

Research on Supply Chain Collaboration in Smart Manufacturing Based on Demand Forecasting

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Abstract: Smart manufacturing through supply chain collaboration refers to the use of advanced information technology and data analysis means to carry out refined management and collaborative optimization of each link in the supply chain, so as to achieve efficient coordination and cooperation among production, circulation, and service links. As the basis of supply chain collaboration, demand forecasting is of great significance to the smart manufacturing industry. Carrying out supply chain collaboration in smart manufacturing based on demand forecasting could improve the accuracy of production planning, reduce inventory costs, shorten the delivery cycle, enhance the flexibility of the supply chain, and optimize resource allocation, with the aim of improving the competitiveness and profitability of enterprises. In this paper, the significance of demand forecasting for supply chain collaboration in smart manufacturing is explored. The strategy of smart manufacturing supply chain collaboration based on demand forecasting is also investigated.

Keywords: demand forecasting; smart manufacturing; supply chain collaboration

1. Introduction

The “14th Five Year Smart Manufacturing Development Plan” has clearly put forward that “by 2025, 70% of the manufacturing enterprises above the scale will basically realize digitalization and networking, and the maturity of the smart manufacturing capability will be significantly improved”. In 2022, the maturity index of China's smart manufacturing was 106 with an annual growth of 6%. The effectiveness of implementing smart manufacturing in manufacturing enterprises was highlighted.^[1] As shown in Fig. 1, the national level of smart manufacturing maturity has been steadily improved. As China's smart manufacturing became more mature, it has also put forward higher requirements for supply chain management. Smart manufacturing through supply chain collaboration refers to achieving information sharing, collaborative decision-making and resource optimization among manufacturing enterprises and upstream and downstream enterprises in the supply chain through information technology means, so as to improve the efficiency and flexibility of the entire supply chain.

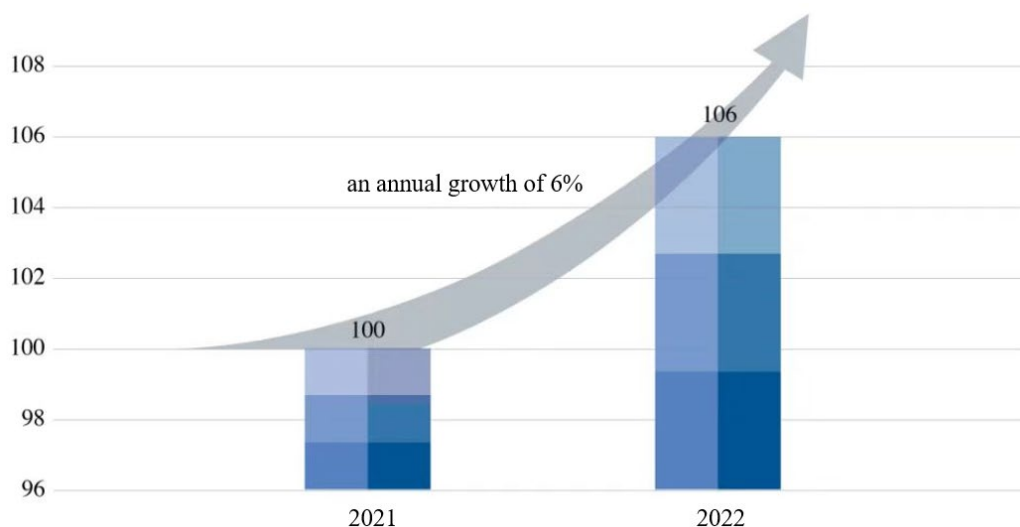


Figure 1: China's smart manufacturing maturity^[2]

However, in the development of smart manufacturing, demand forecasting plays a crucial role. It

could help enterprises make plausible decisions on production planning, inventory management, logistics and distribution. Supply chain collaboration in smart manufacturing based on demand forecasting is an important research field, with the goal of improving the efficiency and accuracy of production planning and logistics processes by optimizing the collaboration and cooperation among various links of the supply chain. Research on supply chain collaboration in smart manufacturing based on demand forecasting focuses on demand forecasting technology, information sharing and collaboration, optimization of the operation model, supply chain finance and risk management, and technical support and platform construction, etc. These researches would help to improve the overall efficiency and competitiveness of the supply chain in smart manufacturing and promote the transformation and upgrading of manufacturing industry.

2. Demand Forecasting Techniques and Features

In digital supply chain management, demand forecasting is a very important technology featuring accuracy, flexibility, real-time and interpretability. It could help enterprises accurately predict the demand in a future period and further make decisions on production, procurement, inventory management and other decisions based on these forecasts so as to optimize the supply chain efficiency and cost. Demand forecasting techniques usually include the following 3 kinds. The first is statistical modeling techniques, which could forecast based on historical data and statistical methods. Common statistical models include moving average method, exponential smoothing method, regression analysis and so on. These methods are suitable for stable demand patterns and longer period forecasts. The second is time series analysis technique, which could analyze and forecast based on time series data. It would take into account factors such as season, trend and cyclical, and use models such as ARMA, ARIMA, GARCH for forecasting.^[3] The third is machine learning techniques, which could forecast future demand by building forecasting models. Machine learning algorithms could automatically learn and adjust models based on historical data and various variables, such as decision trees, random forests, and neural networks. These methods are suitable for dealing with complex demand patterns and large amounts of data. Demand forecasting techniques play a vital role in supply chain management. By choosing suitable technologies and methods and combining them with the actual situation of the enterprises, the efficiency of the supply chain would be improved while costs would be reduced. Moreover, customers would be more satisfied. (As shown in figure 2)

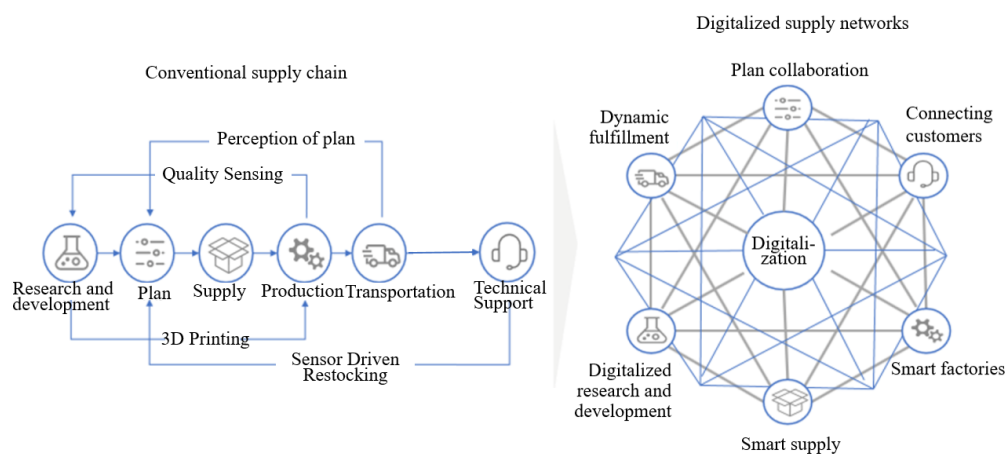


Figure 2: Traditional supply chain and digital supply chain^[4]

3. Significance of Smart Manufacturing Supply Chain Collaboration Based on Demand Forecasting

3.1 Improving Accuracy of Production Plan

Through demand forecasting technology, the demand for products and types could be evaluated more accurately, and production plans could be made according to the forecast results, so as to provide a reliable basis for the production plans of all links in the supply chain. In this way, surplus or out-of-stock situations due to demand fluctuations could be avoided, and the accuracy and feasibility of production plans could be improved. In addition, based on demand forecasting technology, supply chain flexibility

could be enhanced. Moreover, demand forecasting could help enterprises better respond to fluctuations and changes in market demand, and timely adjust the layout and organizational structure of the supply chain. By flexibly adjusting all links of the supply chain, enterprises could better adapt to market demand, provide personalized products and services, and enhance competitiveness.

3.2 Optimizing Inventory Management

Supply chain collaboration based on demand forecasting could help enterprises better control the inventory level. According to the results of demand forecasting, all links in the supply chain could jointly negotiate to determine a reasonable level of safety stock, and avoid the problem of inventory backlog or inventory shortage, so as to reduce inventory costs. At the same time, demand forecasting could help enterprises accurately grasp the trend of changes in customer demand, so as to better manage and control the inventory. Through timely understanding of changes in market demand, the inventory would be adjusted and the efficiency of supply chain management would be improved.

3.3 Shortening Response Time of Supply Chain

Through information sharing and collaborative optimization, participants in the supply chain could obtain market demand information faster and adjust the production plan and logistics process in a timely manner, which would be helpful in shortening the response time of the supply chain and promoting the sensitivity and responsiveness of the enterprise to the market demand. Moreover, supply chain collaboration could improve the efficiency of information sharing and communication between the various links, which can help the enterprise to make plausible production preparations in advance, optimize the logistics distribution plan, reduce delivery time and enhance the satisfaction from customers.

3.4 Optimizing Resource Allocation

Demand forecasting could help enterprises rationally plan and configure production resources, improve resource utilization. Through the accurate demand prediction, enterprises could avoid the surge in costs due to resource wastage, so as to achieve the optimal resource allocation. Meanwhile, through the supply chain collaboration in smart manufacturing based on demand forecasting, the lean management of the supply chain could be implemented while the waste of resources and repeated inputs could be avoided. Moreover, the cost of the whole supply chain could be reduced by means of optimizing the operation mode, reducing the inventory and transportation costs.

3.5 Enhancing Stability of Supply Chain

Supply chain collaboration in smart manufacturing based on demand forecasting could reduce uncertainty and risk in the supply chain. By sharing forecast information of the demand, all participants in the supply chain could better cooperate and coordinate, reduce the impact of order fluctuations on the supply chain, and improve the stability and reliability of the supply chain.

4. The current Situation of Supply Chain Collaboration in Smart Manufacturing Based on Demand Forecasting

4.1 Internet of Things technologies are being widely used

In 2022, 37% of China's manufacturing enterprises had entered manufacturing stage enabled by digitalization and networking, reaching the maturity level of smart manufacturing to L2 and above. The proportion registered a three-year increase of 12 percentage points (Figure 3).^[5] Digitalization technologies have been widely used in smart manufacturing. At the same time, Internet of Things (IoTs) technologies have also been widely used in supply chain collaboration in smart manufacturing. By establishing a unified data platform, the integration and sharing of data from all links could be implemented, and information interoperability between upstream and downstream links in the supply chain could be achieved. In this way, the accurate acquisition of demand information could be obtained while the error and delay of information transmission could be reduced. Meanwhile, IoT technologies could help realize real-time monitoring and data collection of all links in the supply chain, thus providing more accurate demand forecasting and supply chain status monitoring. For example, by utilizing IoT sensors, real-time monitoring of actual product sales, inventory levels and transportation status could be

achieved and more accurate data support for demand forecasting could be offered.^[6]

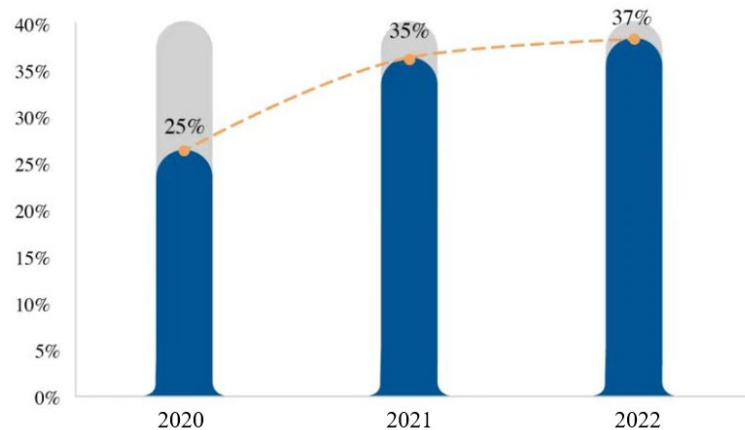


Figure 3: Percentage of manufacturing enterprises enabled by digitalization in smart manufacturing^[5]

4.2 Application of Demand Forecasting Model

When carrying out supply chain collaboration in smart manufacturing, accurate demand forecasting models would be established by utilizing advanced data analysis methods and machine learning algorithms. These models could predict future demand and change trends of the demand based on historical data, market trends and other relevant factors. Applying these models could help manufacturing enterprises and the corresponding upstream and downstream enterprises in the supply chain to plan production and manage inventory more accurately, so as to reduce surplus and out-of-stock situations.^[7]

4.3 Collaborative Decision-making across Organizations

Collaborative decision-making across organizations has been frequently applied in the current supply chain collaboration in smart manufacturing. Through the supply chain management system and collaborative decision-making platform, collaborative decision-making among the upstream and downstream enterprises of the supply chain could be achieved. For example, if a change occurs in the demand forecast, the system could automatically issue an early warning notice and make linkage adjustments to the production plan, inventory and transportation. Note that supply chain collaboration in smart manufacturing based on demand forecasting still faces some challenges, including data privacy protection, data quality and accuracy, and the difficulty of cooperation across organizations. In the future, we need to further strengthen technical research, improve the accuracy and practicality of data analysis and algorithms. Moreover, we need to actively promote cooperation and consensus among parties in the supply chain to achieve more efficient and flexible supply chain collaboration.^[8]

5. Suggestions for Conducting Supply Chain Collaboration in Smart Manufacturing Based on Demand Forecasting

5.1 Improving Information Technology Construction

In terms of information technology construction, first of all, it is necessary to build a unified information platform to integrate and share the data of upstream and downstream links in the supply chain. The platform should support real-time data collection and exchange to ensure that demand information is shared in an accurate and timely manner. In addition, advanced data analysis and forecasting technologies should be introduced. By adopting advanced data analysis and machine learning algorithms, accurate demand forecasting models could be built. These models could predict future demand and demand change trends according to historical data and other relevant factors. Meanwhile, these models should be continuously optimized and updated to improve the accuracy and practicality of the forecast.

5.2 Enhancing Collaborative Decision-making among Links in Supply Chain

During the process of carrying out supply chain collaboration in smart manufacturing based on

demand forecasting, collaborative decision-making among upstream and downstream enterprises in the supply chain could be realized through the establishment of a supply chain management system and collaborative decision-making platform. In case changes occur in demand, early warning notification would be issued automatically through the system, and decisions on linkage adjustment of production plan, inventory, and logistics distribution could be made so as to ensure the efficient operation of the supply chain. Meanwhile, supply chain cooperation and consultation should be strengthened. Cooperation mechanisms and consultation channels among supply chain participants should be established. All participants on the supply chain should jointly formulate rules and decision-making mechanisms for supply chain collaboration, which could enhance trust and cooperation among enterprises and promote information sharing and resource optimization.

5.3 Emphasizing Applications of IoT Technologies

Supply chain collaboration in smart manufacturing could not be carried out without the application of IoT technologies. With the help of IoT, big data, artificial intelligence and other new technologies, the supply chain collaboration platform for smart manufacturing could be constructed to provide real-time data analysis and decision-making support for the supply chain, so as to realize collaboration and win-win cooperation among all participants in the supply chain. IoT technologies could help to realize the real-time monitoring and data collection of all links of the supply chain, so as to provide a more accurate demand forecasting and supply chain state monitoring. For example, by using IoT sensors real-time monitoring of actual product sales, inventory levels and transportation states could be achieved, thus providing more accurate data support for demand forecasting. At the same time, the application of IoT technologies could also optimize the operation mode of the supply chain, including order management, inventory management, production planning, etc. With the help of demand forecasting technologies and real-time data analysis, IoT technologies could also help to realize the dynamic adjustment and collaborative optimization of all links on the supply chain.

5.4 Continuously Improving Feedback Mechanism of Supply Chain

In the feedback process of various links on the supply chain, information sharing and collaboration is the basis for carrying out supply chain collaborations. However, information distortion may happen among links on the supply chain during information transmission (Figure 4), so information sharing and collaboration among participants in the supply chain is crucial. Through the establishment of an effective information platform and data exchange mechanism, information fluency among upstream and downstream enterprises in the supply chain could be realized while the accuracy and response speed of the plan could be enhanced. In addition, it is also necessary to establish a perfect supply chain feedback mechanism to collect and analyze the data and feedback information from all links on the supply chain in a timely manner, so as to continuously improve and optimize the operation mode and decision-making strategy of the supply chain.

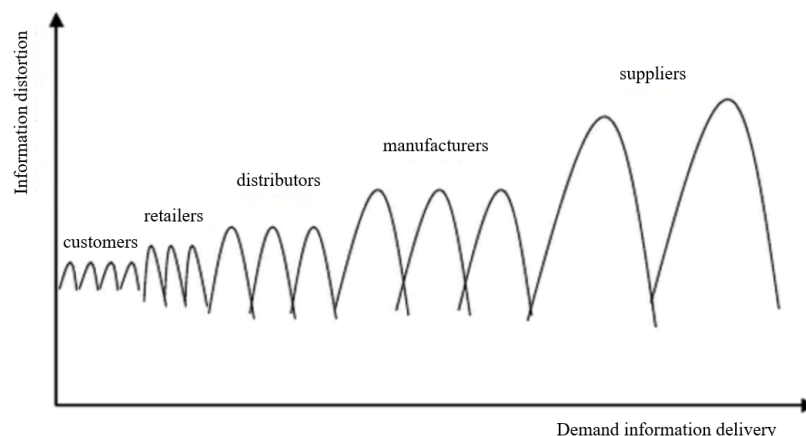


Figure 4: Information transfer efficiency of all links on the supply chain^[9]

6. Conclusion

In summary, supply chain collaboration in smart manufacturing based on demand forecasting could

improve production planning accuracy, optimize inventory management, shorten response time of the supply chain, reduce its costs and enhance its stability. These advantages would help to enhance the competitiveness and sustainable development of the smart manufacturing industry. Therefore, enterprises need to make comprehensive use of information technology, data analysis and collaborative decision-making to achieve close cooperation and collaborative optimization among upstream and downstream enterprises on the supply chain. With the continuous development of technology and the accumulation of application experience, it could be predicted that the supply chain collaboration in smart manufacturing would further improve efficiency and flexibility, bringing more competitive advantages for enterprises.

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