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Supplier relationship management, information system and logistics operation in manufacturing industries: Basis for lean supply chain management framework

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Abstract

Manufacturing success hinges on a synchronized and efficient supply chain. Lean Supply Chain Management (LSCM) principles promote waste elimination and continuous improvement, but their effective implementation necessitates robust foundations in Supplier Relationship Management (SRM), Information Systems (IS), and Logistics Operations. This study explores the intricate relationships between these elements, laying the groundwork for a comprehensive LSCM framework tailored for modern manufacturing industries. The study aimed to examine the supplier relationship, information system and logistics operations management in manufacturing companies that were made as basis in developing a lean supply chain management framework. This study used the descriptive quantitative method to describe and analyze the relationship between supplier relationship management, information systems and logistics operation. Survey questionnaire was used as the data gathering instrument. 500 employees from logistics companies were used as the participants of the study. The respondents showed moderate agreement on the supplier relationship management in terms of cooperation, quality and cost. Supplier relationship management is an effective way to manage supplier relationships and improve business performance. They also moderately agreed on logistics operation as to time, space, and cost and that the logistics operation is well-managed and efficient. The high significant relationship between Supplier Relationship Management, Information System and logistics operation implies that these three factors are interconnected and that they all play an important role in business success. A lean supply chain management framework was developed for manufacturing companies. The study can contribute to the dissemination of best practices in lean supply chain management by showcasing how effectively integrated supplier relationship management, information systems and logistics operations can optimize supply chains. The research can inspire further innovation in LSCM approaches and technologies, leading to the development of new tools and frameworks for effective supply chain management.

Keywords: supplier relationship management, information system, logistics operation, lean supply chain management

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1. Introduction

Since entering the 21st century, globalization has been deepening and market competition has become increasingly fierce. Manufacturing enterprises, always through the production of newer products to attract customers, so as to win the opportunity to survive. This is mainly reflected in the following aspects of product homogenization. With the promotion of technology and standardization, the production process and product planning of many commodities become similar. The same production equipment, may be a different brand, different operators to operate, the production of product quality is much the same; and the use of the same industry quality standards, similar industry testing equipment or methods as commodity testing tools, the quality of products produced under such standards is not much difference. Market-oriented competition and imitation. In the market competition of a single commodity, when an enterprise launches a new product, then other competing enterprises can easily through reverse research, and will soon use the same or similar equipment, technology to realize the related standard products. As industrial technology continues to mature, the speed of catching up between product technologies is becoming faster and faster, and the composition of finished products seems to be transparent from the manufacturing end, and this is a serious situation faced by manufacturing companies, especially automotive manufacturers or automotive component manufacturers. To stay ahead of their competitors in terms of cost, companies must focus on supply chain management. Only by paying attention to supply chain management, can we have a stable supply of parts, work in progress, finished products, can we have a reasonable supply chain costs, and ultimately realized in the product, can reflect the competitive price.

Supply chain costs include, but are not limited to, supplier development and management costs, costs related to logistics planning and operation. In the production and operation, if the suppliers provide raw material prices lower than competitors, internal warehousing, packaging, logistics personnel losses, packaging, appliances, transportation and other costs are lower than competitors, then in the product homogenization of today's products, the price of the product has a greater optimization of the space, will be able to let the consumer benefit. Supply chain management includes the integration of business processes from the end user to the initial supplier to provide customers with value-added products, services and information, which includes the management of logistics, capital flow and information flow. Lean Supply Chain Management (LSCM), or LSCM for short, originates from Toyota's Lean Manufacturing Theory, which integrates the steps and partners required in the entire process from product development and design, production, and sales to the end consumer's access to the product in order to quickly respond to the changing needs of the customer, and is a way to optimize the entire supply chain, including upstream and downstream, to reduce unnecessary steps. Supply chain optimization to reduce unnecessary steps, waiting, consumption and waste. A series of supply chain planning, implementation and control processes to minimize costs and maximize customer satisfaction with as few resources as possible. Therefore, it can be seen that lean supply chain is divided into three phases, namely planning (or design), implementation (or execution) and control (i.e., dealing with deviations, risks and optimizing them for efficiency). In terms of composition, lean supply chain management also involves supplier relationship management, information systems and logistics operations management, which together influence the stability of lean supply chain management.

Regarding supplier relationship management, Amoako-Gyampah et al. (2019) argued that supplier relationship management is a purposeful practice of firms that emphasizes on supplier relationship development (information sharing, joint investment) and maintenance (information sharing, joint investment) to ensure timely and correct access to minimum quantity and quality of supply. Supplier relationship management, as an important part of supply chain management, has not been able to attract the attention of enterprises for a long period of time, buyer enterprises think that as long as there is a demand for purchase, there will be many sellers willing to provide

products and services, and that the relationship between supply and demand is a simple relationship between buying and selling, and that there is no need to put efforts on the suppliers. (Ma, 2022) Supply chain system is not an information management system in the pure sense, it is more of the integration of various information systems, through the integration of planning, sales, production, procurement, logistics and other systems, to realize the smooth flow of information and enhance the competitiveness of the enterprise supply chain. It mainly carries out information construction or integration at several levels, such as sales order, planning, production, procurement, warehousing and logistics, and collaboration.

The lean supply chain management system of automobile assembly enterprises is based on the core position of automobile assembly enterprises in the supply chain, combined with information technology and its operational processes to determine the sales order management, production management, procurement management, warehousing and logistics systems, system operation should be based on the information management system of dealers and supplier information management system, and the good operation of the above systems should be based on the collaborative platform, combined with the enterprise ERP to better Play the above system functions. Its essence is through the effective planning of automobile assembly enterprises, to realize the order-driven production, reduce the waste of the whole supply chain, and realize lean production. (Zhang, et al., 2022) Supplier relationship management, information systems management, logistics operations management are also interconnected and mutually influential.

The degree of cooperation of the supplier affects the management of logistics operations, the supplier's yield rate will affect the logistics operations of the return cost and emergency costs, the supplier's timely delivery rate will also affect the logistics operations of the emergency costs and inventory costs of a stable and efficient flow of information for the logistics operations have a guiding role. If suppliers cooperate in building factories or setting up shipping points near the delivery destination, it will greatly improve the efficiency of logistics operations. At the same time, logistics operations management also affects the supplier, the logistics department to the supplier to pass the accuracy of information, fluctuations in the difference in timeliness also affects the supplier's scheduling plan, material procurement plan and future production transformation plan. Involved in the material supply problem solving, such as material switching, batch material traceability, etc. need to logistics operations department and the supplier to work together to solve the problem. Good logistics operation management can save the company's operating costs, but also help suppliers to save logistics costs. Information system management is the link of supplier relationship and the guideline of logistics operation. The information system transmits logistics-related information for the supplier, and also assesses the efficiency of the supplier's operation. Information system for logistics operations feedback supplier efficiency, customer demand, but also in the supervision of the efficiency of logistics operations suppliers, logistics operations related departments, according to the feedback of the information system to optimize the information system can also be based on the collection of data, according to a certain logic to give optimization guidelines.

At present, there has been some research on the application and optimization of logistics operation, information system and supplier relationship management in lean supply chain management, but there are still some gaps or deficiencies in some aspects. First of all, in terms of logistics operations, how to better coordinate and optimize transportation, warehousing, packaging, distribution and information management is still an urgent problem. This involves comprehensive monitoring and management of the logistics process to ensure the improvement of logistics efficiency and quality. Secondly, in terms of information systems, it remains a challenge to build more efficient, reliable and transparent information systems to meet the needs of lean supply chain management. This requires an in-depth study of the technical applications and management strategies of information systems to ensure the real-time, accuracy and consistency of supply chain information. Finally, in terms of supplier relationship management, it remains a challenge to establish long-term and stable cooperative relationships, improve supplier reliability and responsiveness, and make this 1+1 model how to produce greater than 2 effects. This involves the development of supplier selection criteria, evaluation methods and relationship management strategies to ensure that suppliers are able to meet the needs of the enterprise and create value for the enterprise.

Studying logistics operations, information systems and supplier relationship management is the foundation of lean supply chain management, which helps us to better understand and improve the performance, efficiency and cost of the supply chain to make it lean. Pursuing this study can help companies to better understand and master the key factors of supply chain management and achieve sustainable development, which will help to improve the overall performance and efficiency of the supply chain and enhance the competitiveness of the company.

Objectives of the Study - The study aimed to examine the supplier relationship, information system and logistics operations management in manufacturing companies that was made the basis in developing a lean supply chain management framework. Specifically, the study determined the supplier relationship management as to cooperation, quality and cost; described the information system in terms of technology, business and management of information system; assessed the logistics operation in terms of time, space and cost, tested the significant relationship among supplier relationship, information system and logistics operations management and developed a lean supply chain management framework for manufacturing firms.

2. Methods

Research Design - The study utilized descriptive design as it aimed to understand and characterize the current state of affairs in manufacturing supply chains. Descriptive research is ideal for this purpose as it helps gather information on the characteristics of supplier relationship management (SRM), information systems (IS), and logistics operations in manufacturing industries. Descriptive research allows the study to gather information on how supplier relationship management, information systems, and logistics operations are currently functioning in manufacturing industries. This provides a clear picture of the strengths and weaknesses in existing practices. By understanding the current state, the study can identify areas for improvement and opportunities to implement lean principles. This information serves as a solid foundation for developing a lean supply chain management framework that addresses the specific needs of manufacturing companies.

Data were collected by conducting a questionnaire survey. Since I was not in China at the time of questionnaire collection, a lot of information communication and interviews were done online, while the distribution and collection of questions were done through the online questionnaire platform "Questionnaire Star". In the content of the study, the first step is to establish the theoretical foundation and the definition of variables. Next, the questions were summarized by reading and organizing the literature, and the questions were tested in small batches of 20 people, and the results were fed back to the tutors and approved before large-scale questionnaire distribution and retrieval was carried out. Finally, for the recovered results, descriptive analysis, correlation analysis and regression analysis were conducted on the collected feedback information through the researcher's multivariate statistical public analysis based on SPSS software.

Participants of the Study - Since the authors have been working in the field of production logistics in China's automobile manufacturing and auto parts manufacturing for many years, in which they have worked in several units, there are a lot of ex-colleagues who are also in this work field. Therefore, the main respondents were colleagues in the logistics and supply chain departments of the units where they used to work, colleagues in the IT department, and colleagues related to the logistics of suppliers with whom they had contact. In the end, 500 questionnaires were collected from employees of 12 logistics and automobile manufacturing companies.

Instrument of the Study - A self-made questionnaire was used by the proponent as the data gathering instrument. A self-made questionnaire allows the researchers to tailor the questions to precisely address the information needed on supplier relationship management, information systems, and logistics operations in the context of lean principles. It allows the researcher to customize the questions to account for these differences and gather data relevant to the specific industry segment being studied and also designed to gather information on the actual practices used by the target population. The questionnaire was composed of two main parts, the first part was a survey of the respondents' personal information, and the second part was a measurement of the nine dimensions derived from the three variables in the research topic. The supplier relationship management was

assessed as to cooperation, quality and cost. The information system was described in terms of technology, business and management of information system and the logistics operation was determined in terms of time, space and cost,

Data Gathering Procedure - To understand current practices in supplier relationship management (SRM), information systems (IS), and logistics operations within manufacturing industries, this study employed a descriptive research design which focused on data collection through a self-made questionnaire. The target population encompassed 12 logistics and manufacturing companies. A purposive sampling method was used to identify a representative sample from employees in logistics and manufacturing companies that utilize various supplier relationship models and information systems in their operations. The primary data collection method was self-made questionnaire specifically designed to capture information relevant to the research objectives. The questionnaires were developed through a comprehensive literature review on lean supply chain management practices, information system and logistics operations. Prior to administering the final questionnaire, content validation from experts was done to ensure the questionnaire accurately measures what it is intended to measure. Experts ensured that the questions asked are truly relevant to the topic being researched and encompass all the important aspects. Moreover, a pilot test was conducted with a small group of employees in the manufacturing companies. This pilot test assessed the clarity, comprehensiveness, and effectiveness of the questionnaire in gathering the desired data. Based on the pilot feedback, the questionnaire was refined before being distributed to the entire sample population. The completed questionnaires were generated through the Questionnaire Star website and disseminated using WeChat. The quantitative data were interpreted and analyzed using statistical software to identify trends and relationships. The data were used to serve as the foundation for developing a lean supply chain management framework.

Data Analysis - Weighted mean and rank were used to determine the supplier relationship management as to cooperation, quality, cost; to describe the information system in terms of technology, business, management; and to assess the logistics operation dimension of time, space and cost. The result of Shapiro-Wilk Test showed that p-values of all variables were less than 0.05 which means that the data set was not normally distributed. Therefore, Spearman rho was used as part of the non-parametric tests to determine the significant relationship. All analyses were performed using SPSS version 28.

Ethical Considerations - The research was based on academic ethics to ensure transparency in the research process and results. The questionnaires used were non-standard in character, incorporating the findings of existing scholars while incorporating the researcher's reflections on the topic. References were cited in accordance with international standards and norms. The confidentiality of the questionnaire was emphasized by explicitly assuring the respondents that the data they provided would be handled confidentially and would not be shared with others without their consent in order to uphold ethical principles. In addition, respondents' names were not involved in the design of the questionnaire, and questionnaires with missing or incorrect data will not be adopted into the study and will not be disclosed to anyone.

3. Results and discussions

Table 1 summarized the supplier relationship management with a composite mean of 3.11. Among them, the cooperation dimension scored 3.16 points and ranked first.

Table 1
Summary Table on Supplier Relationship Management

Key Result Areas	Composite Mean	VI	Rank
Cooperation	3.16	Agree	1
Quality	3.07	Agree	3
Cost	3.09	Agree	2
Composite Mean	3.11	Agree	

Legend: 3.50-4.00 = Strongly Agree; 2.50-3.49 = Agree; 1.50-2.49 = Disagree; 1.00-1.49 = Strongly Disagree

It shows that most of the respondents have a positive attitude towards the cooperative dimension of supplier relationship, and it also shows that cooperation is very critical and important in supplier relationship management. The strategic cooperative relationship between enterprises and suppliers, which has been transformed from traditional non-cooperative competition to cooperative competition and the co-existence of cooperation and competition, is the latest interpretation of the win-win mechanism of today's business relationship. Cooperative relationship is a win-win relationship between enterprises and suppliers to share information with each other, through cooperation and consultation, coordination of each other's behavior, the enterprise to participate in the quality control process, the joint development of product quality standards, the enterprise grasps the customer's demand for products and services demand for information feedback, so that the supplier can accurately provide market demand for the product, in the business operation of the enterprise to continue to create benefits at the same time, but also will help suppliers to Reduce costs, improve quality, speed up product development, the two sides to establish the integrity of the relationship and partnership effect, long-term trust and cooperation instead of short-term contracts, the two sides will effectively reduce transaction and management costs and improve production and service efficiency. Stable partnership can reduce the risk of demand changes, through the sharing of information resources, to reduce and timely and effectively deal with such as logistics and transportation risks, corporate credit risk, product quality risk. Strategic partnership can avoid the price negotiation that must be carried out in the competitive relationship, and can jointly negotiate the procurement strategy to reduce the procurement cost, and the sharing of information will also bring lower transaction costs to both parties (Ma, 2022).

The cost dimension was rated second after the cooperation dimension with a score of 3.09, also in the Agree range. This section evaluates the cost of cooperation between the company and its suppliers, indicating that most of the respondents believe that cost is important for supplier relationship management. Along with the economic development and social progress, SMEs have ushered in a period of rapid development, and the competition among them has become more and more intense. Therefore, they have also begun to gradually focus on supplier management and effectively improve the quality of management in the expectation of effectively controlling costs, and thus enhancing their core competitiveness. Supplier product costs: product prices change with the price of raw materials, labor costs and production costs. Therefore, enterprises must have an in-depth understanding of the various components of the supplier cost, so as to better control the purchase price (Song, 2021). The quality dimension score of 3.07. It is also in the Agree range, indicating that most respondents recognize the importance of quality in supplier relationship management. However, the fact that it ranked third shows that although this indicator is important, the actual performance needs to be improved.

In the process of localization of parts, the product technology and quality level of enterprises in China's supporting automotive supply chain has also been significantly improved. It is worth noting that, in the process of localization of parts, the maturity of technology is a gradual process; in this process, the quality of the parts will become very obvious, the supplier quality management will appear in the operation of the enterprise in a very important position. Supplier quality management is the enterprise will extend the activities of quality management to the supplier side, then there is a customer, supply relationship, once there is a customer, supply relationship. Therefore, there must be a service and be served relationship, when the supplier to provide service problems, but also affects customer satisfaction, customer satisfaction is not high, it will inevitably have a certain impact on its performance evaluation or quality control of the relevant process. Thus, it can be seen that the supplier's service quality is also the supplier's quality management process is also a very important factor (Wen, 2023).

The overall mean score of supplier relationship management is 3.11, which is also in the range of "Agree", indicating that, in general, most of the respondents have a positive attitude towards supplier relationship management, and believe that good supplier relationship management can help to realize lean supply chain management. Yang, (2022) considered that supplier relationship management is an integral part of the supply chain information flow, and that business management software and business practices, supported by a wide range of information technologies, can help to improve the efficiency of tasks such as acquiring products and services, managing inventory, and handling materials. The strong resource advantages of strategic suppliers are the guarantee for the smooth flow of the supply chain, so that enterprises can still obtain the quality and quantity of

materials and resources quickly under various special circumstances, and strategic suppliers play an important role in optimizing the allocation of resources, enhancing the competitive advantages of buyers and sellers, and reducing the operational risks. Through the establishment of long-term mutual support and common development of strategic alliance with strategic suppliers, the formation of a common interest mechanism, both sides can obtain high-quality and efficient development (Ma, 2022).

Table 2
Summary Table on Information System

Key Result Areas	Composite Mean	VI	Rank
Technology	3.14	Agree	2
Business	3.15	Agree	1
Management	3.09	Agree	3
Grand Composite Mean	3.13	Agree	

Legend: 3.50-4.00 = Strongly Agree; 2.50-3.49 = Agree; 1.50-2.49 = Disagree; 1.00-1.49 = Strongly Disagree

Table 2 presents a summary of the dimensions in the information system with a grand composite mean of 3.13. The overall average score for information systems is 3.13, which is in the "agree" range. This is due to the fact that information systems have achieved good results in terms of technical performance, business support and management support, and also due to the fact that information systems are recognized by the majority of respondents for their outstanding performance in terms of technical and business investment and development. In recent years, informationization has become an important force for upgrading and change in all industries, and informationization, with the application of management information systems as the main means, is promoting the reduction of enterprise costs, the improvement of operational efficiency, and the change of operation and management modes. Office systems, production and operation systems, knowledge management systems and other systems are widely used, promoting the reduction of enterprise costs and profound changes in internal operation and management modes. The continuous application of management information systems optimizes business processes and resource allocation, provides supporting data for management decisions, improves the enterprise's operation and management level and centralized control capability, and promotes the innovation of the enterprise's management mode and operation mode (Fang, 2021).

The second item which evaluates the performance of information systems in terms of business. The mean score of 3.15, which was agreed by the respondents got the highest score. This indicates that the majority of respondents believe that information systems perform well in supporting business. The automation of business processes and the optimization of business processes are indispensable to the application of modern information technology, which is a powerful tool to solidify the optimized processes and achieve twice the result with half the effort. In the past, manual management was slow and inefficient, and in the face of the complex and changing external environment, the use of information technology to automate the process is one of the effective means to improve the efficiency of the process (Fang, 2021). Only by matching the application of information technology with the strategy, business and management of the enterprise, so that managers can comprehensively, quickly and accurately grasp the production situation of the workshop, and rationally allocate manufacturing resources and adjust the production plan in time according to the feedback information, can we really improve the overall level of information technology of the enterprise, so that the enterprise can obtain the best operational efficiency (Gao, 2017).

The first item is technology, and this part evaluates the performance of information systems in terms of technology. The data show that the overall average score of 3.14, in the range of "agree", ranked second, indicating that most respondents have a positive attitude towards the technical performance of information systems. In the context of global economic integration and increasingly fierce market competition, information technology has played a positive role in promoting the internal control of enterprises, which has led to the rapid development of the internal control of enterprises at this stage. The use of enterprise information technology, so that managers can obtain more information, a sound information system can be accurate, comprehensive and timely information for enterprise managers and regulatory bodies, but also for the establishment of the enterprise's governance mechanism to create a favorable environment. Under the conditions of new technology, the traditional internal control system

and process has been changed greatly, the new management system and process is to use the least resources information technology to achieve optimal control (Ye, 2023).

In order to achieve survival and development in the fierce market competition, manufacturing enterprises will turn their attention to the comprehensive informationization construction of the enterprise, and the wide application of various information technologies has stimulated the vitality of the enterprise to a certain extent (Gao, 2017). The third item is management, and this part evaluates the performance of information systems in management. The composite mean score of 3.09 is also in the "agree" range, indicating that most respondents believe that information systems perform well in management support. The third highest ranking indicates that information systems provide limited management support and do not meet expectations beyond what is expected. The use of information technology and automation technology for integrated management, the construction of an Internet of Things platform for oil and gas production and engineering technology based on uniform standards, the realization of the centralized processing of each potential system and supporting inputs, and the continuous expansion of the coverage and scope of the enterprise Internet of Things. In the implementation of the system, it is necessary to achieve automation, standardization and development, and to realize the construction and development of the intelligent oilfield, and to achieve the optimization and improvement of the program design, labor organization structure and process flow (Yang, 2020).

Control activity is a strategy an procedure to ensure that the management orders of the enterprise can be effectively implemented, which is spread across all levels and functional departments of the enterprise, and is a measure that must be taken in order to cope with the risks related to the enterprise in the business process and specific control points.

Table 3
Summary Table on Logistics Operation Dimension

Key Result Areas	Composite Mean	VI	Rank
Time	3.12	Agree	2
Space	3.18	Agree	1
Cost	3.07	Agree	3
Grand Composite Mean	3.12	Agree	

Legend: 3.50-4.00 = Strongly Agree; 2.50-3.49 = Agree; 1.50-2.49 = Disagree; 1.00-1.49 = Strongly Disagree

Table 3 presents a summary of the dimensions of logistics operations. The overall score for logistics operations was 3.12, indicating that the majority of respondents believe that the company's logistics operations play a role in a lean supply chain. The core requirement of lean management is to take customers as the center, establish customer value-oriented operation process, establish cost management mechanism matching with value creation, gradually eliminate non-value-added operations, reduce low-value operations, optimize value-added operations, eliminate waste, and realize lean cost management. This is supported by this lean management idea, it can also be calculated according to the object, and the logistics cost can be analyzed for different objects, such as commodities, regions, customers or business units, in order to understand the distribution of logistics cost for different objects (Yang, 2023).

In the second item, this section evaluates the spatial dimension of the logistics operations dimension, and the data show that the overall average score is 3.18, which is in the "agree" range, indicating that most respondents believe that the spatial aspect of logistics operations is reasonable. The fact that the company ranked first in this area shows that it has performed well in the spatial dimension. Due to the irrational distribution of warehouses, some areas are seriously out of stock, while other areas have high stock, this unbalanced inventory structure not only wastes enterprise resources, but also increases the transportation cost and time cost (Xiao, 2023). Warehouse management theory is an efficient management theory related to warehouse receipt and storage business, which is a process of planning, organizing, controlling, coordinating and directing. Any business needs suitable inventory to meet the demand of production and sales. Warehouse management theory is widely used and warehouse management is an important part of coordinating various departments. Warehouse management theory includes warehouse planning, warehouse personnel management, facilities and equipment management, goods in and out

of stock management, warehouse process management, warehouse information management, logistics and transportation management and other warehouse-related all activities management theory. Warehouse management is spatial management, warehouse management is spatio-temporal management (Zhao, 2023), the background of the rapid development of the automobile industry, auto parts industry development is also rapid progress. Components industry is more complex than other industries, parts of the warehouse management is the automobile production enterprises and parts of the key aspects of enterprise cost control, reasonable warehouse storage area planning and optimization, allocation of goods is the enterprise must achieve the goal. Through the functional partition and inventory prediction, calculate a more accurate functional partition area, to provide a data base for the allocation of cargo space; through the optimization of the functional partition, the realization of the "two warehouses in one" strategy proposed in this paper, to a large extent, improve the utilization of warehouse space (Zhao, 2023).

With the second highest ranking in this area, respondents believe that performance in the time dimension is moderate and that there is room for optimization. This part evaluates the time aspect of logistics operation dimensions. The data shows that the overall average score is 3.12, which is in the "agree" range, indicating that the majority of respondents believe that the time aspect of logistics operations is reasonable. The study shows that effective measures such as shortening waiting time, streamlining intermediate links, and optimizing equipment and facilities can effectively improve the logistics management of an enterprise and thus significantly reduce logistics costs. Reasonable choice of transportation mode and route, reduce transportation mileage and transportation time. (Xiao, 2023). Through rational allocation and integration of resources, improve the loading rate of transportation vehicles, increase the frequency of transportation, reduce inventory, save operating time and labor costs, reduce waiting and waste, thus improving the efficiency of logistics work, improve and shorten the cost of capital, distance and time costs, and thus reduce the overall cost of the company. The JIT concept is not only reflected in the product manufacturing process, but also needs to be assisted and supported by JIT just-in-time logistics, which can maintain low inventory levels while avoiding parts shortages and ensuring operational accuracy. The right quantity of parts are available at the right place at the right time (Sui, 2021).

The third item, this section evaluates the cost aspect of the logistics operations dimension. The mean score of 3.07, also in the "agree" range, indicates that the majority of respondents believe that the cost aspect of logistics operations is reasonable. The third place in the ranking shows that there is still room for optimization in terms of logistics cost control. The research on the optimization of inbound logistics mode for auto parts enterprises can effectively play the function of cost control, which is crucial for enhancing the competitiveness of the enterprise market and maintaining the sustainable development of the enterprise. Through rational allocation and integration of resources, improve the loading rate of transportation vehicles, improve the frequency of transportation, reduce inventory, save operating time and labor costs, reduce waiting and waste, thus improving the efficiency of logistics work, improving the shortening of capital cost, distance cost and time cost, and then reduce the overall cost of the company (Sui, 2021).

The concept of logistics was first formed in the United States, and research on logistics cost control first appeared in Western countries. Early logistics cost management mainly focuses on the transportation field, and it is proposed that the control of logistics cost and the evaluation standard of high and low cost should be from a holistic perspective, and the cost expenditure should be controlled in each logistics link, such as warehouse storage and transportation. Logistics cost refers to all the costs incurred in the supply chain for the transmission of products or services from producers to consumers. These costs usually include transportation, warehousing, packaging, transportation insurance, logistics information systems, human resources, equipment and technology. Logistics costs can affect the efficiency and profitability of a supply chain, so supply chain managers often try to reduce logistics costs to improve supply chain performance. Logistics cost is only a small part of the total cost of the enterprise, similar to the iceberg only a small part of the surface exposure, and its bottom is hidden in a larger volume. Specifically, logistics cost iceberg theory points out that, in addition to logistics infrastructure construction, warehousing facilities and other costs directly related to logistics, there are also some indirect costs, such as the cost of production line downtime caused by the cost, the cost of excessive inventory caused by the cost of funds,

etc., which are also closely related to logistics, but it is easy to be ignored (Yang, 2023).

The lean supply chain management system of automobile assembly enterprises is based on the core position of automobile assembly enterprises in the supply chain, combining information technology and its operation process to determine the sales order management, production management, procurement and logistics management. Sales order management, production management, procurement management, warehousing and logistics systems, system operation should be based on the dealer information management system and supplier information management system, the good operation of the above system should be based on the collaborative work platform, combined with the enterprise ERP to better play the function of the above system. Its essence is through the effective planning of automobile assembly enterprises, to realize the order-driven production, reduce the waste of the entire supply chain, to achieve lean production (Zhang,et al., 2022).

Table 4
Relationship Between Supplier Relationship Management and Information System

Variables	rho	p-value	Interpretation
Cooperation			
Technology	0.421**	0.000	Highly Significant
Business	0.322**	0.000	Highly Significant
Management	0.341**	0.000	Highly Significant
Quality			
Technology	0.326**	0.000	Highly Significant
Business	0.297**	0.000	Highly Significant
Management	0.245**	0.000	Highly Significant
Cost			
Technology	0.303**	0.000	Highly Significant
Business	0.280**	0.000	Highly Significant
Management	0.256**	0.000	Highly Significant

***. Correlation is significant at the 0.01 level*

Table 4 illustrates the results of the correlation analysis between the dimensions under vendor management and the dimensions under information systems. In this case, all p-values are 0, i.e., p-value is less than 0.01, so the correlation between these two variables, or between their dimensions is analyzed statistically significant, i.e., there is a very low probability that it will affect the statistical results. The rho scores of the dimensions in the supplier relationship management and information system range between 0.256 and 0.421, which indicates that the relationship between the cooperation dimension and the dimensions under the information system is a direct, positive relationship, but the strength of the relationship is moderately weak, which indicates that the supplier relationship management and the information system's has a positive correlation relationship, but the influence of both sides is limited in terms of the current situation. Currently, the supplier relationship management in China's automotive (and parts) industry is realized through the information system, including the transmission of orders, forecasting information, process information, quality feedback, and other information is based on the information system or will be completed through the information system.

Through the information system integrated feedback, the buyer can also intuitively understand the status of the supplier's production, inventory, quality, shipping, etc., which saves feedback costs and personnel costs. In addition, through the planning of appropriate information systems for supplier relationship management, so that the assessment of supplier performance is more accurate, more direct, more rapid, which also saves the time of the supplier to rectify the situation, improve efficiency and thus achieve a win-win situation. The current feedback rating is low, reflecting the current stage, the enterprise in the supplier relationship management and information systems, is still in the construction stage, some features are not perfect, or even not developed, which indicates that the combination of strengthening information systems construction and supplier relationship management is a long way to go, in short: the direction is right, just need to be strengthened.

On the macro side, most of the enterprises in China's industry have a low level of automation, low integration of theoretical knowledge and practice, insufficiently effective collection of information in the digitization process, and insufficient ability to integrate and utilize data and information. On the meso side, due to the shrinking of the

product sales life cycle on the supply side, the problem of individualization of customer demand has emerged, which is out of sync with the improvement of customer value and technological upgrading, and the degree of automation and the level of intelligence are also not high. On the micro side, the application of "Big Intelligence, Mobile and Cloud" in enterprise supply chain cost management is more prominent. The application of "Big Intelligence Mobile Cloud" in enterprise supply chain cost management has prominent problems, including complicated types of data and information, huge amount of data and information, insufficient real-time data and information, outdated intelligent technical equipment, high cost of information system, and data and information silos, etc. The above problems have seriously inhibited the wide application of "Big Intelligence Mobile Cloud" in supply chain cost management system in the manufacturing industry. The above problems seriously inhibit the wide application of "Big Intelligence Mobile Cloud" in supply chain cost management system of manufacturing industry. (Wang, et al., 2023).

The current situation of the integration between supplier relationship management and information system is described by Liu Xin, a scholar. Company F's purchasing mode is mainly order-pull and operates in a semi-manual and semi-MRP environment, because there is no effective forecasting data recorded in the system, which results in the need to complete the material demand planning through the auxiliary system outside the system. The end customer is the driving force of pull-type supply chain, i.e., the customer demand is the source driving force of product production, not coordinated production according to the forecast. However, in the pull-type supply chain mode, due to the high uncertainty of the demand and the tight cycle, the whole supply chain has a very high requirement on the speed of information exchange and the degree of integration, which is one of the key indexes in the evaluation and selection of suppliers. The key indexes for supplier evaluation and selection are flexible production capacity, JIT (Just-In-Time) service capability and the ability to respond to sudden changes in customer orders in an agile manner, etc. In the current supplier evaluation and selection index system of Company F, flexible production capacity and JIT service capability are not mentioned. (Liu, 2022) Information communication is particularly important in the procurement supply chain, which directly affects the supply of materials and parts from upstream suppliers. Therefore, in order to cope with complex supply types, in terms of information management, an information system suitable for procurement supply chain management in the shipbuilding industry should be established to set up modules such as purchase order management, supplier management, inventory management and so on.

The centralized management and sharing of data are realized through the information system to improve the efficiency and accuracy of information processing. In addition, in terms of supply and demand information exchange, information technology is used to collect, organize and analyze procurement and supply chain data, and quickly exchange procurement information to ensure the relevance and accuracy of procurement. Constructing an integrated management platform, integrating procurement management, supplier management, inventory management, logistics management and other functional modules, it can realize the efficient operation and optimization of procurement and supply chain. According to the characteristics and demands of ship manufacturing industry, design the overall architecture of the system, including front-end interface, back-end database, middleware and data interface and other components, to ensure the stability, scalability and security of the system. Realize data integration and sharing between different modules through data interface and middleware. Integration of procurement, supplier, inventory, logistics and other data are integrated to provide comprehensive information support and decision-making basis. Meanwhile, in terms of information management, it establishes functional modules such as purchase order management, supplier management and inventory management.

Table 5
Relationship Between Supplier Relationship Management and Logistics Operation

Variables	rho	p-value	Interpretation
Cooperation			
Time	0.376**	0.000	Highly Significant
Space	0.369**	0.000	Highly Significant
Cost	0.367**	0.000	Highly Significant

Quality			
Time	0.278**	0.000	Highly Significant
Space	0.341**	0.000	Highly Significant
Cost	0.338**	0.000	Highly Significant
Cost			
Time	0.323**	0.000	Highly Significant
Space	0.314**	0.000	Highly Significant
Cost	0.344**	0.000	Highly Significant

***. Correlation is significant at the 0.01 level*

Table 5 illustrates the results of the correlation analysis between the dimensions under supplier management and the dimensions under logistics operations. In this case, all the p-values are 0, i.e., the p-value is less than 0.01, so the correlation between these two variables, or between their dimensions is statistically significant when analyzed, i.e., there is a very low probability that it will affect the statistical results. The rho scores of the dimensions in supplier relationship management and logistics operations range between 0.278-0.376, indicating that the relationship between supplier relationship management and the dimensions under logistics operations is direct and positive, but the strength of the relationship is moderately weak, which indicates that supplier relationship management and logistics operations have a positive correlation relationship, but the influence of both sides is limited from the current situation.

In the manufacturing industry, logistics operation generally starts from doing the goods handover with suppliers and ends until the finished products are shipped to customers, in which some units will give the logistics department the responsibility of managing suppliers. Logistics operations cannot be separated from the close, fast and effective communication with the supplier in order to ensure the smooth flow of physical and information flow. The supplier should understand the logistics needs of the client as soon as possible and carry out timely follow-up, and solve the problems quickly when found, in order to achieve a smooth cooperation with the buyer. Feedback from many participants recognized the importance and relevance of supplier relationship management and logistics operations, the reason for the low score may be the supplier's attitude, many of the results of the work cannot be recognized by the buyer's department, some of the specific performance of the cooperation cannot be done in a timely and efficient feedback, in the quality of the quality of the service cannot provide high quality services, and in the cost of controlling the above cannot be done in a professional manner. Researcher Zhao (2023) to BTET company parts and materials as an example of supplier management optimization research, first of all, through the questionnaire survey and data collection and analysis found that there are three problems in the supplier management: supplier delivery of the qualified rate of decline in the supplier's delivery rate is low, the supplier delivery of low timeliness, the supplier to communicate with the time is long.

Before the delivery of each batch of parts, suppliers must complete a full inspection, and after the delivery of parts, the factory where BTET models are produced will carry out product qualification rate testing. according to BTET's statistics on 188 defective products delivered by 26 parts suppliers, it is found that the proportion of defective products from the suppliers has increased resulting in an increase in the number of product returns, which generates additional production and transportation costs. in the second half of 2022, the rate of defective product arrivals increased month by month. In the second half of 2022, the rate of defective product arrivals increased month by month, with the rate of defective products increasing from 2.1% in July to 6.6% in December, far exceeding the target rate of defective products, and the rate of increase from August to September was as high as 1.9%, which indicated that there were serious problems in product quality control of suppliers' parts and components and the rate of qualified products was declining. BTET Production Management Office arranged TTCC logistics company to pick up the goods according to the delivery time feedback from the suppliers by e-mail.

All of the 28 suppliers involved in the 188 items of materials followed up by e-mail, and some of the suppliers needed to be urged several times before giving feedback on the delivery time after receiving the pickup plan. In the second half of 2022, the timely delivery rate of parts and components did not exceed 90%, with the highest timely delivery rate of 89% in July and the lowest timely delivery rate of 54% in October, and the long

communication time of BTET parts and components suppliers is mainly manifested in the fact that the suppliers could not give feedbacks on production and shipment situation in a timely manner after they received the demand for supply and each time they need to be urged by the BTET production management office and the purchasing office through telephone calls and emails to get the reply on the progress. It is necessary for BTET Production Management Office and Purchasing Office to make phone calls and send emails every time to get the progress reply. The most time-consuming type of communication is product delivery, but also a large increase in communication time, from 81.4 hours in July to 118.8 hours in December. The next largest increase in communication time was for quality exception feedback, from 37.4 hours in July to 83.6 hours in December (Zhao, 2023).

For auto parts suppliers, due to the vastness of China, many suppliers are scattered all over the country, and it is not easy to deliver many auto parts to automobile manufacturers and after-sales departments at the right time and in the right quantity because of the complexity of the connection of each link. In this case, if you do not do a good job of logistics supply chain management, then from the upstream procurement department, to the downstream end of the distribution of parts and components, and then to the parts of the information transfer and other logistics and information flow cannot be effectively integrated, efficient operation, the supply chain will have a huge impact on the response cycle, and then produce ineffective waiting or emergency orders, resulting in the so-called "urgent need for the parts not to the goods, do not need parts full of The so-called "urgent need of parts not to goods, do not need parts full of warehouse", in the increase of transportation and inventory costs at the same time, the delivery of the end-customer reliability of the disastrous impact, in the long run will be the credibility of the enterprise and the market caused by irreparable losses (Song, 2023).

Table 6
Relationship Between Information System and Logistics Operation

Variables	rho	p-value	Interpretation
Technology			
Time	0.327**	0.000	Highly Significant
Space	0.308**	0.000	Highly Significant
Cost	0.363**	0.000	Highly Significant
Business			
Time	0.329**	0.000	Highly Significant
Space	0.320**	0.000	Highly Significant
Cost	0.285**	0.000	Highly Significant
Management			
Time	0.256**	0.000	Highly Significant
Space	0.282**	0.000	Highly Significant
Cost	0.297**	0.000	Highly Significant

***. Correlation is significant at the 0.01 level*

Table 6 illustrates the results of the correlation analysis between the dimensions under information systems and the dimensions under logistics operations. In this case, all the p-values are 0, i.e., the p-value is less than 0.01, so the correlation between these two variables, or between their dimensions is statistically significant when analyzed, i.e., there is a very low probability that it will affect the statistical results. The rho scores of the dimensions in information system and logistics operation range between 0.256-0.363, which indicates that the relationship between the information system and the dimensions under logistics operation is direct and positive, but the strength of the relationship is moderately weak, which indicates that the supplier relationship management has a positive correlation relationship with the logistics operation, but the influence of both sides is limited from the current situation.

A good system can provide feedback on the status of logistics operations as soon as possible, which includes order receipt, production planning, shipping, supply lines, warehousing, receiving, warehousing, arrival, etc., and can provide early warning based on set thresholds. With the deepening of the system development, automation, digital system scheduling, receiving and dispatching orders, etc. can greatly reduce the cost of logistics operations in the human cost as well as the cost of error correction, which is helpful for the optimization of logistics operations. The feedback score of the current evaluation shows that the cooperation between logistics operation and

information system needs to be improved, which on the one hand shows that the currently developed system is not in line with the actual needs of logistics operation, and on the other hand, the real needs of logistics operation functions, to be developed by the information system. The management organization of digital logistics: emphasize planning synergy and visual transparency, and become the company's operation and management center. Digital factory needs to build an integrated planning center, integrating demand forecast, sales plan, order management, procurement plan, logistics plan, production plan, shipping plan, inventory plan, production, sales and inventory agreement, etc., applying digital technology and algorithms to build intelligent scheduling and discrepancy management capability to realize value chain pull-through and synergy.

On the other hand, the digital factory realizes real-time and accurate data collection and transmission through the comprehensive interconnection of man, machine, material, method, environment and measurement. All static and dynamic data are integrated into the unified management of the data center, which is fully responsible for data management, data analysis, performance management, data output, discrepancy management, decision-making support and other related work, so as to realize the visualization and transparency of the factory operation process, and real-time monitoring and discrepancy analysis of the operation performance. Therefore, the data center and logistics information platform construction functions are also incorporated into the logistics operation center to realize the closed-loop management of factory operation. The focus of factory logistics operation management lies in the integration and consolidation of logistics, so as to realize effective support for business strategy, business plan, strategic performance and business plan. Ideally, logistics operation planning, execution and discrepancy management are automatically completed by intelligent logistics systems. However, in the actual operation process, even if it has become a generally accepted smart factory, may not be matched with fully automated, intelligent logistics system, in different application scenarios, usually lean, digital, intelligent three logistics paradigm coexist, and in the process of continuous optimization iteration (Li, et al., 2022).

Informatization technology enables data and information in the logistics process to be collected, analyzed, and displayed in real time, making logistics activities real-time and visible. By monitoring the data and indicators of logistics links, logistics managers can quickly understand the logistics operation situation, find abnormalities and problems in time, and take corresponding measures to adjust. Informatization technology realizes the tracking of the logistics and transportation process, and the location and status of goods can be tracked in real time through barcode, RFID and other technologies. Logistics managers can obtain the real-time location and delivery status of goods through the logistics information system to improve the reliability and accuracy of logistics transportation. Information technology realizes the automation and intelligence of the warehousing and inventory management process. Through the logistics information system, logistics managers can grasp the inventory situation in real time, carry out inventory forecasting and planning, so as to achieve the goal of reducing inventory costs and improving inventory turnover rate. Information technology provides tools and methods to optimize transportation route planning and transportation resources. Through logistics information system and intelligent algorithms, it can realize the optimal selection of transportation routes and rational allocation of logistics resources to minimize transportation costs and improve transportation efficiency (Wang, 2023).

The management of the manufacturing process is difficult and important for all manufacturing industries, especially in the automotive industry. How to organize and complete the production against orders in a low inventory situation, quickly, is becoming more and more a concern for decision makers. Production to order, combined with inventory, the use of modern scientific management techniques and information technology, monitoring and controlling all aspects of production, to provide a guarantee for the on-time delivery of ordered products. Through the scientific arrangement of the production plan, we can reasonably and efficiently arrange the sorted production of the products and timely constraints and monitoring, forming the closed-loop management of "planning-execution". Through the realization of Kanban management, timely replenishment, procurement, to ensure that the production is carried out to maintain a reasonable level of inventory (Zhang et al., 2022)

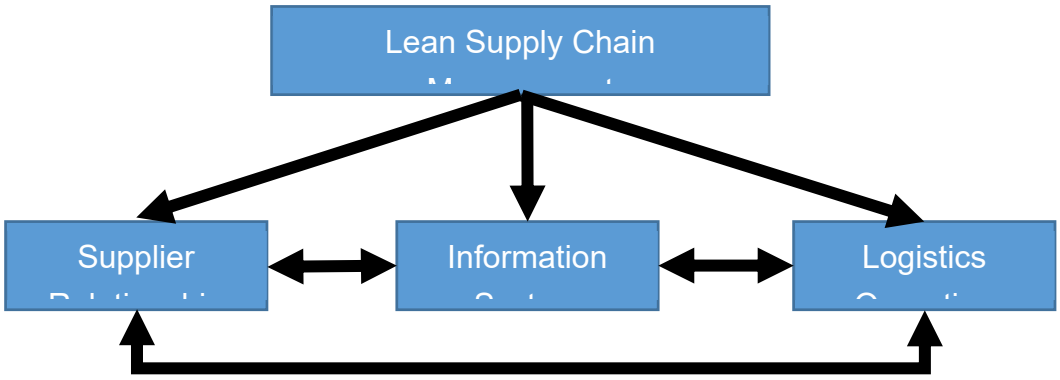

Figure 1. Integrated Framework of Lean Supply Chain Management

As can be seen from Figure 2, lean supply chain management is an organic combination of supplier relationship management, information systems and logistics operations. For the manufacturing industry, especially in the automotive and parts division, good supplier relationship management plays an important role in lean supply chain management. Good supplier relationship management enables suppliers to provide excellent quality parts and services, reduces the cost of error correction and loss, and helps to improve the transparency of the supply chain, which enables buyers and suppliers to be more comfortable with production scheduling, parts ordering, and the handling of potential supply crises. Excellent suppliers also provide professional and efficient feedback and assistance in product development and problem solving, which also help buyers save costs.

4. Conclusions and recommendations

The respondents showed moderate agreement on the supplier relationship management in terms of cooperation, quality and cost. Supplier relationship management is an effective way to manage supplier relationships and improve business performance. Respondents moderately agreed on logistics operation as to time, space, and cost and that the logistics operation is well-managed and efficient. The high significant relationship among supplier relationship management, information system and logistics operation implies that these three factors are interconnected and that they all play an important role in business success. Businesses that focus on SRM, IS, and logistics operation are more likely to be successful. A lean supply chain management framework was developed for manufacturing companies.

The management of manufacturing firms may continue to strengthen supplier relationship management, particularly in the areas of innovation and technical support, in order to sustainably increase the level of cooperation. In terms of information systems, IT managers may consider providing continuous upgrading and maintenance of systems to ensure that they continue to support the growth of business needs. In terms of logistics operations, the operations manager may focus on inventory management to further optimize inventory costs. The lean supply chain management framework may be recommended for adoption in manufacturing companies. Future researchers may develop new models and theories on supplier relationship management, information system and logistics operation to explain these relationships and to provide insights into how businesses can improve their performance.

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