjustments[2].

In addition, reliance on data for management paves the way for process transparency. Transparent information enables departments to collaborate effectively under a data standard, eliminating manual scheduling, manual triggering of links, and process blockages commonly seen in traditional management. Particularly in distributed multi-location supply chain scenarios, a unified data platform is enabled to share and track materials across regions, assisting enterprises in scheduling available materials and making supply forecasts. With the continuous improvement of data mining and

visualization technologies, the mining process of material management is gradually becoming traceable, predictable, and quantifiable[3].

1.2 Platform-Based Collaborative Intelligent Integration

How do enterprise digital material management platforms achieve cross-company collaboration from order generation to material receipt by integrating procurement systems, warehouse management systems, and logistics tracking systems.By operating in a platform-based integrated management model, enterprise digital material management platforms can break through departmental information islands and connect procurement, warehousing, logistics, finance, and other links of the supply chain.In traditional operations mode, due to the lack of connection and information dispersion between different data systems, often lead to delayed and erroneous information from different links.

Built on common standards and process architectures, the intelligent collaborative platform can form an integrated linkage relationship of “systems + data + processes” of “systems + data + processes”. The operation efficiency is greatly improved.The other important advantage of intelligent integration is the ability of dynamic collaboration. Based on the application of AI algorithms and rule engines, it can automatically recommend material allocation and optimize logistics routes; based on the intelligent alarm mechanism, it can timely warn situations such as out-of-stock of warehouses and late delivery, reducing the risk of decision-making caused by manual intervention. In the face of multiple suppliers, warehouses, and customer demands, platform intelligence is an important means to coordinate supply and demand and ensure the stability of the supply chain.Based on the collaboration platform, enterprises can further extend the integration of information to upstream and downstream, promote the construction of digital ecosystem-oriented supply chain[4].

1.3 Flexible Responsiveness and Efficiency Enhancement

When large amounts of digital material in material storage and management systems are highly automated and intelligently coordinated, enterprise flexibility is greatly enhanced. Traditional planning models are static, meaning enterprises adjust to changing market demand only after the fact. In contrast, modern supply chains can adjust in real time to changes in inventory and delays in supply. Enterprises set multi-scenario rules in the system to automatically activate procurement replenishment, priority shipping, or transfer of inventory, enhancing timeliness and adaptability of material assurance significantly. This highly flexible response capability is of particular value to manufacturing and engineering enterprises, which can thereby reduce downtime due to shortages of materials, backlogged inventory, and associated operational risk.Flexibility is manifested in two dimensions: system adaptability and changes in enterprise management mode.

Enterprises are transformed from “manual oversight” to a new management mode of “system-driven plus human-machine collaboration” on the basis of using digital platforms. The system enables reengineering of enterprise business processes and optimized allocation of human and material resources. In addition to supporting stable daily material flow, the system can analyze historical data and run AI forecasting in enterprises experiencing emergencies to assist them in quickly establishing alternative plans, thereby enhancing emergency preparedness. By combining flexible response mechanisms and efficient execution systems, enterprises can ensure stable daily flow and maximize resource efficiency and effectiveness with greater flexibility and resilience in face of emergencies[5].

2 Problems in Enterprise Digital Material Management Based on Supply Chain

2.1 Difficulty in System Integration

In the practical applications of many enterprises, the materialization management related systems have always been "siloed" architecture, namely the procurement, warehousing and transportation, finance and other modules are independently running and independently deployed. This architecture makes it impossible for the data between systems to be connected and form a closed process.Even if enterprises start the digital transformation in practice, there will always be conflicts in data structure, communication protocol and process logic between the old and new systems. Therefore, it is hard to connect and integrate them, taking a long time and high cost. Without unified standard and specification to support the integration of the systems, the problems like failure of system interface, data conversion error and duplicated

development often happen, which seriously affect the efficiency of the data.

In addition, when choosing and running the systems, enterprises always blindly rely on one vendor and lack of proper architecture design, which makes it hard to expand in the future. If the business requirements change, such as multi-warehouse distribution, cross-regional allocation, upstream and downstream cooperation, the previous systems can't scale flexibly, and enterprises will have to invest a lot of human and material resources to redevelop and waste a lot of time and money.The difficulty of system integration not only hinders the promotion of digital material management but also reduces the expectation of enterprises on the digital transformation and becomes a big bottleneck for the efficient supply chain management.

2.2 Information Silos Impact Decision Making

The most obvious and urgent building block issue in the digitalization of the material management of enterprise is the information silos.According to the departmental segmentation, system segmentation and permission segmentation, the data in the enterprise is trapped in each department and each system. The procurement department only knows the supplier delivery data, warehouse only knows the goods storage status, finance only knows the cost accounting and budget control of each department, and there is no real-time linkage between three situations.That is to say, the business makes decisions based on delayed, partial and even false data, and the ability of enterprise response and carry out the refined management is limited.

Even worse, the information silos will trigger the problems of such as duplicate purchasing, stock backlog and deviation between account and material. Especially when the demand of material rises sharply or the supply is unstable, if the department can’t trigger the automatic warning and sharing of resource based on the system, it will lead to some department “emergency stockout” and other department “surplus storage”. In the end, it will lead to the cost increase and material utilization rate decrease. The information silos not only affect the management efficiency, but also directly restrict the data importability of the digital platform. The data-driven management is only a superficial level and can’t get the expected data support.

2.3 Weakened Supply Chain Collaboration

Although many enterprises have established an internal digital platform for material management, the efficiency of collaboration upstream and downstream with upstream and downstream partners in the whole supply chain is still weak. External entities such as suppliers, carriers and customers all use their own information system, interface specification is not unified and the business process is also different, which leads to poor efficiency of cross-organization data exchange.Material procurement and distribution plans are made through manual communication and data entry. This not only leads to an increase in the rate of human error and communication cost, but also leads the material supply chain to be powerless to market demands.

Weaken Collaboration with the Material Supply Chain Also Reflects the Lack of Awareness of Whole-Chain Optimization and Mechanism. Enterprise often develops process and rules based on itself, ignoring the coordination and optimization of resources along the whole material chain, which leads to information distortion between upstream and downstream, and even the cutoff of supply and delay in delivery.When there are sudden material shortages, restrictions on transportation strength, sudden order surge or other extreme situations, the lack of collaboration mechanism will lead the material supply chain to be greatly affected in terms of material assurance and contract fulfillment ability.Only by changing the "enterprise-centered" thinking into "throughout the whole material chain" and establishing the collaboration mechanism centered on data sharing, risk linkage and process integration, can we play the value of enterprise digital material management.

3 Optimization Strategies for Enterprise Digital Material Management Based on Supply Chain

3.1 Building a Unified Data Platform

The construction of common data platform is the beginning point of digital materialization for enterprise. The key point of common data platform lies in breaking the data isolation for various internal functional modules and construct a

kind of standardized, reasonable and open-type interface data system. By the construction of common data platform, integrate the enterprise's ERP, WMS, MES and other business systems, realize the cross-module sharing of data for various links from procurement, inventory, logistics to finance, and the whole material flow process from origin to warehouse can be monitored and tracked centrally. The standardized data interface can avoid the repeated data entry and information transmission errors, and greatly improve the timeliness, accuracy and consistency of data, data cleaning, interface data interface data, providing a good basis for the following intelligent analysis and efficient decision-making.

In terms of technical implementation, enterprises can adopt "data middle platform + business front end" solution. Data integration, cleaning, storage and invocation are concentrated in the layer of common data platform, and the front-end system calls data according to the business configuration. By using the cloud platform and microservice architecture, the cost of system construction and maintenance can be greatly reduced, and the scalability and adaptability are enhanced. The construction of unified data platform can not only improve the efficiency of enterprise's daily operations, but also quickly allocate and mobilize resources, inventory and procurements in time of sudden material demands, and enhance the material assurance response speed.

More importantly, the unified data platform enables the enterprise to build its own data assets. The platform accumulates historical data continuously during the operation. Combined with data visualization and BI analysis based on historical data, the manager has an intuitive and comprehensive material management profile, and the plan, budget and strategy of the enterprise can be based on this profile to achieve a strategic upgrade from "experience-driven" to "data-driven". The unified data platform is the enterprise's digital nervous system, and it is the first handle to keep the enterprise running efficiently in the face of complex supply chain.

3.2 Promoting Upstream and Downstream Collaboration

Promoting upstream and downstream cooperation is an important way to break enterprise boundaries and extend the application of digital material management.Under the traditional "manual-based" material management mode, although the internal process has reached certain levels of informationization, cooperation with suppliers, carrier and customers are still mainly based on "documents + manual", and there are no efficient real-time business interface mechanisms.By creating a cooperation platform for the supply chain, enterprise can share information like material demand forecast, inventory and logistics in-transit with upstream and downstream partners, and then do advanced production or allocation planning to ensure the response capability and stability of the whole chain.

Promotion of cooperation can be promoted from both procurement and distribution ends.On the procurement end, through electronic bidding, online confirmation of orders and supplier performance evaluation system, it is possible to achieve digital integration and dynamic management of upstream supplier resources.On the distribution end, through the logistics visualization system and integration of logistics third party platform, it is possible to achieve route optimization of transportation, monitoring and early warning of delivery timeliness.

Finally, through the establishment of VMI (Vendor Manged Inventory) or CPFR (Collaborative Planning, Forecasting and Replenishment) mechanism with key customers, it is possible to achieve true integration of production, supply and sales. This kind of planning linkage under information symmetry can greatly reduce the inventory cost and stock-out risk.Cooperation realization is not only about technological system integration, but also about establishing stable cooperative mechanism. On the one hand, enterprise should sign data sharing agreement with key core suppliers and customers, and set the standard of cooperation operation, and then promote the cooperation from "transactional" to "strategic". On the other hand, by creating a multi-acts co-constructed and shared collaborative ecosystem, enterprise can establish a good external support system for digital material management, and then further enhance the flexibility and stability of the chain through this ecosystem.

3.3 Introducing Intelligent Decision-Making Systems

On the basis of preliminary improvements in data platforms and collaborative mechanisms, introducing intelligent decision-making systems is the next critical step to further improve quality and efficiency of material management.Based on artificial intelligence, machine learning and big data technologies, enterprises can establish intelligent models of

material procurement, inventory and allocation planning, and automate and optimize core decision-making links such as material procurement, such as demand forecasting, timing of procurement judgment and inventory optimal solution, replacing previous experience-based judgment through intelligent systems outputting the best solutions in history and current data. This will greatly improve decision-making quality and efficiency.

For example, when it comes to inventory management, intelligent systems will use sales forecast, seasonality, material characteristics and procurement cycle as multidimensional models to automatically generate safety stock and replenishment strategies to avoid over-purchasing and stockouts. In case of emergencies, the system will automatically simulate and recommend several feasible allocation plans to the enterprise to respond to market changes rapidly. On the other hand, intelligent algorithms will discover procurement anomalies and supply risks in advance and trigger early warning. This helps the enterprise improve management with an awareness in advance and foresight.

Intelligent decision-making systems are not about completely replacing humans but establishing a new management model of "human-machine collaboration". When it comes to complicated decisions, the system recommends several analytical directions and decision-making references, and the manager uses experience and situation judgment to select and control in order to help achieve more scientific and robust overall decisions. Intelligent decision-making systems represent the enterprise's evolution from "informatization" to "intelligentization" and are also the basic weapons to achieve lean material management, cost reduction, efficiency improvement and risk control. The value of algorithms and data will increase exponentially to the enterprise gradually.

4 Summary

This paper systematically studies the optimization of enterprise digital material management based on the supply chain from three dimensions: digital characteristics, existing problems, and optimization paths. The analysis reveals that modern material management features three main characteristics — data-driven, platform collaboration, and flexible responsiveness — indicating a shift from informatization to intelligent management. However, during practical implementation, enterprises still face bottlenecks such as difficulties in system integration, severe data silos, and insufficient supply chain collaboration efficiency, which hinder the full realization of digital management's value.

To address these issues, this paper proposes three optimization strategies: first, building a unified data platform to solve data inaccessibility and information fragmentation among systems, thereby improving information sharing and process transparency; second, promoting upstream and downstream collaboration to break enterprise boundaries and achieve real-time linkage with suppliers, logistics providers, and customers; third, introducing intelligent decision-making systems leveraging artificial intelligence and big data technologies to enhance forecasting, scheduling, and optimization capabilities, thus advancing scientific and forward-looking decision-making in material management. In the future, with continuous technological iteration and upgraded enterprise management concepts, digital material management will play a greater role in the supply chain. Enterprises should strategically emphasize data capability building, promote business process reengineering, and implement ecological collaboration mechanisms to truly realize the leap from "data-governed enterprises" to "intelligence-governed supply chains."

References

[1] Jiao Xiaojing. Does Enterprise Digitalization Enhance Supply Chain Resilience? — From the Perspective of Supply and Demand Fluctuations [J]. Enterprise Economics, 2025, 44(05):128-139.
[2] Hu Haiyang. Research on Digital Material Management Practice in Power Enterprises [J]. Sales and Management, 2025, (02):21-23.
[3] Wang Junsheng, Cui Wei, Chu Huayu, et al. Optimization Strategies for Digital Material Management of Power Grid Enterprises Based on Supply Chain [J]. Logistics Technology, 2024, 47(22):139-142.
[4] Huang Tao. Research on the Impact of Enterprise Digital Transformation on Supply Chain Management [J]. China Electronic Business, 2024, (15):64-66.
[5] Wang Qipeng, Li Tailin, Gong Ye, et al. Application of Digital Supply Chain Collaborative Management in Manufacturing Chain-Lead Enterprises [J]. Value Engineering, 2024, 43(02):89-91.