J. COMBIN. MATH. COMBIN. COMPUT. 127a (2025) 6655--6674

Journal of Combinatorial Mathematics and Combinatorial Computing
www.combinatorialpress.com/jcmcc

Combinatorial Press

Enterprise Supply Chain Management and Information Assurance Mechanism Based on Error Backpropagation Algorithm

Qiaoning Zhang[1,2], Han Liu[1,3,✉]

[1] *College of Business Administration, Lyceum of the Philippines University, Batangas, 4200, Philippines*

[2] *School of Education and Management, Bozhou Vocational and Technical College, Bozhou, Anhui, 236000, China*

[3] *School of Economics and Trade, Shanghai Modern Chemical Industry Vocational College, Shanghai, 310116, China*

ABSTRACT

Adapt to the new competitive environment, the supply chain concept and management model of horizontal integration and cooperation between enterprises have begun to rise, and continuously demonstrate enormous competitive strength and superiority. However, the existing enterprise supply chain management (SCM) system has problems of low security, low efficiency, and high management costs. In view of the above problems, this paper studied the enterprise supply chain management and its information assurance mechanism based on the error back propagation algorithm. By analyzing the problems in enterprise supply chain management and introducing error back propagation algorithm as an optimization method, the efficiency and accuracy of the supply chain have been improved. At the same time, corresponding guarantee mechanisms were proposed to address the importance of information security in the enterprise supply chain. The research results indicated that the information leakage rate of the supply chain information protection mechanism based on the error back propagation algorithm was below 3.21%, and the average leakage rate of 20 experiments was 2.654%. For supplier management in enterprise supply chain management systems, the selected users scored the system based on error back propagation algorithm at least 8.84 points, and the average score of 10 users was 8.995 points. Enterprise supply chain management and information assurance mechanism based on error back propagation algorithm can effectively improve the effect of supply chain management and enhance the security of information.

Keywords: Enterprise Supply Chain Management, Information Assurance Mechanism, Error Back Propagation Algorithm, Supplier Management, Deep Learning

1. Introduction

Supply chain management, as a new information-based logistics management mode, cannot be separated from the role of information guarantee mechanism. Supply chain is a functional network structure model that connects suppliers, manufacturers, distributors, retailers, until the end users

✉ Corresponding author.
E-mail address: laq17101@163.com (H. Liu).

Received 05 March 2024; Revised 10 May 2024; Accepted 05 December 2024; Published Online 15 April 2025.
DOI: 10.61091/jcmcc127a-369

© 2025 The Author(s). Published by Combinatorial Press. This is an open access article under the CC BY license (https://creativecommons.org/licenses/by/4.0/).

into a whole by controlling the information flow, logistics and capital flow around the core enterprise, starting from purchasing raw materials, making intermediate products as well as final products, and finally delivering the products to the consumers by the sales network [1-3]. Supply chain management is the integration of all activities in the supply chain from the initial supplier to the end-user with respect to the flow and transformation of logistics and information flows in order to achieve a sustained competitive advantage. It can be seen that supply chain management involves four main areas, supply, production planning, logistics, and demand [4-6].

By the definition and content of supply chain management can be seen, supply chain management has two main components, materials and information, in which information is the communication carrier of the links in the supply chain, the implementation of the supply chain is synchronized, integrated production planning as a guide to a variety of technical support, especially information technology as a basis for the implementation of the supply, production operations, logistics, to meet the needs of the implementation of the [7-9]. It can be seen that the supply chain management and information have closely related to the close connection [10].

In the traditional enterprise management model, the functional departments within the enterprise is according to the interests of the department to carry out business activities [11]. Due to the conflict of interests of functional departments, information exchange is not effective, it is difficult to realize the overall goal of the enterprise optimization, enterprises and suppliers, wholesalers, retailers and end users are also independent of each other, they are mutually antagonistic trading relationship, the lack of necessary information exchange and sharing, according to their own interests in business activities, easy to cause friction of interests between enterprises [12-14]. In supply chain management, the enterprise transcends the boundaries of the organization, combines the internal departments and nodes of the supply chain, overcomes the traditional management defects based on functional departments, changes the traditional concept of opposing interests between the two sides of the transaction, and establishes a collaborative partnership of common interests within the entire supply chain, so that competitors become allies, and the logistics activities, starting from the supplier to the end-user, are managed as a whole. Logistics activities from suppliers to end-users as a whole for unified management, from the overall and global grasp of the activities, so that the entire supply chain inventory level is the lowest, to achieve the optimization of supply chain management [15-18]. It regards all the node enterprises in the supply chain as a whole, which covers the whole logistics, from suppliers to end-users in the process of purchasing, manufacturing, distribution, retailing and other functional areas, is based on the "competition-cooperation-coordination" mechanism, and is guaranteed by the distribution of enterprise integration and distribution of the operation coordination of the new enterprise operation mode, which is mainly based on the following principles Cooperation, decision-making, incentives, self-regulation and other mechanisms to achieve to meet customer demand, to achieve the ultimate goal [19-22].

The supply chain management environment leads to a significant increase in information flow, integrating three important factors: logistics, information flow, and capital flow [23]. The strength of the supply chain depends on each node on it, which pays close attention to the mutual cooperation and coordination among the members of the product distribution channel to maximize the smooth flow of the three important flows [24-25]. A good supply chain is not only a material chain, information chain and capital chain connecting suppliers to users, but also a value-added chain, where products in the supply chain are processed, packaged, transported and other processes to increase their value, thus bringing benefits to the whole supply chain [26-28].

Literature [29] systematically reviews the research related to AI technology in supply chain management, identifies the main research methods and research directions, and lays the foundation for further research on AI technology in supply chain management. Literature [30] qualitatively analyzes the practice of integrating consulting systems into the supply chain management of multi-component manufacturing enterprises, and concludes that there is a need for the existence of the most effective supply chain information to support the measurement, which involves the identification and confirmation of the sources of supply chain uncertainty, risk, and cybersecurity, and correspondingly proposes a solution for the security of supply chain data information systems. Literature [31] evaluates the cyber supply chain risk management model based on data collected from empirical investigations such as supply chain cyber risk management and confirms the validity of the analytical model. Literature [32] conceptualized an applicable supply chain metrics framework for industrial environments to improve the cyber information data risk in the process of digital transformation of supply chains, as well as positively for supply chain resilience enhancement. Literature [33] identified the logic and influencing factors of reverse logistics supply chain in the construction industry based on the organizational information processing theory, combined with semi-structured interview methodology, and constructed an information processing framework based on it to assist relevant practitioners and researchers in understanding and responding to the cognitive uncertainty of successful QA in DW RLSC. Literature [34] utilized one-on-one interviews, self-surveys, and other methods to reveal that supply chain risk management is an important tool for weighing supply chain performance and supply chain vulnerability.

With the rapid development of science, technology, and commerce, the form of enterprise competition has gradually shifted from competition between markets to competition between supply chains. In this situation, supply chain management plays an extremely important role. Supply chain management refers to the establishment of cooperative relationships between enterprises, utilizing advanced information technology to comprehensively restructure resources and businesses on the chain, achieving a “seamless” connection between enterprises and providing better services. This paper studied the enterprise supply chain management and its information assurance mechanism based on the error back propagation algorithm, improve the efficiency and information security of the supply chain, and enable information to be shared among all organizations in the supply chain, so that logistics, operation status and other data can be effectively circulated in real time among all link organizations in the supply chain, which can improve the flexibility of the entire supply chain.

2. Design of Enterprise SC Management Model

2.1. *Supply Chain Management*

Supply chain management refers to a management system that takes suppliers as the source, through joint marketing, centralized circulation, and ultimately provides customers with good service and useful products. The purpose of SC management is to promote the rational operation of various activities such as data, information, finance, etc., to achieve truly effective cooperation among enterprises in the supply chain, and to improve all business partnerships. SC management consists of many business activities and processes, and the healthy development of enterprises cannot be separated from the application of SC.

Due to the fact that SC management is a management concept based on SC theory, it can be divided into two parts: the content of SC management and the visual management of SC management chain, as detailed in Table 1.

Table 1. Supply chain classification table

Classification basis	Name	Concept
SC management content	Internal SC management	It is aimed at the management methods of various internal management functions such as production management, inventory management, warehouse management, etc.
	External SC	Relying on the Internet, according to the final needs of customers, it is

	management	a management method that uses various information technologies to guide the synchronization and integrated management of production plans.
	Internal and external SC integration	According to the internal SC and the external SC situation in which it is located, to determine the appropriate SC management strategy and partner management methods.
Visible management scope of supply chain	Internal SC management	Through various means, the information management of internal business processes of the enterprise is realized to meet the complex and changeable customers.
	Upstream and downstream SC management	On the basis of the internal supply chain management of the enterprise
	Industrial supply chain management	As an intermediate link, each enterprise in the industrial chain has a corresponding supply and demand relationship between the enterprises in each link. It is based on the internal SC management of the enterprise, and then expands the upstream and downstream supply chains in both directions.
	Global network SC management	Starting from the standpoint of globalization and integration of the international economy, it emphasizes the management of resource acquisition and allocation among firms under global production.

2.2. *Production Plan Management*

The production department makes products based on customer needs. Firstly, the production department needs to plan the raw materials required for the product. After creating the raw material list, there are still some steps required to print the production task list. After the production task order is printed, the production management personnel decide whether to accept the production order and whether adjustments are needed. After confirmation, the manager signs and agrees. The production plan management flowchart is shown in Figure 1.

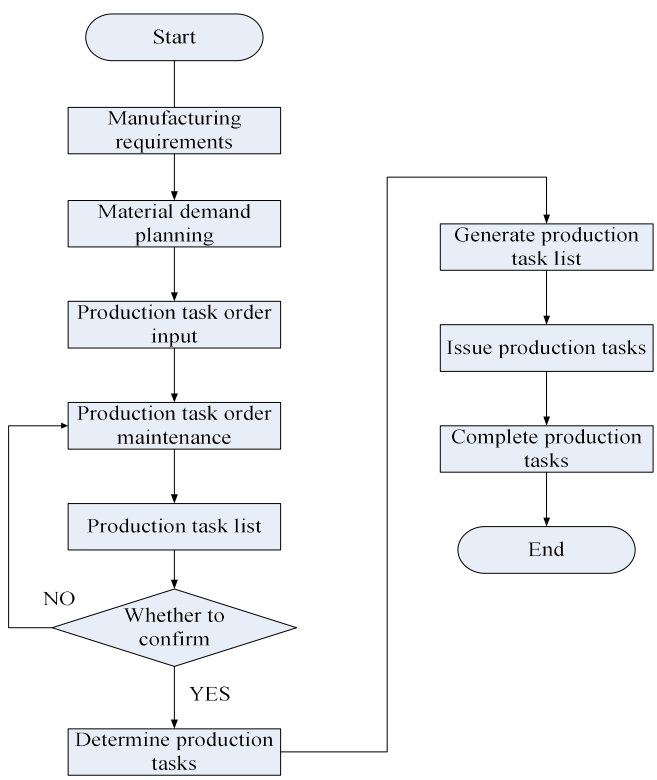


Fig. 1. Production plan management flowchart

2.3. *Inventory Management*

Inventory management business often involves inbound and outbound operations. The analysis of some business processes in inventory management is as follows:

2.3.1. Warehousing Process. The business of warehousing involves a lot of content. When goods are put into storage, it is necessary to carefully calculate the quantity of goods, and confirm and verify the information. Only after all inspections are completed can the goods be put into storage. This is a strict process. The inbound process diagram is shown in Figure 2.

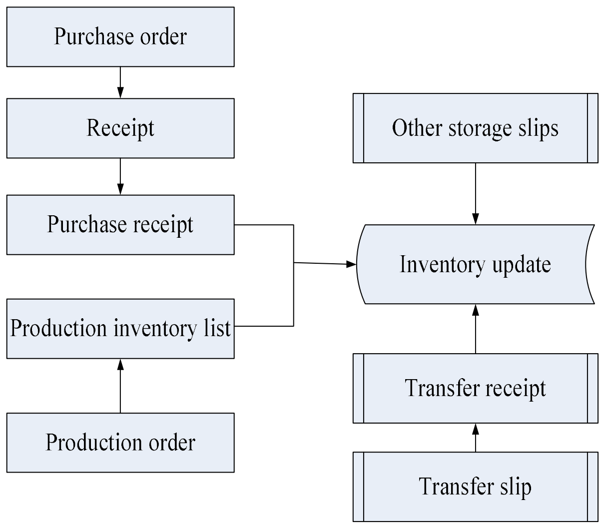


Fig. 2. Warehousing process diagram

2.3.2. Outbound Process. The process of goods leaving the warehouse is as strict as that of goods entering the warehouse. The responsible personnel of each department must carefully inspect each link and ensure that there are no errors before they can leave the warehouse. The outbound business consists of multiple elements such as sales outbound, picking outbound, and transfer outbound. The outbound process diagram is shown in Figure 3.

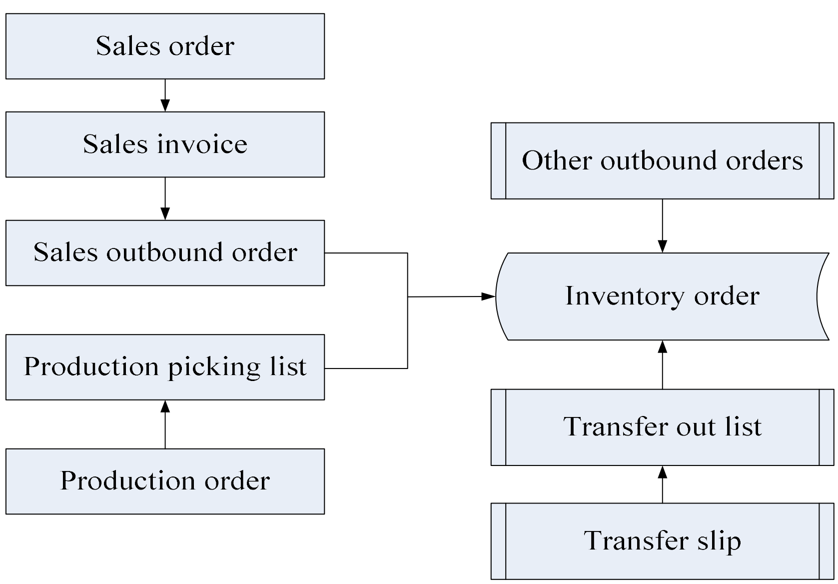


Fig. 3. Outbound flow chart

2.4. Supplier Management

On the new page, basic information can be entered and the preliminary design can be completed after successful submission. On the new customer page, contact information can be added, and the supplier creation operation can be completed by adding a note and submitting it. On the inquiry page, the seller's information is queried by details such as the shipment order number and the supplier's name. The supplier information page includes basic information such as supplier name, supplier number, short name, and contact information. On the supplier details page, people can also edit basic information, add contact information, change important information, and add or change notes.

2.5. Procurement Management:

1) Purchase request. When certain items need to be purchased, the department must identify them based on actual needs and list them for review by the relevant supervisory department. After the audit is completed, the manager can verify and send the final purchase list to the purchaser to complete the product procurement.
2) Order process. When purchasers make a purchase, they first review the merchant who purchased the product, then analyze the merchant who decided to purchase, and finally create an order.
3) Receipt and warehousing process. After the order is created, the supplier delivers the materials required by the enterprise on the list to its warehouse at the specified time. At this point, the purchaser checks the goods according to the purchase order. If there is no error after verification, the goods can be stored in the warehouse, otherwise they are returned according to the agreement. The procurement process diagram is shown in Figure 4.

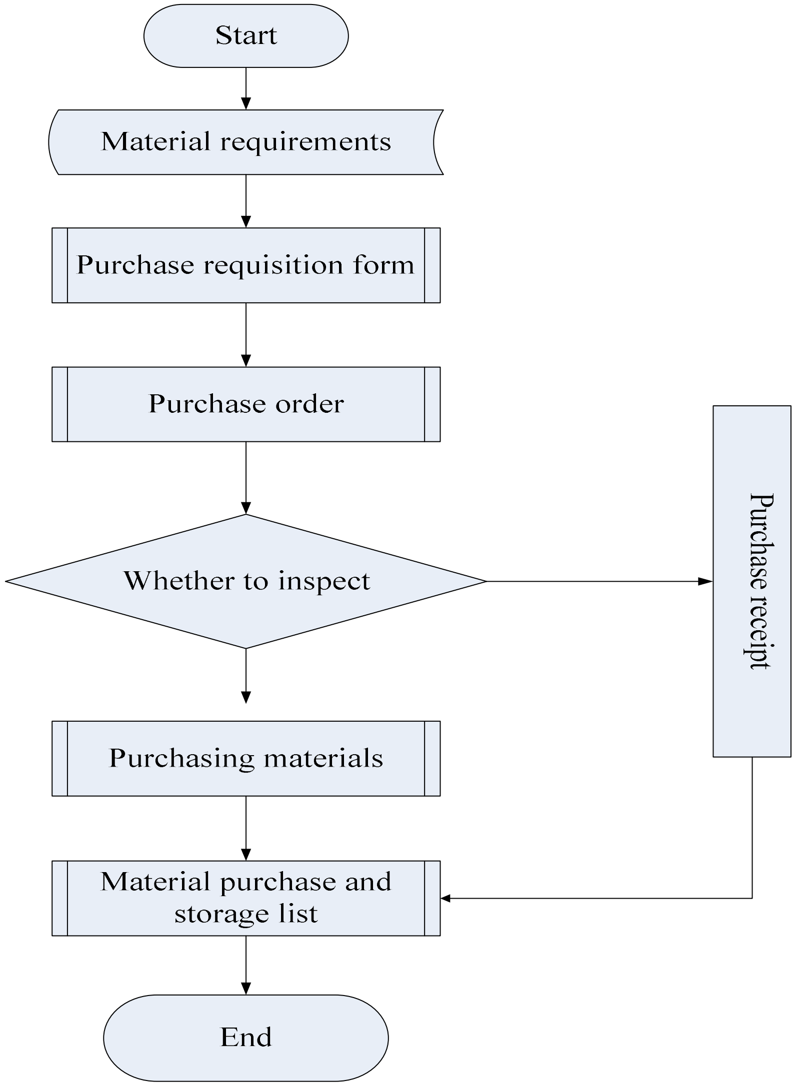


Fig. 4. Procurement process diagram

2.6. *Design of SC Management Model Database*

The design of a database includes many aspects. Conceptual structure design is the key to the entire design process, which should create specific models based on changes in requirements. The procurement requirement management database based on error backpropagation algorithm is shown in Figure 5.

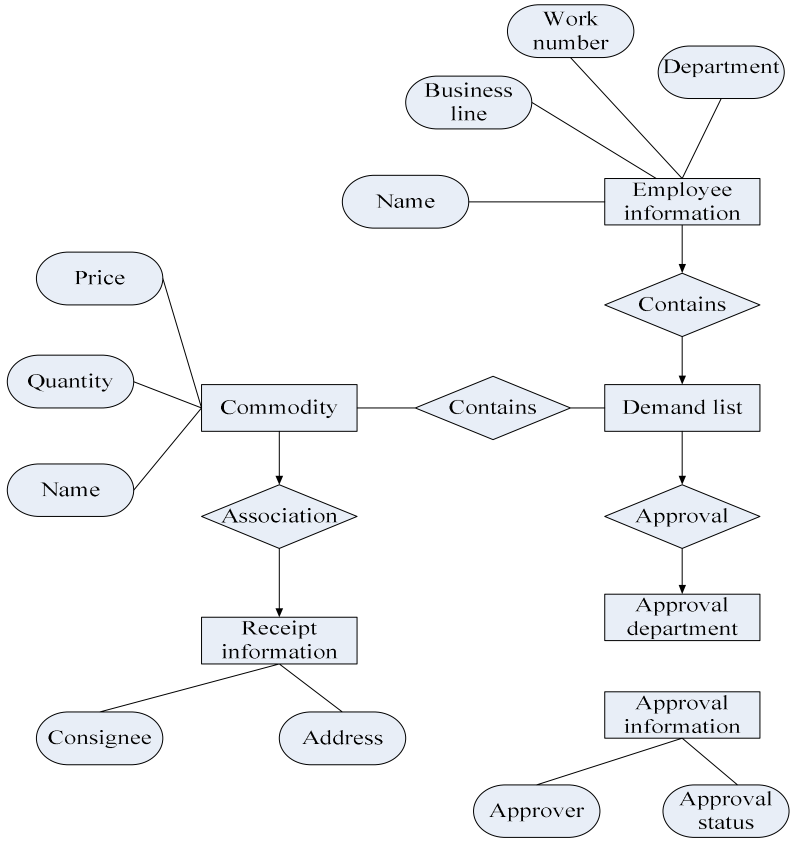


Fig. 5. Procurement requirements management database based on error back propagation algorithm

After the conceptual design of the database, it is necessary to display the data in the database. There are many database information tables based on the error back propagation algorithm, which extract product sales order tables, procurement plan tables, and supplier information tables for introduction. The product sales order table is shown in Table 2. The procurement plan table is shown in Table 3, and the supplier information table is shown in Table 4.

Table 2. Product sales order form

Field name	Field description	Data type	Whether the primary key
Identity document	Sales order account number	Int	Yes
Sales_order_id	Sales item number	Int	No
Sales_item_number	Sales contract number	Var char	No
Product_name	Product name	Var char	No
Product_model	Product specifications	Var char	No
Sales_order_status	Sales order status	Var char	No
Unit_id	Sales unit	Var char	No
Qty	Quantity	Double	No
Customer_number	Customer number	Var char	No
Customer_name	Customer name	Var char	No
Deliver_time	Delivery date	Date time	No

Table 3. Procurement plan

Field name	Field description	Data type	Whether the primary key
Identity document	Purchase plan account number	Int	Yes
Purchase_plan_number	Purchase plan number	Var char	No
Purchase_plan_time	Procurement planning time	Date time	No
Employee_no	Employee number	Var char	No
Planner	Planner	Var char	No
Check_status	Review status	Var char	No
Remark	Remarks	Var char	No

Table 4. Supplier information table

Field name	Field description	Data type	Whether the primary key
Identity document	Supplier account	Int	Yes
Supplier_number	Supplier number	Var char	No
Supplier_name	Supplier name	Var char	No
Supplier_type	Supplier type	Int	No
Supplier_status	Supplier status	Int	No
Leader	Person in charge	Var char	No
Phone	Contact number	Var char	No
Bank_name	Name of the bank that opened the account	Var char	No
Bank_account	Open an account bank account number	Var char	No
Address	Supplier address	Var char	No
Email	Email	Var char	No
Remark	Remarks	Var char	No

3. Modeling of Supply Chain Management Based on Error Back Propagation Algorithm

One of the most widely used neural network models at the moment is the error back propagation technique, which is used to train multi-layer feedforward networks. The input layer, hidden layer, and output layer are its three separate but related layers. However, without affecting the relationships between units in the same layer, when the network is assigned to the learning model, the activation values of neurons propagate from each intermediate layer through the input process to the output process. Moreover, after receiving the response from the network during the output process of each layer of neurons, the direction of reducing the error between the target output and the actual output is determined.

The calculated values Q and P for the hidden layer and output layer are:

$$\begin{cases} Q_j = h\left(\sum_{i=1}^{m} m_{ij} a_i - \theta_j\right) \\ P_k = \sum_{j=1}^{l} Q_j m_k - \theta_k \end{cases} \tag{1}$$

Among them, θ_j and θ_k are the corresponding thresholds for the hidden layer and output layer. The mean squared error between the output value P and the expected output value $\hat{P}$ is:

$$E_{MSE}\left(P_k\right) = E(P_k - \hat{P}_k)^2 \tag{2}$$

The weighting coefficients for the hidden layer and output layer are:

$$\begin{cases} m_{ij} = m_{ij} + \mu F_i\left(1 - F_i\right) a_i \sum_{k=1}^{n} m_{jk} Q_{NS}\left(B_k\right) \\ m_{jk} = m_{jk} + \mu F_i Q_{NS}\left(B_k\right) \end{cases} \tag{3}$$

Among them, μ is the learning rate.

Supply chain management typically includes manufacturers, consumers, suppliers, packaging, recycling, and warehouses. Supply chain management is the process of creating a good supply of goods by connecting various parts. Suppliers play an important role in traditional supply chains, providing raw materials and products that meet business needs for their main business. In key enterprises, the selection of suppliers always considers the commercial benefits that suppliers can bring. Therefore, the main purpose of key enterprises is to monitor indicators such as price, quality, and delivery. Sustainable suppliers are enterprises and manufacturers located upstream of the supply chain system that provide environmentally friendly, cost-effective raw materials or products based on the true needs of enterprise development.

The present flow from the collection and inspection center to the recycling, repair, and disposal center is equal to the entire flow from the customer center to the collection and inspection center at each period:

$$\sum_i X_{it}^k = \sum_m X_{am}^k + \sum_r X_{ar}^k + \sum_n X_{an}^k \quad , \forall a, k \tag{4}$$

The average distance index between the obtained approximate optimal Pareto optimal solution set and the ideal Pareto front is the smallest, and the specific expression is:

$$y_i = \min_{J}^{\left|q^*\right|} \sqrt{\sum\nolimits_{m=1}^{5} \left[\frac{f_m\left(a_i\right) - f_m\left(b_j\right)}{f_m^{max} - f_m^{min}}\right]^2} \tag{5}$$

The purchase cost usually includes the cost of goods, purchase handling fees, acceptance and warehousing fees, etc. The calculation formula for these fees is as follows:

$$X_o = \sum_{i=1}^{m} \left[\mu_1\left(P_{ik}\right) * P_{ik} * X_{oik}\right] \tag{6}$$

Among them, P_{ik} is the order quantity of each warehouse, and X_{oik} is the purchase cost per unit of goods.

Typically, carrying weight, transportation distance, and unit freight rate all affect the cost of transportation. According to the assumption, the transportation cost is directly proportional to the transportation volume:

$$X_k = X_{dit} d_i \sum_{i=1}^{m} P_i \tag{7}$$

Among them, d_i represents the distance from the supplier to each retail point, and X_{dit} is the transportation unit price.

Calculation formula for total storage cost:

$$X_F = \sum_{i=1}^{m} \left[\left(p_{it} + P_{it} - Y_i \right) * q_j \left(Y_{jt} \right) * X_{Fit} \right] \tag{8}$$

p_{it} is the inventory quantity at the ordering time, and the storage fee per unit product is X_{Fit}.

The size of the loss cost is closely related to the shortage of goods, and the larger the shortage, the greater the cost. The formula for calculating the total shortage loss cost is:

$$X_s = \sum_{i=1}^{n} \left[\left(Y_i - p_{it} - P_{it} \right) * q_j \left(Y_{jt} \right) * X_{sit} \right] \tag{9}$$

Among them, X_{sit} represents the loss of stock cost per unit of goods.

Supply chain system inventory optimization model:

$$\min EX = \mu \left(\sum_{k=1}^{m} S_{kt} - \sum_{k=1}^{m} p_{kt} \right) * \left(EX1 + EX2 \right) \tag{10}$$

According to the change in the value of unit fitness, if the unit fitness is less than the mean of fitness, the corresponding higher value of q_n is taken; if the fitness is greater than the mean of fitness, the smaller value of q_n is taken, as follows:

$$q_n = \begin{cases} q_{n1} - \dfrac{\left(q_{n1} - q_{n2}\right)\left(h_{\max} - h\right)}{\left(h_{\min} - h\right)} & h \geq h_{uvg} \\ q_{n1} & h < h_{uvg} \end{cases} \tag{11}$$

In the formula, h, h_{uvg}, and $h_{\max}$ respectively represent the fitness of the unit, the mean fitness of the contemporary group, and the maximum fitness of the contemporary group.

4. Supply Chain Collaboration and Decision Support

Basically, a SC is a network formed by autonomous or semi autonomous companies. There is usually a core enterprise in each SC, which can be a manufacturing enterprise or a retail enterprise. For the main enterprise, the SC and its suppliers are interconnected. Each link in the chain has a corresponding relationship between the supply side and the demand side. Therefore, there are many interconnected but legally independent enterprises in the SC. These enterprises are centered around a certain enterprise to meet the needs of users and enhance the value-added network of supply chain participation in enterprise value.

4.1. Decision Model Framework for Supplier Selection

Figure 6 illustrates the decision model's structure for choosing a raw material provider.

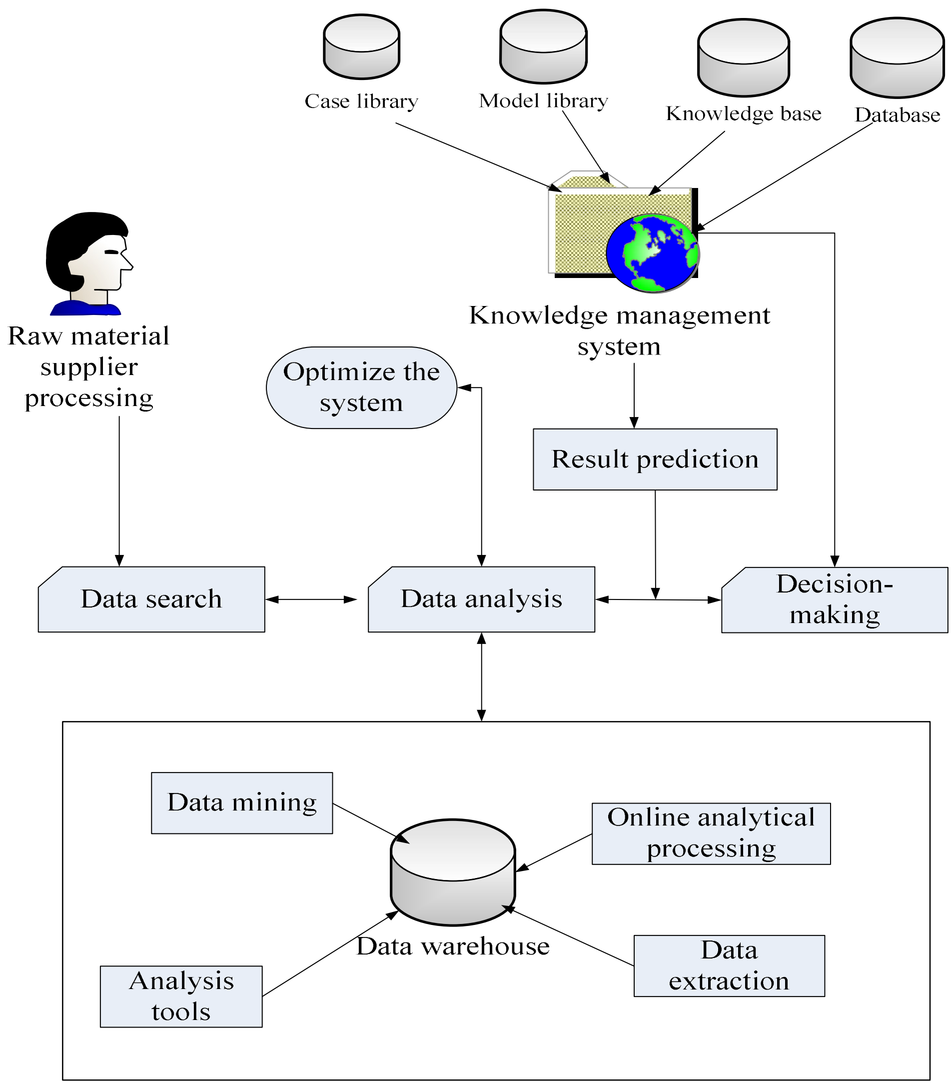


Fig. 6. Framework of decision model for raw material supplier selection

The main functions of each module are as follows:

1) Data search. It is used to search for information related to raw materials. Information search receives data and information from various sources, accepts various information needs, and conducts data retrieval from the collected information through online analysis and completion.

2) Result prediction. The prediction of results mainly comes from the processing of knowledge management information, including knowledge bases, models, cases, and other information databases. The knowledge base stores past experiences and decision rules, helping to complete the work of model construction. A model library is a library composed of many models stored in a design organization, and provides methods for extracting, modifying, accessing, and designing models.

3) Decision analysis. Based on the prediction results provided by knowledge management, the system is optimized for processing and analysis. Then, based on business objectives, decisions are adjusted in a timely manner to ultimately create the best decision plan.

4) Knowledge management. Knowledge management includes databases such as knowledge bases, models, and cases. The negotiation evaluation model can be used in supplier evaluation.

4.2. Manufacturer Marketing Decision Model

Information technology and network technology provide support for the application and use of product business decision model. The use of error back propagation algorithm is conducive to the application and implementation of marketing decision model, which is the premise for enterprises to make marketing decisions. Enterprises can effectively obtain relevant information through data warehouse technology and data mining technology, so as to improve the decision-making ability and environmental adaptability of business decision model. The decision model architecture of manufacturer marketing is shown in Figure 7.

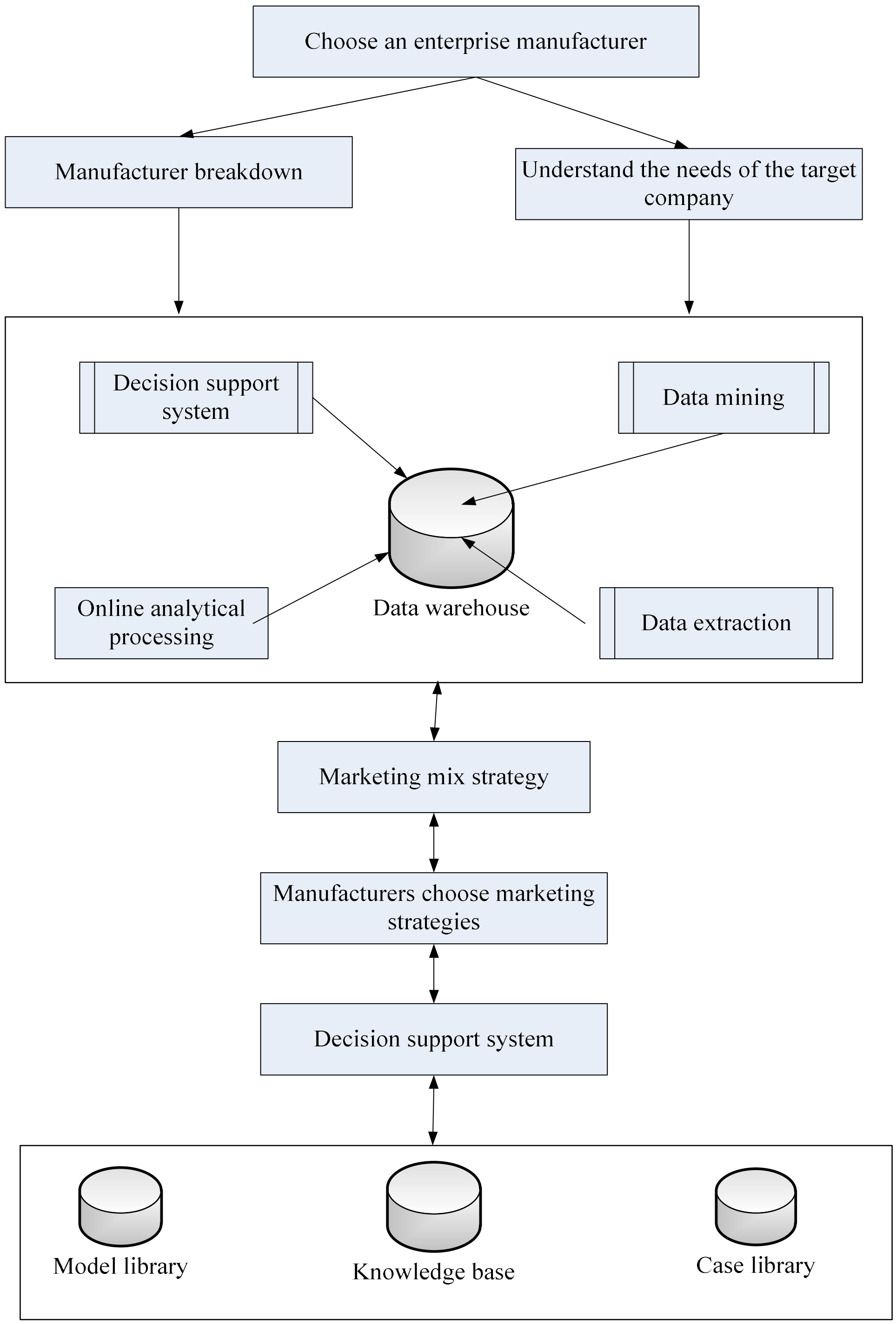


Fig. 7. Enterprise manufacturer marketing decision model architecture

Data mining refers to extracting good data from data sources such as data warehouses, mainly used for collaboration, classification, grouping, and other aspects in decision-making. Online analytical processing refers to the online processing and analysis of various data in a database, creating new data while monitoring business results to help experts analyze and managers. Decision support refers to the integration of information databases such as model libraries, process libraries, knowledge bases, and case studies. The knowledge base collects some experience and rules for determining models, which helps to complete the work of building and selecting models.

5. Enterprise SC Information Assurance Mechanism

5.1. Information Risk Assessment

When conducting risk assessment research on the supply chain, experts can evaluate the risks of members on the chain, but they should consider the existing risks of the members themselves, which is the basis for the use of enterprise supply chain information assessment. However, due to the differences in various aspects of each member in the chain, it is difficult to compare the information risk coefficients obtained in this way horizontally. To this end, a differentiation factor A_K is introduced to represent the position of members in the SC and evaluated based on their bargaining power and the contribution of each member to the operation of the SC. The specific expression is as follows:

$$H_i = \frac{H_1^{'} * A_{1K}}{H_1^{'} * A_{1K} + H_2^{'} * A_{2K} + \cdots + H_i^{'} * A_{iK}} \tag{12}$$

Among them, H_i represents considering the impact of various factors on the entire SC system.

Comprehensive credibility of experts:

$$x = H\left(\overline{x_1}, \overline{x_2}, \cdots, \overline{x_m}\right) = 1 - \left(1 - \overline{x_1}\right)\left(1 - \overline{x_2}\right) * \cdots * \left(1 - \overline{x_m}\right) \tag{13}$$

Among them, $\overline{x_m}$ represents the comprehensive credibility of the experts.

5.2. Information Security Strategies and Measures

The supply chain systemic risk is that some of its own interests can be damaged due to the involvement of equipment, which is reflected in the resistance of enterprises to SC services and the estimated life of enterprises to supply chain operation time. Supply chain organizational risk management includes whether the supply chain is horizontally transferred from organizational departments and control management.

Successful data sharing cannot be achieved overnight. Understanding the value of information in the chain is essential to achieving information exchange, and this cannot be done without the assistance of information technology, which is crucial for keeping an eye on every supply chain link. There are many information technologies used by enterprises in the supply chain.

Electronic data interchange (EDI) is a crucial tool for enterprise information integration and a productive way for business partners to share information when supply chain management is used. Through EDL, information can be quickly obtained, and better services can be provided. Good communication and exchange can be increased. Costs can be reduced, and good business results can be provided.

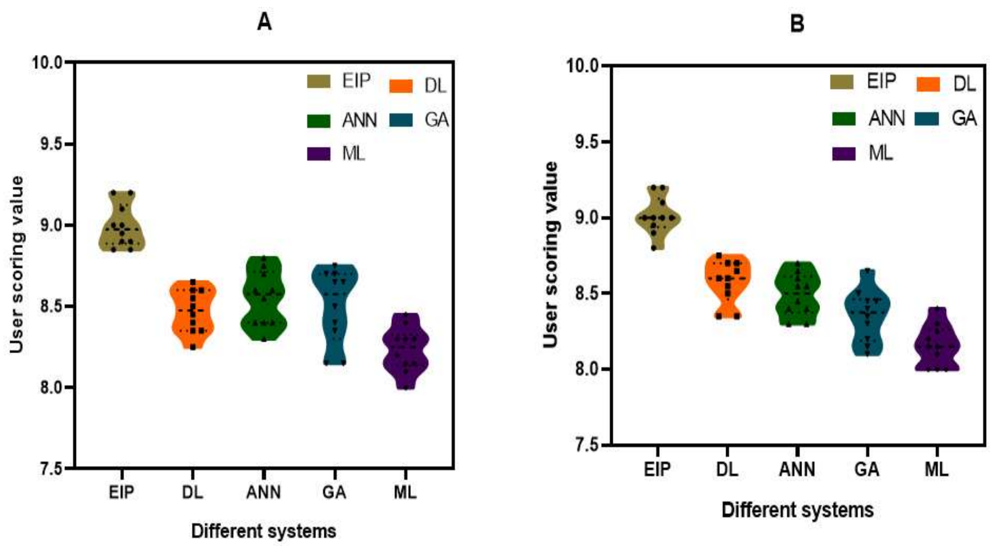
Barcode technology is based on automatic recognition, which can quickly, accurately, and reliably record data, achieving automatic control of warehousing, sales, and outbound. Enterprises using barcode technology can use digital technology to track products, obtain information in real-time to reduce uncertainty, and respond quickly and efficiently to eliminate product shortages and improve service levels.

The development of communication technology has improved the level of supply chain management. Because all links in the control chain are in a state of motion or looseness, information and direction are often sent together with real activities in space and time, which affects the availability and accuracy of information. The use of communication technology effectively overcomes these problems.

The scope of use of radio frequency technology is relatively small, while satellite technology can play a role in a wide geographical area, thus compensating for the shortcomings of radio frequency technology. The electronic ordering system utilizes computer technology and communication to replace traditional ordering and receiving. Specifically, order information is entered into the store and then sent via communication to the headquarters, store, or factory.

6. Experimental Verification and Evaluation of Enterprise Supply Chain Management and Its Information Assurance Mechanism

Product, supplier, order, procurement, logistics, warehousing, procurement settlement, and sales result management are just a few of the many management components that are typically included in SC management of businesses. The purpose of these management features is to give users of the corporate SC management system a better service experience. The error back propagation algorithm is used by the corporate SC management system based on the Error Inverse Propagation (EIP) algorithm to process and sample enterprise SC management data, giving system users higher-quality services. Twenty consumers were chosen at random to grade, on a scale of 1 to 10, the procurement and supplier management described in the appeal. The user assessment effect increases with the score. The obtained results were compared with enterprise SC management systems based on deep learning (DL), artificial neural network (ANN), genetic algorithm (GA), and machine learning (ML). The specific comparison results are shown in Figure 8.



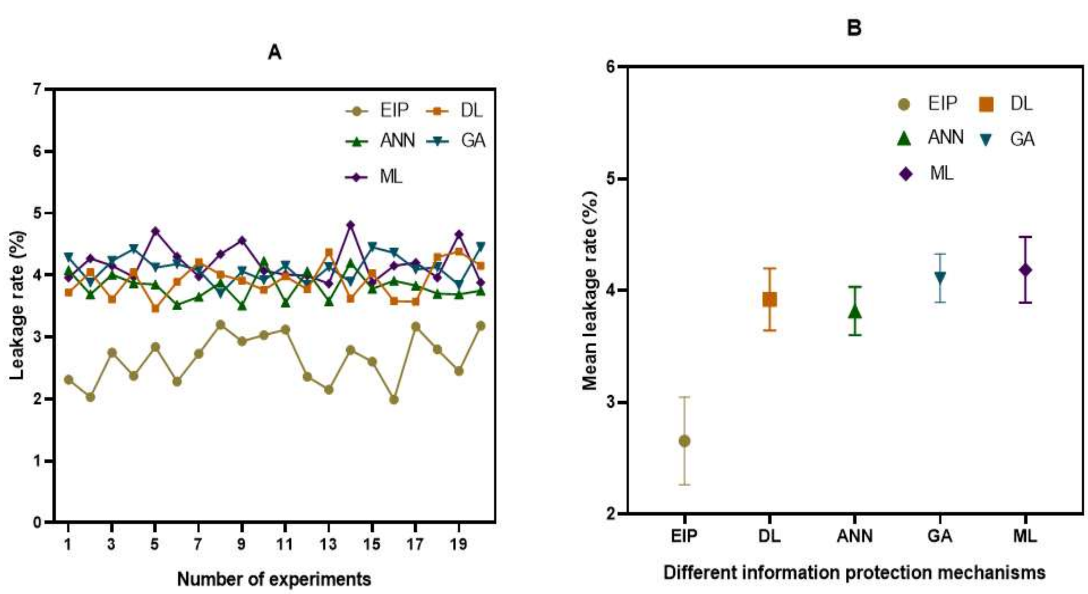
A. Supplier Management B. Procurement Management

Fig. 8. User ratings for different enterprise SC management systems

The x-axis in Figures 8A and B represents several enterprise SC management systems, and the y-axis shows user scores. Figure 8 illustrates how enterprise SC management solutions based on the EIP method scored significantly higher than other SC management system types. Whether it is supplier management or procurement management, user ratings were higher, and the satisfaction of evaluation was also better. As shown in Figure 8A, for supplier management in the enterprise SC management system, the selected users scored the EIP algorithm based system at least 8.84 points, and the average score of 10 users was 8.995 points. The extracted users' ratings for enterprise SC management systems based on DL, ANN, GA, and ML were below 8.66, 8.81, 8.76, and 8.46, respectively. Moreover, the average scores of the 10 users were 0.525 points, 0.445 points, 0.495 points, and 0.76 points lower than the system based on the EIP algorithm, respectively. The sixth user gave the lowest score to the enterprise SC management system based on the EIP algorithm, only 8.85 points, but still scored 0.6 points, 0.05 points, 0.15 points, and 0.85 points higher than the enterprise SC management system based on DL, ANN, GA, and ML, respectively. The 9th user gave the highest ratings for systems based on DL and GA, with scores of 8.65 and 8.75, respectively, which were 0.25 and 0.15 points lower than systems based on EIP algorithm. The second user gave the highest rating to the ML based system, with a score of 8.45, but it was still 0.45 points lower than the EIP algorithm based system.

For procurement management in the corporate SC management system, as illustrated in Figure 8B, the selected users scored the EIP algorithm based system above 8.79 points, and the average score of 10 users was 9.015 points. The extracted users' ratings for enterprise SC management systems based on DL, ANN, GA, and ML were below 8.76 points, 8.71 points, 8.66 points, and 8.41 points, respectively. Moreover, the average scores of the 10 users were 0.44 points, 0.525 points, 0.655 points, and 0.86 points lower than the system based on the EIP algorithm, respectively. The second user gave the lowest score to the enterprise SC management system based on EIP algorithm, only 8.8 points, but still scored 0.15 points, 0.25 points, 0.35 points, and 0.8 points higher than the enterprise SC management system based on DL, ANN, GA, and ML, respectively. The 7th user gave the highest ratings for systems based on DL, ANN, GA, and ML, with scores of 8.75, 8.7, 8.65, and 8.4, respectively, which were 0.2, 0.25, 0.3, and 0.55 points lower than systems based on EIP algorithm.

For the enterprise SC information assurance mechanism, its main purpose is to improve the information security of the enterprise SC, reduce the risks existing in the enterprise, and improve the efficiency of enterprise SC management, helping improve the confidentiality and security of enterprise information data. The error back propagation algorithm was used to study the enterprise SC information assurance mechanism, which effectively improved the security of enterprise SC information. A certain amount of information data was randomly selected, and the information assurance mechanism based on EIP algorithm was used to process these information data. After processing for a period of time, the leakage rate of the data was studied. The lower the leakage rate is, the higher the security of information is, and the information assurance mechanism built is effective. Make the experiment more scientific, 20 experiments were conducted, and the experimental results were compared with the SC information assurance mechanism based on DL, ANN, GA and ML. The specific comparison results are shown in Figure 9.



A: Information leakage rate of 20 experiments B: Mean leakage rate of different mechanisms

Fig. 9. Comparison of information leakage rate of SC Information assurance mechanisms of different enterprises

The number of experiments—20 in total—is shown on the x-axis in Figure 9A, while the leakage rate is shown on the y-axis. Figure 9B shows the average leakage rate on the y-axis and several information assurance measures on the x-axis. As shown in Figure 9, the information leakage rate of each experiment of the information assurance mechanism based on the EIP algorithm was far lower than that of other information assurance mechanisms. As shown in Figure 9A, the information leakage rate of the SC Information assurance mechanism based on the EIP algorithm was below 3.21%. The information leakage rate of the SC information assurance mechanism based on DL, ANN, GA and ML was more than 3.45%, 3.5%, 3.69% and 3.85% respectively. Among them, the mechanism based on EIP algorithm had the highest information leakage rate in the 8th experiment, at 3.2%, but it was still 0.81%, 0.68%, 0.5%, and 1.14% lower than the mechanisms based on DL, ANN, GA, and ML, respectively. The mechanism based on DL algorithm had the lowest information leakage rate in the fifth experiment, only 3.46%, but it was still 0.62% higher than the mechanism based on EIP algorithm. The mechanism based on ANN algorithm had the lowest information leakage rate in the 9th experiment, only 3.51%, but it was still 0.58% higher than the mechanism based on EIP algorithm. The mechanism based on ML algorithm had the lowest information leakage rate in the 13th experiment, only 3.86%, but it was still 1.71% higher than the mechanism based on EIP algorithm. As shown in Figure 9B, the average information leakage rate of the mechanism based on the EIP algorithm in 20 experiments was 2.654%, while the average leakage rate of the mechanism based on DL, ANN, GA, and ML in 20 experiments was 3.9205%, 3.8175%, 4.11%, and 4.1855%, respectively, which was 1.2665%, 1.1635%, 1.456%, and 1.5315% higher than the mechanism based on the EIP algorithm.

After determining the system requirements, test data was collected and the system was configured to verify its operation. According to the needs of the data used, test data was produced to check whether the available functions of the system are good. This process may have many aspects, such as requirements, design, functionality, etc. The supplier management function testing is shown in Table 5 for example.

Table 5. Test case table

Use case name	Precondition	Expected result	Test results
Create a sourcing strategy	Have the role of buyer	Through the generation of a draft sourcing strategy	Pass
Edit the supplier list	Draft existing sourcing strategy	Added successfully	Pass
Editorial review team	Draft existing sourcing strategy	Added successfully	Pass
Edit the supplier list	Draft existing sourcing strategy	Added successfully	Pass
Edit attachment	Draft existing sourcing strategy	Added successfully	Pass
Edit the basic information of sourcing	Draft existing sourcing strategy	Saved successfully	Pass
Announcement of Sourcing strategy	The sourcing strategy has been approved	The supplier received the sourcing announcement in the portal system	Pass

Supplier registration	The supplier received the sourcing announcement	Successful registration	Pass
Sourcing strategy Release Sourcing Matters	The sourcing strategy has been approved	New sourcing items have been added to the list of sourcing items	Pass
Weight of the editorial review team	The review team has approved	The weight is set successfully	Pass
Supplier quotation	The supplier received the inquiry form	Sourcing monitoring can view the quotation information about the goods through the supplier	Pass

7. Conclusions

Since previous management models would have significantly hampered the development of enterprises and were unable to meet the demands of contemporary enterprise development, many small and medium-sized businesses have gradually modified their previous management systems in order to achieve the goal of healthy and sustainable development. Many enterprises have begun to introduce SC management systems. Despite being in use for a long time, the initial manual management mode has gradually developed performance and safety difficulties. Therefore, it is necessary to establish supply chain management that is in line with the actual situation of small and medium-sized enterprises. Therefore, this paper used EIP algorithm to study the enterprise supply chain management and its information assurance mechanism, and built a bridge between management and information to analyze the business needs of enterprises, evaluate the business status of enterprises, and reorganize individual chains, so as to improve the supply chain management system.

Funding

This work was supported by 2024 Anhui Provincial Research Plan Preparation Project: Research on Improving the Marketing Efficiency of Traditional Chinese Medicine Health Products in Bozhou City Based on Customer Journey Analysis and Optimization Strategies. Project Approval Number 2024AH052855.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Conflicts of Interest

These are no potential competing interests in our paper. And all authors have seen the manuscript and approved to submit to your journal. We confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

References

[1] Min, S., Zacharia, Z. G., & Smith, C. D. (2019). Defining supply chain management: In the past, present, and future. Journal of business logistics, 40(1), 44-55.

[2] Jacobs, F. R., & Chase, R. B. (2018). Operations and supply chain management. McGraw-Hill.

[3] Wieland, A. (2021). Dancing the supply chain: Toward transformative supply chain management. Journal of Supply Chain Management, 57(1), 58-73.

[4] Wisner, J. D., Tan, K. C., & Leong, K. (2021). Principles of supply chain management: A balanced approach. South-Western, Cengage Learning.

[5] Sanders, N. R. (2025). Supply chain management: A global perspective. John Wiley & Sons.

[6] Hugos, M. H. (2024). Essentials of supply chain management. John Wiley & Sons.

[7] Coyle, J. J., Novack, R. A., Gibson, B. J., & Langley, C. J. (2021). Supply chain management: a logistics perspective. Cengage Learning.

[8] Lambert, D. M., & Enz, M. G. (2017). Issues in supply chain management: Progress and potential. Industrial marketing management, 62, 1-16.

[9] Chansamut, A. (2021). Supply chain management information system model for quality assurance in educational management for ASEAN University network quality assurance (AUN-QA). International journal of research in industrial engineering, 10(4), 307-317.

[10] Alzoubi, H. M., Ghazal, T. M., Sahawneh, N., & Al-kassem, A. H. (2022). Fuzzy assisted human resource management for supply chain management issues. Annals of Operations Research.

[11] Russell, R. S., & Taylor, B. W. (2019). Operations and supply chain management. John Wiley & Sons.

[12] Alshurideh, M., Alquqa, E., Alzoubi, H., Kurdi, B., & Hamadneh, S. (2023). The effect of information security on e-supply chain in the UAE logistics and distribution industry. Uncertain Supply Chain Management, 11(1), 145-152.

[13] Waters, D. (2019). Supply chain management: An introduction to logistics. Bloomsbury Publishing.

[14] Latif, M. N. A., Aziz, N. A. A., Hussin, N. S. N., & Aziz, Z. A. (2021). Cyber security in supply chain management: A systematic review. LogForum, 17(1), 49-57.

[15] Benton Jr, W. C. (2020). Purchasing and supply chain management. Sage Publications.

[16] Durowoju, O., Chan, H. K., & Wang, X. (2020). Investigation of the effect of e-platform information security breaches: a small and medium enterprise supply chain perspective. IEEE Transactions on Engineering Management, 69(6), 3694-3709.

[17] Sodhi, M. S., & Tang, C. S. (2021). Supply chain management for extreme conditions: Research opportunities. Journal of Supply Chain Management, 57(1), 7-16.

[18] Kaewngam, A., Chatwattana, P., & Piriyasurawong, P. (2019). Supply Chain Management Model in Digital Quality Assurance for ASEAN University Network Quality Assurance (AUN-QA). Higher education studies, 9(4), 12-20.

[19] Rajeev, A., Pati, R. K., Padhi, S. S., & Govindan, K. (2017). Evolution of sustainability in supply chain management: A literature review. Journal of cleaner production, 162, 299-314.

[20] Cheung, K. F., Bell, M. G., & Bhattacharjya, J. (2021). Cybersecurity in logistics and supply chain management: An overview and future research directions. Transportation Research Part E: Logistics and Transportation Review, 146, 102217.

[21] Christopher, M. (2022). Logistics and supply chain management. Pearson Uk.

[22] Attaran, M. (2020, July). Digital technology enablers and their implications for supply chain management. In Supply Chain Forum: An International Journal (Vol. 21, No. 3, pp. 158-172). Taylor & Francis.

[23] Pal, K. (2019). Quality Assurance Issues for Big Data Applications in Supply Chain Management. In Predictive Intelligence Using Big Data and the Internet of Things (pp. 51-76). IGI Global.

[24] Nunes, L. J. R., Causer, T. P., & Ciolkosz, D. (2020). Biomass for energy: A review on supply chain management models. Renewable and Sustainable Energy Reviews, 120, 109658.

[25] Heizer, J., Render, B., & Munson, C. (2020). Operations management: sustainability and supply chain management. Pearson.

[26] Wang, Y., Hulstijn, J., & Tan, Y. H. (2016). Data quality assurance in international supply chains: an application of the value cycle approach to customs reporting. International Journal of Advanced Logistics, 5(2), 76-85.

[27] Chen, J. (2023). The impact and value of information system audit enterprises risk management influencing quality assurance and system optimization—a touch from supply chain domains. Journal of Information Systems Engineering and Management, 8(2), 22289.

[28] Mastos, T. D., Nizamis, A., Terzi, S., Gkortzis, D., Papadopoulos, A., Tsagkalidis, N., ... & Tzovaras, D. (2021). Introducing an application of an industry 4.0 solution for circular supply chain management. Journal of Cleaner Production, 300, 126886.

[29] Pournader, M., Ghaderi, H., Hassanzadegan, A., & Fahimnia, B. (2021). Artificial intelligence applications in supply chain management. International Journal of Production Economics, 241, 108250.

[30] Boiko, A., Shendryk, V., & Boiko, O. (2019). Information systems for supply chain management: uncertainties, risks and cyber security. Procedia computer science, 149, 65-70.

[31] Hampton, C., Sutton, S. G., Arnold, V., & Khazanchi, D. (2021). Cyber supply chain risk management: Toward an understanding of the antecedents to demand for assurance. Journal of Information Systems, 35(2), 37-60.

[32] Santos, H., Oliveira, A., Soares, L., Satis, A., & Santos, A. (2021, August). Information security assessment and certification within supply chains. In Proceedings of the 16th International Conference on Availability, Reliability and Security (pp. 1-6).

[33] Wijewickrama, M. K. C. S., Chileshe, N., Rameezdeen, R., & Ochoa, J. J. (2022). Information processing for quality assurance in reverse logistics supply chains: an organizational information processing theory perspective. Sustainability, 14(9), 5493.

[34] Urciuoli, L., & Hintsa, J. (2017). Adapting supply chain management strategies to security–an analysis of existing gaps and recommendations for improvement. International Journal of Logistics Research and Applications, 20(3), 276-295.