POLITECNICO DI TORINO

Department of Mechanical and Aerospace Engineering

Master’s Degree of Automotive Engineering

Master Thesis

Research on Technologies for Automotive Logistics Optimization in Automotive Supply Chain

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Content

0. Abstract

In this era of information technology, life is becoming more and more abundant and convenient. Therefore, new requirements are set for enterprises. Whoever can provide high-quality services and products to users better and faster will gain an advantage. The same is true for the automotive industry. The automotive supply chain logistics industry has always been recognized as the most professional and complex field in the international logistics industry. Logistics costs have long been one of the important factors that determine the operating costs of enterprises. The role of efficient logistics operations in improving the competitiveness of the automotive supply chain cannot be ignored. With the development of computers and the Internet, logistics technology has also been significantly improved and developed, and can build information networks in all logistics fields. Its application in automotive supply chain logistics has unique advantages. Therefore, this paper studies and analyzes various advanced logistics technologies in automotive supply chain logistics.

First, this paper briefly explains the key technologies of logistics, introduces the relevant theories of supply chain management and automotive supply chain logistics, then makes a brief analysis of the application of logistics technology in supply chain logistics. On this basis, in accordance with the idea of supply chain management, an in-depth analysis of automotive supply chain logistics is conducted from five aspects: automotive procurement and supply logistics, automotive spare parts warehousing management, automotive production logistics, automotive sales logistics and automotive spare parts logistics. Point out the problems in the operation or management of these types of logistics, and determine the requirements for the application of logistics technology in each logistics link. Finally, it puts forward the way to realize the application of logistics technology in automotive supply chain logistics, designs the logistics management process of automotive supply chain, designs some key management processes separately, and analyzes the realization of the logistics management process functions of the corresponding logistics technology.

The application of logistics technology in automotive supply chain logistics has positive effects on inventory reducing, customer response, improving work efficiency and intelligent operation. This thesis studies the demand of logistics technology application in each link of automotive supply chain logistics, and designs the corresponding automotive supply chain logistics management process.

Keywords: Supply chain management, automotive logistics, logistics technologies, RFID, GIS, GPS, EDI.

1. Introduction

1.1 Background of this subject

A long time ago, the automotive manufacturing industries of various countries in the world have already turned their attention to the logistics field, hoping to find out a new continent. In European and American countries, more and more automotive manufacturers have established long-term cooperation with third-party logistics companies to build a better supply chain.

With the development of economic globalization, the automotive industry has developed into the most typical industry with globalization characteristics, and its important sign is the global allocation of resources in the automotive industry. Competition in the auto market is also becoming increasingly fierce. At present, there are thousands of models of cars on sale in the automotive market, and thousands of companies and brands are competing. The market competition in the automotive industry is more severe than ever. In order to cope with fierce competition, it is the general trend to better meet consumer demand, lower product prices, and improve service quality. From the perspective of automotive manufacturers, due to the shrinking profit margins, the requirement to reduce production costs is becoming more and more urgent. The development of automotive supply chain logistics with advanced technology is not only conducive to the optimization of global procurement, production and sales, but also improves the logistics efficiency of the automotive supply chain, making the automotive production and supply model more optimized and refined, reaching the goal of reducing production costs and expanding profit margins.

The automotive industry has entered the era of mass customization. Automotive manufacturing companies customize production according to user needs and customer demand orders are at the forefront of the supply chain. Moreover, user’s requirements for customization are getting more and more urgent, which increases the requirements for logistics and information efficiency of the automotive supply chain.[1]

Automotive logistics is a highly sophisticated high-tech supply chain that requires all phases to be connected well. It is recognized as the most complicated and professional field by all logistics industries in the world. By applying advanced logistics technology in the automotive supply chain logistics, the automation and intelligence of the automotive supply chain can be improved, so we can achieve the goal of controlling costs and improving efficiency, thereby realizing overall benefits and improving overall competitiveness.

1.2 Significance of Logistics technologies in automotive supply chain

Combining modern information technology with complex automotive supply chain logistics, improving automotive supply chain logistics with advanced logistics technology, can obviously get some benefits in the following items.

Index 1: Time. Real-time monitoring of all logistics activities in the automotive supply chain enables all companies in the supply chain to obtain accurate market information in the shortest time, which improves the company’s ability to respond to the market.

Index 2: Accuracy. It can ensure more accurate procurement, supply and demand, and stable production processes.

Index 3: Cost. It reduces warehouse management costs, improves sales efficiency and after-sales service efficiency. It can also reduce transportation cost. Through powerful real-time information management capabilities, the logistics information of the automotive supply chain can be transmitted quickly and accurately, which greatly reduces the excess costs and losses caused by information lag or errors.

Index 4: Availability. Through technical realization, by attaching a simple electronic label to the item can not only realize the seamless connection of information in each link of the supply chain, but also establish a more scientific and reasonable automotive supply chain logistics process, making the supply chain operation process more streamlined and convenient. It can also improve its own production service level and market competitiveness.

This paper firstly analyzes the current situation of logistics management in the automotive logistics supply chain, then analyzes the demand for logistics technology application in automotive and other industries, makes comparisons between technology applied automotive logistics and traditional automotive logistics, finally optimizes the logistics management process of the automotive supply chain through the rational use of technology, providing a reference in the field of automotive supply chain logistics management for related enterprises

2. Overview of supply chain

In today society, the way to obtain profits through the resources and human resources is increasingly restricted by the development of science and technology. With the potential of these two sources of profit becoming smaller and smaller, the “third source of profit”, the logistics sector, is gradually Valued by people. The manufacturing cost of today’s products is less than 10% of the total cost, and the processing time of the product only accounts for 5% of the total time.[2] The logistics links such as product storage, handling, transportation, sales, and packaging have already accounted for manufacturing costs and operations. Most of the time, thus reducing costs and shortening operation time through logistics rationalization has become an important means for enterprises to improve competitiveness and obtain higher profits.

2.1 Definition and characteristics of modern logistics

The concept of logistics was first proposed by Crowell in 1901 " Report of the Industrial Commission on the Distribution of Farm Products " of the U.S. Government. Since then, people's understanding of logistics has been unveiled.

In 1921, American economist Arch Shaw put forward in his book "Several Problems in Market Circulation" that "logistics is a problem that is not connected with the creation of demand, and materials will generate added value through the transfer of time or space."[3] It can be concluded that the logistics at this time are related transportation and warehousing activities carried out to cooperate with sales, namely physical distribution.

In 1935, the American Sales Association made a relevant definition of logistics at that time. At that time, logistics was at the very early stage of the development. In this stage, people start from the desire to facilitate the sale of goods and discuss how to allocate and distribute materials. The core part of rational management in the process of material circulation is that logistics is regarded as an extension of the market.

From the 1950s to the 1970s, the logistics that people studied were logistics activities related to the sales and circulation of commodities. Therefore, the term "Physical distribution" (abbreviated as PD) was often used in the concept of logistics, that is, logistics in the traditional sense.[4] In 1963 The American Logistics Association has also made a clear definition of logistics management.

In 1985, the American Logistics Association defined logistics as "a process of planning, implementation, and control for the efficient and low-cost flow and storage of goods, services, and related information from the place of supply to the place of consumption for the purpose of meeting customer needs. "[5] Thus completing the transformation of logistics from physical distribution to modern logistics.

With the fierce competition in the market and changes in the modern management concepts of enterprises, people's understanding of logistics has been further broadened. In 1998, the latest definition of logistics by the American Association of Logistics Management was that "logistics is a part of the supply chain process, which is to meet the needs of customers for the high efficiency and high benefit of goods, services and related information from the place of origin to the place of consumption[5]. The process of planning, implementation and control towards and reverse flow and storage.” This definition not only includes logistics in the management of the interactive and collaborative relationship between enterprises, but also requires enterprises to consider themselves in a broader market space. Logistics operations. In this way, companies must consider not only their customers, but also their suppliers, but also their customers’ customers and suppliers’ suppliers: companies must not only work to reduce the cost of various logistics operations, so that the entire supply The lowest cost of chain operation. This definition reflects that with the emergence of supply chain management ideas, the logistics industry has a deeper understanding of logistics, emphasizing that logistics is part of the supply chain, and further broadening from the perspective of "reverse logistics"

The connotation and external edge of logistics are shown in Figure 2.1.

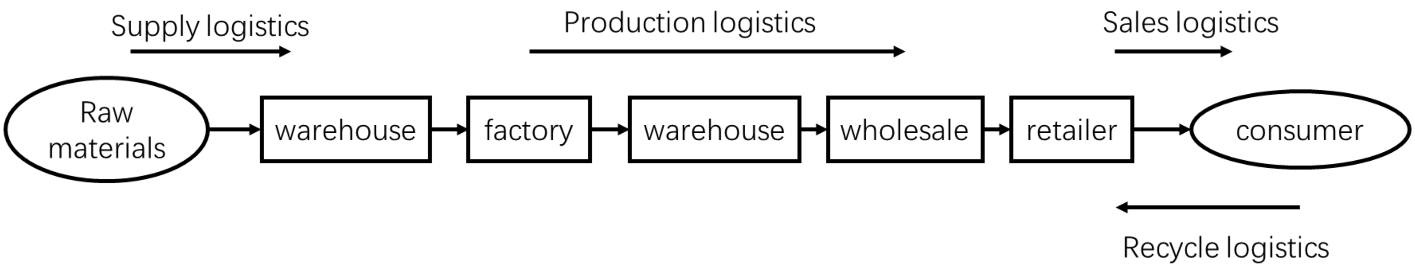

Fig.2.1 General logistics flow

2.2 Definition and characteristics of supply chain management

2.2.1 The concept of supply chain

Many scholars have analyzed the definition of supply chain from different perspectives. Stevens believes that "supply chain refers to the process by which products flow from suppliers' suppliers to users' users through the control of distribution channels and value-added processes. It starts at the point of supply and ends at the point of consumption."[6] Harrison explained the supply chain in this way: "The supply chain is a network function chain that starts with the purchase of raw materials, converts them into semi-finished products and finished products, and finally sells them to customers."[7] Evans believes that "supply chain is an overall model that connects suppliers, manufacturers, retailers, and users by feeding back the information flow and material flow of items."[8]

The definition of a supply chain generally accepted by modern people is: The supply chain is centered on core enterprises and based on customer needs. It starts with the purchase of raw materials from suppliers, then processes them into semi-finished or finished products through manufacturers, and then delivers products to consumers through distributors and retailers. Coordinate the above-mentioned various links, control and manage the two-way flows of information, logistics and capital generated in the process, which is connected as a whole function network chain structure model.[9] This can achieve the purpose of improving overall efficiency. The network structure is shown in Figure 2.2.

According to this definition, materials in the supply chain increase their value through the processes of manufacturing, assembly, warehousing, transportation, and distribution of different upstream and downstream enterprises. Therefore, the supply chain is also a value-added chain.

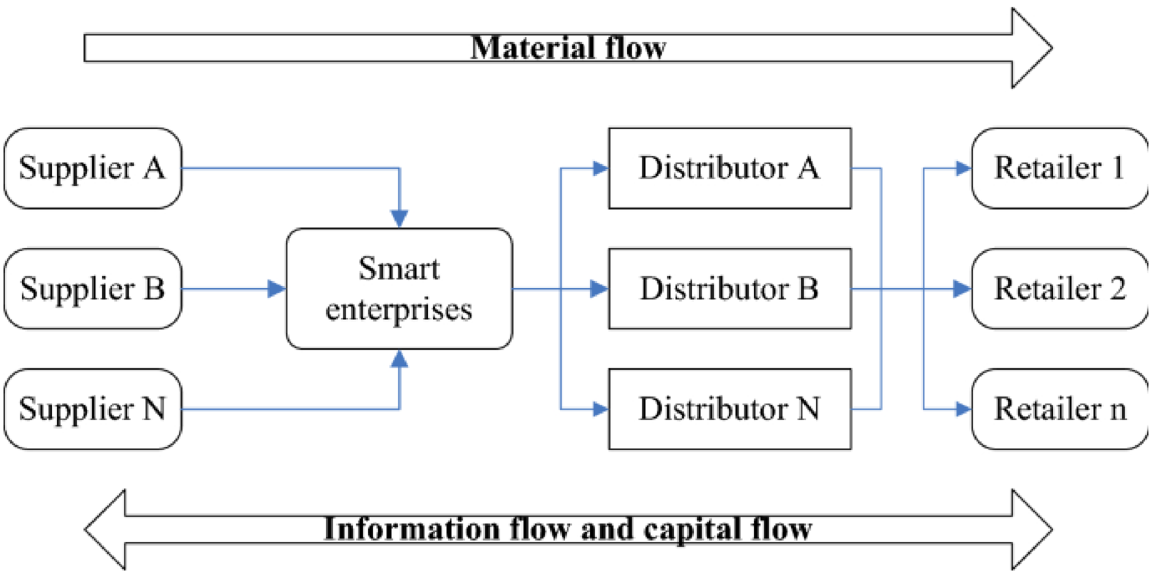

Fig.2.2 Supply chain network structure

2.2.2 Supply Chain Management

The term Supply Chain Management (SCM) was first proposed by management consultants of some world-class large companies in the early 1980s, and first appeared in academic articles in 1982. It was in 1990 that academia first really elaborated and defined the supply chain in a theoretical way, and distinguished it from the traditional methods of managing material flows and related information flows. It mainly focuses on how to enable companies to use the supplier's process, technology and capabilities to improve their competitiveness, and to achieve collaboration in product design, manufacturing, logistics and procurement management functions within the organization.

2.2.2.1 Basic concepts of supply chain management

As an advanced management method, supply chain management enhances the value of shareholders and customers by optimizing the flow of products and services and related information from suppliers to customers.

Supply chain management can be said to be developed from logistics management, but it is higher than logistics management. The object of logistics management is material flow and activities closely related to material flow. Supply chain management has a broader scope, including business flow, information flow, capital flow, value-added flow, etc., and logistics management is also among them. Logistics management has become a key component of supply chain management. Enterprises often reduce costs through logistics management to achieve thr goal of product value-added, then improve logistics efficiency to reduce inventory and distribution costs. This has become an important means for enterprises to improve their supply chain efficiency and competitiveness. Supply chain management is the expansion and extension of logistics management, and a new strategy for the development of logistics management from internal integration to external integration.

Supply chain management is an integrated management thought and method to satisfy all the processes of the end user. From the perspective of the minimum total cost of the supply chain, it is not just purely pursuing the optimization of a certain link, but the entire supply chain operation. Achieve optimization. By planning, organizing, coordinating and controlling all links in the supply chain, establish a "cooperation-competition" strategic partnership between supply, production and marketing enterprises, implement complementary advantages, minimize costs, and achieve optimal overall supply chain efficiency. It is a kind of cross-enterprise management. All different enterprises including suppliers, manufacturers, wholesalers, and retailers in the entire chain use system concepts for integrated planning and coordination. Through the establishment of strategic supply chain partnerships between enterprises, three aspects of management significance can be realized in terms of improving customer satisfaction, reducing company costs, and the overall "process quality optimization" of the enterprise. In the supply chain, all member companies are a whole. They must truly share information, share risks, and profit together. Each node company is in a cooperative and competitive relationship to achieve efficient supply chain management. Each node enterprise brings benefits and reaches the best level of supply chain management. Supply chain management is guided by synchronized and integrated production plans, supported by various technologies, especially relying on the Internet, it is realized around supply, production operations, logistics operations (mainly manufacturing processes), and meeting demands. Supply chain management mainly includes planning, cooperation, coordination, operation, control and optimization of materials (parts and finished products, etc.) and information from suppliers to customers.

The goal of supply chain management is to deliver the Right Product required by customers to (Right Place) at (Right Time), in accordance with (Right Quantity), (Right Quality) and (Right Status)—that is, “6R”[10] and reduce total Transaction costs, and seek a balance between the two goals.

2.2.2.2 Basic characteristics of supply chain management

From the structural model of the supply chain, we can see that the supply chain is a network chain structure, which is composed of suppliers around the core enterprise, suppliers and users of suppliers, and users of users. An enterprise is a node, and there is a demand and supply relationship between the node enterprise and the node enterprise. Combined with the relevant theories of supply chain management, it is concluded that supply chain management has the following characteristics:

①Supply chain management is the management of interactive interfaces. From the perspective of management objects, logistics takes inventory assets as its management objects. The supply chain management is the management of the business process in the flow of inventory (including necessary pauses), and the latter is the management of the relationship, so it is more interactive. Professor Lambert believes that fine management, demand management, order execution management, manufacturing process management, procurement management, new product development and commercialization management must be implemented for all key business processes in the supply chain. In some enterprises, the supply chain management process also includes the management of commodity recycling channels based on the concept of environmental protection.

②Supply chain management is a more advanced form of logistics. In fact, supply chain management is also developed on the base of logistics. At the level of corporate actions, starting from physical distribution, to integrating material management, and then to integrating relevant information, the concept of logistics is formed through the gradual integration of functions. From the perspective of corporate relationships, there is forward integration from manufacturers to wholesalers and distributors to end users, and then backward integration to suppliers. The concept of supply chain management is formed through the integration of relationships. From the integration of operational functions to the integration of channel relationships, logistics has been elevated from a tactical level to a strategic level. Therefore, supply chain management seems to be a relatively new concept, but it is actual a logical extension of traditional logistics. In 1988, the American Logistics Association revised the definition of logistics in order to adapt to the development of logistics. From this definition, it can be concluded that the concept of supply chain management covers the concept of logistics. From the point of view of system theory, logistics is the part of supply chain management system. Subsystem. Therefore, the operation of logistics must obey the overall arrangement of supply chain management.

③Supply chain management is a negotiation mechanism. Logistics is a planned mechanism in management. The dominant enterprise is usually the manufacturer trying to control the flow of products and information through a plan. The relationship with suppliers and customers is essentially a buying and selling relationship with conflicts of interest, which often leads to the transfer of inventory to upstream companies or the transfer of costs. Supply chain management also makes plans, but the purpose is to seek linkage and coordination among channel members. United Technologies Corporation held a large-scale online auction in Asia in March this year and signed a motor supply contract totaling more than 200 million US dollars. In order to improve the efficiency of the production cycle, the company even announced the production plan on the Internet to make its suppliers Be able to respond more quickly to changes in demand.

Supply chain management is an open system. One of its important goals is to reduce or eliminate buffer stocks held by all supply chain member companies by sharing information on demand and current inventory levels. This is the concept of "co-management of inventory" in supply chain management.

④Supply chain management puts more emphasis on external integration of the organization. Logistics is mainly concerned with the functional integration within the organization, while supply chain management believes that only the integration within the organization is far from enough. Supply chain management is a highly interactive and complex system engineering, which requires simultaneous consideration of interrelated technical and economic issues at different levels and a cost-benefit balance. For example, it is necessary to consider within and between the organization, in what form and place the inventory is placed, and when to implement what plan; the layout and location of the supply chain system, the depth of information sharing; the implementation of the business process How can the overall benefits obtained after integrated management be distributed among supply chain members; especially the supply chain members are required to jointly participate in the formulation of overall development strategies or new product development strategies at the beginning. Cross-boundary and cross-organizational integrated management have become popular. The boundaries of naming organizations have become blurred.

⑤Supply chain management is more dependent on common value. As a logical inevitability of increasing system structure complexity, supply chain management will rely more on the support of information systems. If the action of logistics is to improve the customer feasibility of the product, then supply chain management is the first to solve the problem of information reliability between supply chain partners. Therefore, the supply chain is sometimes regarded as a series of relationships between cooperative partners based on the value-added exchange of information. The Internet provides technical support for improving the reliability of information, but how to manage and distribute information is based on the business process between supply chain members. Consensus level of integration. Therefore, rather than saying that supply chain management relies on network technology, it is better to say that supply chain management is, firstly, the mutual trust, interdependence, mutual benefit and common development of common values and dependence on supply chain partners.

⑥Supply chain management is an "external source" integrated organization. Different from vertically integrated logistics, supply chain management is more based on its own "core business," and through collaboration and integration of external resources to obtain the best overall operational effect. Except for the core business, almost everything may be "External sources" are obtained from outside the company. Well-known companies such as Nike and Sun Microsystems usually outsource or partially outsource the components, they concentrate on the development and marketing of new products. This category Companies are sometimes referred to as “virtual enterprises” or “network organizations.” In fact, 90% of the manufacturing cost of a standard Apple computer is also an exception. On the surface, these companies make some or all of the manufacturing And service activities are entrusted to other companies to process and manufacture in the form of contracts, but in fact, they are in accordance with market demand and integrate or re-allocate social resources with a network system composed of rules equal to standards, brand, knowledge, core technology and innovation capabilities.

Vertical integration aims at ownership, while supply chain management uses collaboration and win-win as a means. Therefore, supply chain management is a more preferred method of resource allocation, and its inherent philosophy is "doing something and not doing something".

While supply chain management obtains the configuration of external sources, it also externalizes the original internal costs. With clear process accounting and cost control, it can better optimize customer service and implement customer relationship management.

⑦Supply chain management is a dynamic response system. In the specific implementation of supply chain management, the management evaluation of key processes throughout cannot be ignored. The highly dynamic business environment requires enterprise management to implement standardized and frequent monitoring and evaluation of the actions of the supply chain. When the management objectives are not achieved, they must consider possible alternative supply chains and make appropriate changes.

2.3 Automotive supply chain structure

The automotive supply chain integrates the logistics planning and control functions from the supplier of parts to the end user. It uses an integrated mode of thinking. The automotive supply chain adopts such a management model, through the feedforward and feedback information flow, capital flow and logistics information, the automotive parts suppliers and the finished car manufacturers, the vehicle distributors at all levels and the end users are connected into one overall. The integrated supply chain model of the automotive industry integrates all companies in the supply chain, increases the operational efficiency of the entire supply chain, and pays more attention to the cooperative relationship between enterprises in the supply chain. Using this model can connect the parts suppliers, vehicle manufacturers and vehicle distributors in the supply chain into a whole, so that various enterprises can share the functions of procurement, production, distribution and sales. It is more conducive to the coordinated development of the supply chain. Figure 2.3 shows the structure of the automotive supply chain.

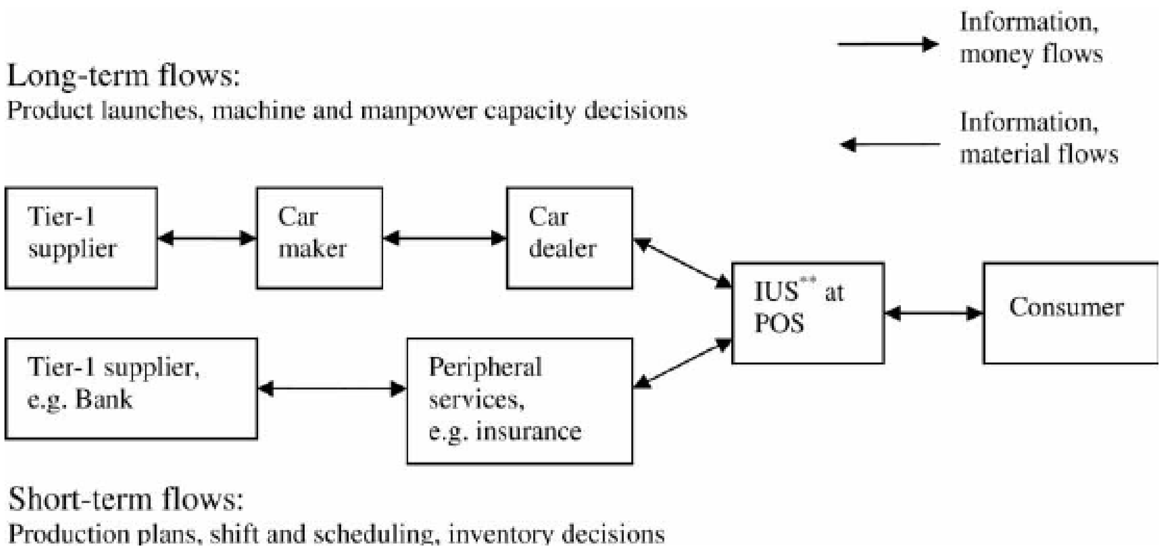

Fig.2.3 Automotive supply chain

2.4 Key logistics technologies and their application in other industries logistics

2.4.1 RFID technology

RFID (Radio Frequency Identification Technology) is commonly known as electronic tags. It is an automatic identification technology that does not require direct physical contact but relies on the transmission of radio frequency signals to automatically identify tag targets and obtain data. The work project will not be affected by manpower and the environment. RFID identification technology will not be affected by the speed and quantity of the identification tags, and it can also identify multiple tags at the same time. It is very powerful and easy to operate.

(1) Application cases of RFID in other industries

Wal-Mart Stores uses RFID technology in merchandise logistics activities, and it brought very good results. According to the analysis of Wal-Mart experts, “The reduction of individual scan work due to RFID technology each year can reduce Wal-Mart’s costs by 15%, or 6.7 billion labor costs. In fact, according to EAN’s Erwin De Spielgelere forecast, using RFID technology saves Wal-Mart USD 8.35 billion annually. " Simon Langford, manager of Wal-Mart’s RFID strategy department, once said, “Every employee scans a bar code on a pallet or container in the warehouse at a cost of 5 cents. If this work is automated, it will bring us millions of dollars in benefits."[20]

According to the survey, the use of RFID tags has reduced Wal-Mart’s out-of-sale phenomenon by 16%. In terms of product replenishment, RFID technology is 3 times faster than bar code technology, and manual orders are reduced by about 10%. The inventory is also greatly reduced; in terms of technical replenishment of out-of-stock products, RFID technology makes Wal-Mart’s operational efficiency 63% higher than that of ordinary shopping malls. The application of this technology can not only realize the visualization of inventory, but also reduce the inventory of the entire supply chain, thereby reducing logistics costs. From this point of view, RFID technology is worthy of being promoted and popularized in the entire logistics industry.

(2) RFID system structure
The standard RFID system consists of three parts: tag, reader and antenna, as shown in Figure 2.4. A complete system also needs a data transmission and processing system. Antennas are usually integrated with tags or readers, so RFID technology is also called radio frequency identification technology.

Electronic tags are the true carrier of the RFID system. Each tag has a unique electronic code to store the information that needs to be identified and transmitted. It is attached to the object to make the target object uniquely identifiable. The tag antenna and the tag chip form an electronic tag, and the chip package includes three parts: a memory, a control module, and a radio frequency module. The antenna can be used to receive the signal sent by the reader and at the same time transmit the signal processed by the radio frequency module.

The radio frequency module is responsible for encoding and modulating the information in the memory. On the one hand, the control module can decode the information and write it into the memory according to the write or read command of the reader. On the other hand, it can read the information in the memory and transmit it to the radio frequency module after encoding; the memory only saves the relevant information of the target object. According to whether there is a battery on the label, it can be divided into active label and passive label.

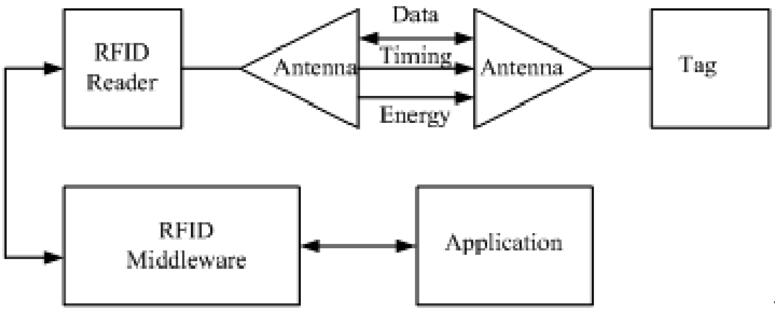

Fig.2.4 RFID system composition diagram

The reader is a device that performs operations on tags and can read and write stored information. It is a very critical infrastructure in the Internet of Things system. In the entire system, information collection is a very critical basic work. All data transmitted and shared is completed through data collection, and data collection is achieved by relying on electronic tags and RFID readers. Real-time and accurately collect data in readers distributed in different locations, then transmit them according to business needs.

The RFID reader is composed of an antenna, a radio frequency module and a main control module. The main control module includes a controller and an external interface. The radio frequency module performs identification and information collection operations on electronic tags through a unified standard frequency band. The main control module passes the interface of the middleware realizes the communication between the hosts and receives the management of the reader from the host. The reader can either independently complete the operation of the electronic tag, or it can be combined with other devices to jointly complete the functions of reading and writing tags, displaying information and processing control.

(3) RFID working principle
The framework of the working principle of the RFID system is shown in Figure 2.5. After the electronic tag enters the electromagnetic field where the reader is located, the reader sends out a radio frequency signal, and the tag sends the item information stored in the chip to the reader. After the reader reads the information and decodes it, it is transmitted to the central information system through the network for data transmission and processing. The working method and workflow of the RFID system can be introduced from three aspects: energy, timing and data exchange.[11]

Energy refers to the energy required by the electronic tag to work. For passive tags, they rely on the reader to provide energy during normal operation. The radio frequency signal emitted by the reader generates induced current, so that the tag gains energy and passively sends item information to the reader. The electronic tag will be in a dormant state after the reader works. For an active tag, relying on its own power supply to provide energy, it can actively send a certain signal to the reader to transmit item information. Once it enters the working range of the reader, the electronic tag is in an active state.

Since the RFID system is a two-way system, a working sequence must be determined to prevent communication conflicts. The RFID system sequence refers to the working sequence of the electronic tag and the reader. There are usually two working sequence methods: the reader speaks firstly, or the electronic tag speaks first. The former is the reader asks first, and the electronic tag responds, the latter is the electronic tag sends out information first, and the reader reads the information record or further issues commands to the electronic tag.

Data exchange in the RFID system refers to the data exchange between the reader and the electronic tag, including two aspects: on the one hand, the reader transmits the data to the electronic tag, firstly consider whether to issue a command to the electronic tag, and secondly consider whether the reader should rewrite electronic label. On the other hand, there are two ways for the electronic tag to transmit data to the reader: one is to send information directly to the reader, and the other is to enter the sending state or the dormant state according to the reader's command.

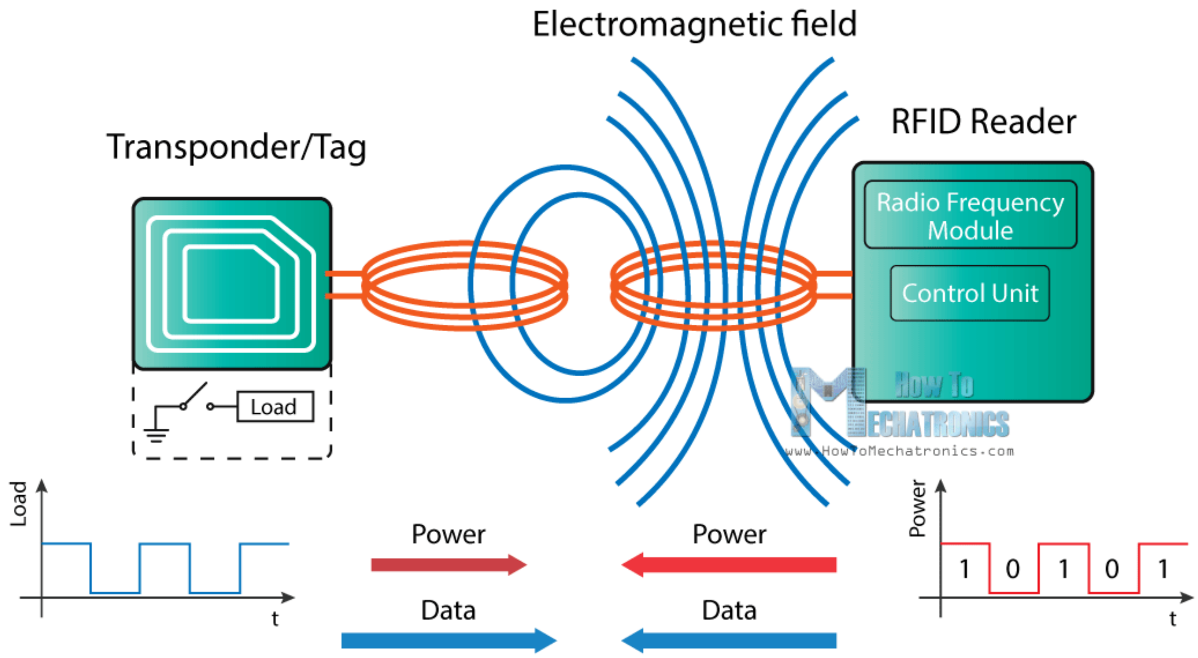

Fig.2.5 RFID working principle

2.4.2. EPC electronic coding technology

The full name of EPC is Electronic Product Code, which is a global unified identification system launched by the International Article Numbering Association and the American Uniform Code Association. Each item is assigned a globally unique EPC code, using electronic tags as the carrier, and using RFID radio frequency identification technology for information Collect and exchange, use EPC network for data transmission and storage.

(1) Application cases of EPC in other industries

EPC technology is mainly used in the warehousing and transportation of large and medium-sized logistics companies, as well as in the logistics express industry. For example, the use of this technology by SF Express is relatively mature. EPC technology has successfully transformed logistics activities from manual operations to digital and automated operations, overcoming the shortcomings of manual operations such as slow speed, high error rate, and low production efficiency. For example, SF Logistics Company makes full use of EPC technology in logistics warehousing and distribution activities. The following impacts were brought:

① The shipment speed was greatly improved. It takes 1.6 seconds for a typist with a typing speed of 90 characters per minute to input 12 characters, while the same job using electronic tags only takes 0.3 seconds. The acceleration of the speed has caused the volume of logistics to develop from 500 pieces per day in the past to tens of thousands of pieces of goods in and out every day.

②The error rate is almost zero. In the past, during manual operation, the error rate was three per thousand, but after using EPC, the scanning error rate was only six per 100,000, or even zero.

③Save manpower. The use of EPC makes the inbound and outbound of goods easier and faster, and the labor force of warehouse personnel has been saved, which can reach 1000-2000 square meters/person, or even 4000 square meters/person.

For another example, in the distribution and storage of books in Xinhua Bookstore. In the past 7 years, the progress of logistics information system has brought huge operating benefits to it. Before the introduction of EPC system, facing hundreds of shelves and thousands of types of books, 20 staff members could only rely on memory to search for the positions of shelves and books. The work pressure was high, the picking time was long, and the error rate was high. Only 10% of customer needs can be realized. Now every book is affixed with an electronic label, just scan the bar code to find the specific location of the book and the number of needs. With the increasing number of books, the number of staff did not rise, instead, dropped to 10, the work is simpler, and the error rate is almost zero. The application is also in the book return system. In the initial stage of the establishment of the logistics center, due to the lack of a complete book return system, work efficiency was low, most of the work was done manually, large number of books were backlogged in the logistics center. According to statistics, the total amount of books returned during the most stressful period reached 50 million, and it took 100 workers 2 months to sort these books and return them to the publisher. Nowadays, the use of a comprehensive return system allows the return center to handle books worth 80 million yuan up to the maximum. If it is to deal with the same business volume as the original, 50 million yuan, worth of return books, it consumes the same time and only requires 20 people. The 80% reduction in labor costs is the economic benefits brought by the logistics information system to Xinhua Logistics. In addition, there are also increasing customer satisfaction. The system is also used in the sorting process of books. It can sort 100 books in basic stores at the same time. Through the perfect combination of this system and the automatic sorting machine, it can process 3000-4000 books per hour, with higher work efficiency dozens of times the original one. It can be known that the three main logistics information systems of Xinhua Book logistics have played a role in improving logistics efficiency and logistics processing capacity, while reducing logistics costs and time. At last, in terms of electronic ordering, after using this technology, downstream stores do not need to go to the headquarters to place orders, instead can place orders via the Internet at any time and from any place. The order information is immediately transmitted to the logistics center to generate orders and other documents. The goods will be delivered to the destination within 24 hours, and the distant areas can also be reached within 2 days. The entire ordering time and cost are greatly reduced.

(2) EPC system composition

The EPC system mainly consists of three parts: EPC coding system, radio frequency identification system and EPC information network system. It mainly includes EPC tags, tag readers, EPC middleware, Internet, ONS server and PML server, as shown in Table 2.6.

All parts cooperate to realize the functions of identification, storage, transmission and sharing of data in the entire system, thereby realize the process of product identification and tracking in the range of world.

Chart 2.1 EPC System Composition

System composition	name	function
EPC Coding System	EPC coding standard	Identify the target code
EPC Radio Frequency Identification System	EPC label	Identify the item
	EPC Reader	Read the memory information in the EPC tag
EPC Software Support System	EPC Middleware	Connect the reader and application
	ONS (Object Name Service)	Specify the PML server for storing information for the middleware
	PML (Physical Markup Language)	Save product information file

(2) Features of EPC system
The EPC system is an open global product identification system, which can be widely used in all links, nodes and aspects of the supply chain, and can achieve obvious results, with its unique advantages:

First, the EPC system is based on the world's largest public Internet system and is an open structural system. Second, the EPC system has an independent platform and a high degree of interactivity. On the one hand, the objects recognized by the EPC system include various content and a wide range of specific single entity objects. Different countries and regions have different identification technology standards. Therefore, it is impossible to use only one technique to identify all objects. An open structure system must have an independent platform. On the other hand, the EPC network and the Internet work together to the maximum extent and must have a high degree of interactivity. Third, the EPC system is a flexible and sustainable system that can be upgraded without replacing the original system.

2.4.3 Global positioning technology
Logistics is simply the flow of things, which also shows that geographic space is an important factor considered in logistics operations. For example, the transportation process requires a lot of manpower and material resources, and often due to some uncertain factors, the goods are damaged. The longer the transportation time, the more serious the loss. So how can we reduce or even eliminate this part of the loss? There are also some issues such as facility location and spatial query. An effective logistics network must be large-scale, if only some items are tracked and monitored, then it is difficult to play the intelligent role of the network. At the same time, it must also be fluid, the production activities and daily life items are usually not static, but in motion. It is required that items can be monitored and tracked in real time when the items are in motion or even in high-speed motion. At the time, we need to use advanced logistics information technology, and geographic information system (GIS) and global positioning system (GPS) technology are typical representatives to solve these problems. [12]

Unlike traditional forms or words to process data and information, GIS is a computer system that can obtain, store, manage, query, simulate and analyze geographic information. It is most commonly used in the process of distribution operations, such as: In the center, when delivering to multiple users, use GIS to select a route with the shortest delivery time, the shortest route, the least damage rate, and the lowest logistics cost. The GPS is often used in cooperation with GIS. GPS is also known as the Global Positioning System. It uses satellites and wireless technology to perform omnidirectional positioning for designated targets on a global scale 24 hours a day, with accurate information and fast positioning speed.
Through GPS, the best route for goods transportation can be selected, and a higher level of service can be

provided at the lowest cost; in addition, this technology is often used for real-time monitoring of goods and vehicles in transit, which is convenient for drivers and the information center to exchange information in time, and ensures the efficiency of the transportation process and the safety of the goods.

For example: SF Logistics company uses GPS technology in logistics transportation, which can monitor goods in real time, the completeness rate of goods reaches 99%, and it is convenient for customers to inquire information. At present, technology that combines GIS and GPS has been developed, which is mainly used for remote management of vehicles such as positioning, tracking, alarming, and communication. Due to the fact the technology is highly specialized and requires certain financial support, it is not so popular yet. According to surveys, more than 90% of logistics companies are not using this technology, but generally use global eye technology or communication equipment instead. However, the industry has a deep understanding of GIS and GPS technology, and believes that this technology will help save logistics time and costs, and improve logistics security, and said that it will gradually introduce this technology in future development. This also shows that with the continuous development of the logistics industry, this technology will be an indispensable part of logistics management.

2.4.4 Electronic Data Interchange (EDI) Technology

In recent years, electronic data interchange technology (EDI) has been gradually promoted in the logistics industry. With the popularity of the Internet, Internet-based EDI methods have gradually become popular. The Internet provides a development platform for EDI with a wide coverage area and a low cost. The emergence of this method makes the large amount of information existing in logistics operations no longer need to be exchanged manually. The information is transmitted to each other through the network in EDI standard format, so that both parties can obtain timely and accurate information, which is beneficial to production, transportation and warehousing. The coordination between them can shorten the delivery cycle, reduce the inventory level, and ultimately reduce the logistics cost while improving the logistics service level. At present, this technology is mainly used in various logistics information platforms built by the government.

Take the electronic port public information platform as an example. With the rapid growth of global foreign trade, relying only on traditional paper-based customs clearance and on-site methods can no longer meet the needs of modern foreign trade, port and shipping, and logistics. Building a port public information platform is the most effective way to solve this problem. The electronic port is first to realize electronic, reduce the repeated input of data in each link, and at the same time, through process optimization and process reengineering, change the enterprise series operation to parallel operation, and gradually cancel the paper documents, and finally achieve the optimal process and the fastest process. So as to facilitate enterprises, reduce costs and improve efficiency. The construction of the electronic port platform enables the electronic data related to logistics operations to be shared and quickly exchanged in customs, quarantine, border inspection, maritime, taxation, banking and other port departments, so that the circulation of various paper documents is converted into electronic flow. Complete the comparison, verification and confirmation on the Internet.

Take China's Nanjing Electronic Port Public Information Platform as an example. The information platform can connect 200 port-related units and accept simultaneous visits and operations by 200 shipping agents, freight forwarders, and logistics companies, with an average daily visit volume of more than 900 people. With the strong support of the government and logistics companies, the electronic port platform will be further improved. For example, it is preparing to start the construction of the "Port Inspection Network System". The ship declaration function realizes one single and four reports. In terms of cost and work efficiency, the average port logistics cost per container at the port can be reduced by more than 20 yuan, of which the container port logistics cost for inspection and quarantine inspection can be reduced by more than 200 yuan per container on average, which can save the company 2 million yuan in operating costs each year the above. In terms of time, each batch of exported goods can save 2 to 4 hours of customs clearance time, and each batch of imported goods can save 7 to 10 hours of customs clearance time.

2.5 Current situation of global logistics technology research and development

At present, the United States has achieved a leading position in the research and application of RFID and EPC Global. The "Smart Earth, Internet of Things, and Cloud Computing" proposed by the United States shows its determination to become the leader of a new round of IT technology revolution.[13] The United States has not only carried out a large amount of research work, but also attached great importance to the practice and application of related technologies. It has established more than 800 RFID application centers nationwide, becoming the world's largest RFID application market.[14]

The EU has done a lot of innovative work in the application of technology. The European Commission put forward the "European Digital Plan" in 2010.[15] The plan mainly involves: management, privacy and personal information protection, trust acceptability, safety, standardization, research and development, innovation, overall European communication, pollution management and future evolution, including 14 Items.

Japan and South Korea launched national informatization strategies with similar goals in 2004 and 2006 respectively, which became "U-Japan" and "U-Korea" respectively. Japan and South Korea have promoted the construction of national information infrastructure on a large scale, hoping to use information technology to promote national economic and social development and strengthen industrial advantages and national competitiveness.[[16] At present, RFID is widely used in the consumer sector in Japan. The Japanese economy has selected seven major industrial sectors for RFID application experiments. RFID has entered the practical application stage from the conceptual stage. The application of RFID technology in South Korea is also deepening and popularizing, especially, it has outstanding applications in freight ports, parking management systems, and clothing supply chains.

China initiated the standardization of sensor networks in 2007, which is ahead of other countries in the world. At the first international sensor network standard ISO/IEC conference held in Shanghai in 2008, the "Sensor Network Standard System Framework and System Architecture" submitted by China was recognized by representatives of various countries. As of May 2010, a joint working group for IoT standards has been formally established. In 2010, the top-level design of the sensor network standardization network part of the research results submitted by research institutions as the main body, including the reference model and system architecture, was adopted by the National Standardization Organization.[17]

3. Automotive logistics

3.1 Automotive logistics

Automotive logistics is a process in which automotive parts, spare parts and complete vehicles are transferred from supply to demand.[18] The main activities include transportation, storage, loading, unloading, distribution, and information processing. Its goal is to achieve the highest level of service with the smallest logistics cost, and it is characterized by complexity, professionalism and capital and technology intensive. Automotive logistics is recognized as the most complex and professional logistics field in the world. According to the supply chain business process of automotive logistics, it can be divided into production logistics, manufacturing and assembly logistics, vehicle sales logistics, supply logistics and recycling logistics. Based on the above content, the details of automotive logistics can be seen in Figure 3.1 below

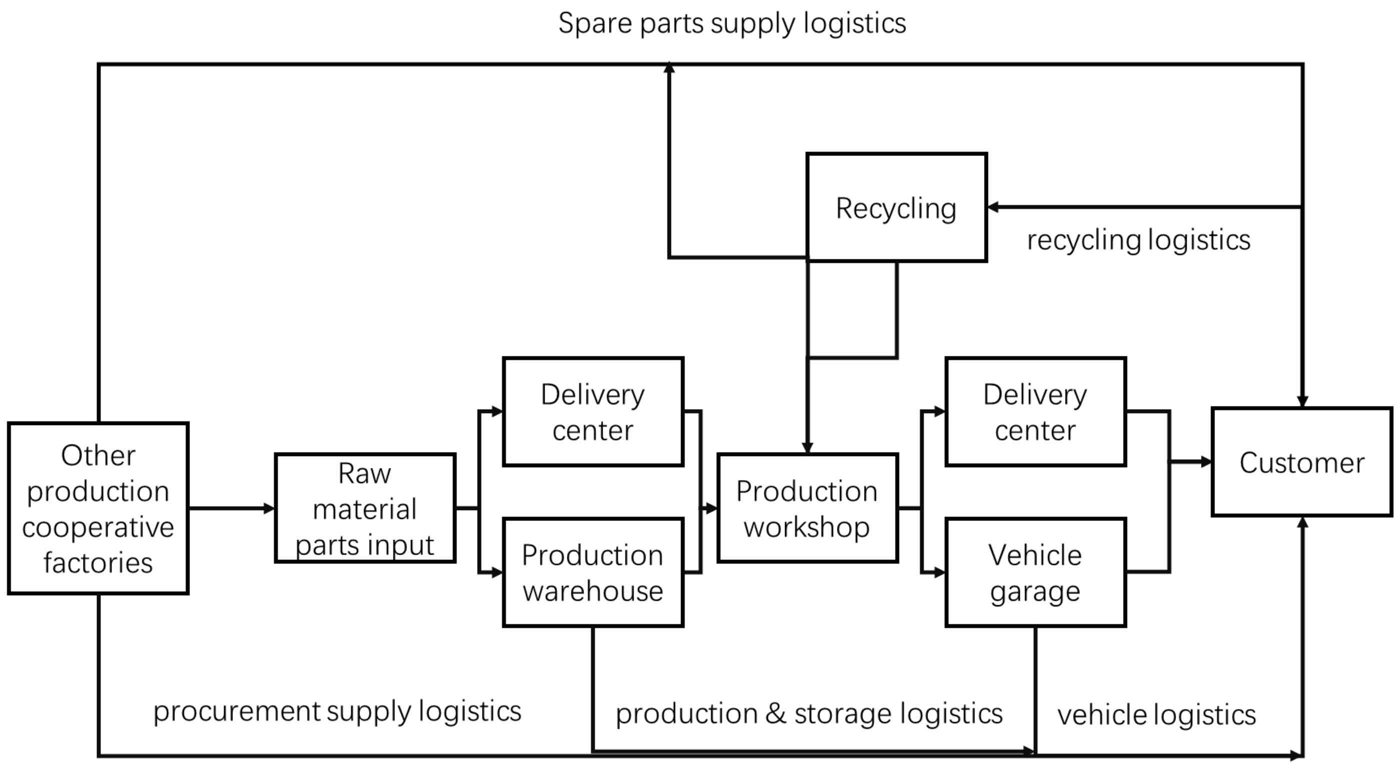

Fig.3.1 Automotive logistics classification

3.1.1 Automotive procurement and supply logistics

This activity refers to the logistics process of the supply of raw materials, parts and other materials for automotive manufacturing enterprises. Automotive supply logistics is the supply of raw materials and parts from upstream manufacturers until the start of automotive production activities. Automotive supply logistics can ensure the continuous progress of automotive production, circulation and consumption activities. While ensuring the supply of materials, it is required to minimize costs, minimize consumption in the logistics process, and ensure the smooth progress of logistics activities. Since manufacturing enterprises occupy large amounts of funds when purchasing raw materials and semi-finished products, rationalizing the logistics of the automotive industry is the key to reducing operating costs for automotive manufacturers.

3.1.2 Automotive production and storage logistics

This activity is a series of logistics activities in which the raw materials, parts and other materials in the warehouse of the automotive manufacturing enterprise are processed and distributed until they enter the finished product warehouse of the automotive manufacturing enterprise. Automotive production logistics is the material flow of automotive raw materials, parts and semi-finished products in the production process. It is an important part of the production process connecting the entire automotive manufacturing enterprise. Therefore, the rationalization of automotive manufacturing assembly logistics can save enterprises' manpower, material and financial resources, and effectively reduce enterprise logistics costs.

3.1.3 Automotive vehicle sales logistics

This activity is a logistics activity in which an auto manufacturer transfers products to customers through sales activities. It can bring business benefits to the enterprise, which is a physical flow of vehicles from producers to consumers. Due to the rapid growth of the modern economy, the competition among enterprises has become more intense, so automotive sales and logistics are highly serviceable. The goal of automotive sales logistics is to meet customer needs, and to improve customer service. Automotive sales logistics can be beneficial to the recovery of corporate funds and help companies expand reproduction, which is related to the value of the company's existence. Reasonable organization of automotive sales logistics can reduce the sales price of vehicles and also bring more competitive advantages to enterprises.

3.1.4 Spare parts supply logistics

This activity refers to the logistics activities of auto parts from the auto parts supplier or auto manufacturer to the end customer, including parts replacement and return to the factory. Maintenance (repair, warranty) parts supply logistics has high requirements for quick response, and it needs to provide customers with necessary spare parts support or management services in a timely manner.

3.1.5 Automotive recycling logistics

This activity is a logistics activity resulting from the recycling and reuse of used cars or parts. It can not only help enterprises improve resource utilization, save enterprise costs, but also reduce environmental pollution and waste. It is a very important aspect of green logistics.

3.2 Automotive logistics in Supply Chain Management

3.2.1 Basic models of automotive logistics in supply chain

As an important part of automotive supply chain management, vehicle logistics is developed synchronously with the entire supply chain and industrial environment. As far as the vehicle logistics model is concerned, it can be divided into three modes: one is very closed Intra-enterprise logistics, namely first-party logistics (1 PL), this model is based on the huge production capacity of automotive manufacturers and stable supply and demand as a prerequisite, requiring vehicle manufacturers to have complete logistics facilities and staffing, and requiring automotive manufacturers to set up storage centers across the country.[19] After dealers place an order, the vehicle manufacturer can notify the dealer to pick up the goods at the nearest storage center. This model of vehicle manufacturers has a large investment, but the delivery speed is fast, which is suitable for vehicle manufacturers whose products are in the mature stage.

The second is the very open third-party logistics (3PL). This logistics model is convenient for handling end-of-supply chain business, completing product manufacturing in places that may be close to consumers, reducing transportation costs, shortening delivery time, and facilitating development Large-scale product customization increases corporate revenue and customer satisfaction.

The third one is between the above two modes and becomes an outsourcing logistics. This mode is based on those who choose a completely closed logistics system. The cost is too high, which is not conducive to the long-term development of the company. However, the company is not willing to dispose of the existing logistics assets at one time, or lay off employees, and risk the interruption in the transition phase. For this reason, these automakers have adopted the method of outsourcing to transfer part of its own logistics responsibilities, so an outsourcing logistics model has emerged.

3.2.2 Modern automotive logistics and industry supply chain integration

Supply chain management requires automotive manufacturers to integrate the entire supply chain process, and fully integrate the automotive supply chain through the function integration, process integration and resource integration of automotive logistics. Automotive logistics is centered on automotive manufacturers. The use of logistics management can make products move rapidly in an effective supply chain, benefiting supply chain node enterprises. Core manufacturing enterprises can achieve win-win or multi-win by establishing strategic partnerships with logistics companies, suppliers, and distributors. Connect with upstream suppliers through Procurement and connect with downstream distributors and customers through CRM to promote the smooth flow of logistics channels in the entire supply chain and improve the efficiency of the entire supply chain.

The purpose of the integration of the automotive supply chain is to enhance the competitiveness of the supply chain. The key to supply chain integration lies in whether the automotive logistics is smooth and timely, and the automotive supply chain model based on third-party logistics is well adapted to this demand. This kind of logistics mode is convenient to handle the end tasks of the supply chain, complete the manufacturing of products as close as possible to consumers or buyers, reduce transportation costs, reduce delivery time, facilitate the provision of customized products, increase revenue, and enhance customer satisfaction.

3.2.3 Third-party logistics and automotive supply chain

The future trend of the automotive industry is to strengthen the division of labor. Parts production functions and logistics distribution functions will be separated from manufacturing enterprises, and part of the logistics management functions will be entrusted to third-party logistics system management to reduce operating costs and reduce investment. Centralized allocation of resources to core businesses to promote the development of new automotive products and the improvement of product quality. Therefore, the third-party logistics model will become the dominant form of logistics in the future automotive industry.

Third-party professional automotive logistics companies have their own professional logistics operation experience and technology, professional logistics network and facilities, professional logistics operation management talents and modern logistics information systems, which are conducive to improving the overall logistics efficiency of automotive products.

As one of the means of supply chain integration, the third-party logistics system provides various services for majority of the users, so that suppliers and customers can be linked together. Using the professional operation of third-party logistics can enable auto companies to extend to all corners of the world in an asset less way, gain more market information, and enter the international market quickly.

Third-party logistics companies provide logistics and information flow services for the automotive supply chain, and coordinate when the components of the supply chain change to avoid internal disconnection in the supply chain. In the process of purchasing and supplying auto parts, a third-party logistics system with the function of a coordination center can be introduced to cancel and reduce the inventory of both the supplier and the demander, thereby increasing the agility and coordination of the supply chain, and greatly improving the service of the supply chain Level and operational efficiency.

The information network invested and constructed by the third-party logistics company shares its information resources by the client enterprise and the third-party logistics company, which facilitates the exchange of information between the two parties and ensures the efficient operation of logistics, thereby improving the efficiency of logistics production, reducing logistics costs, and making Both parties benefit from it.

4. Analysis of automotive logistics in automotive company

4.1 Traditional operating situation of Supply Chain Logistics of Automotive companies

4.1.1 Automotive procurement supply logistics

Every car is assembled from parts and components, and the number and types of parts required are very complex, which can reach tens of millions of types and quantities, of which only a few are self-produced products by car manufacturers. Instead, most of them are outsourced parts, and the manufacturers or suppliers of these outsourced parts are all over the world. Therefore, automotive procurement logistics involves a wide range, with large difficulty and high cost.

At present, most automotive manufacturers require Vendor Managed Inventory (VMI) to reduce costs. In the meanwhile, in order to meet requirements of the production line, the parts manufacturing enterprises realize just-in-time production (JIT) to ensure the timeliness and accuracy.[23] Due to positioning, information transmission, and differences in trunk transportation reliability, many spare parts suppliers or third-party logistics companies will establish intermediate warehouses around automotive manufacturers to provide timely delivery services for automotive production lines. Such a large supply of raw materials and spare parts and the corresponding transportation, storage, distribution and other transfers constitute the automotive supply logistics system. As shown in Figure 4.1.

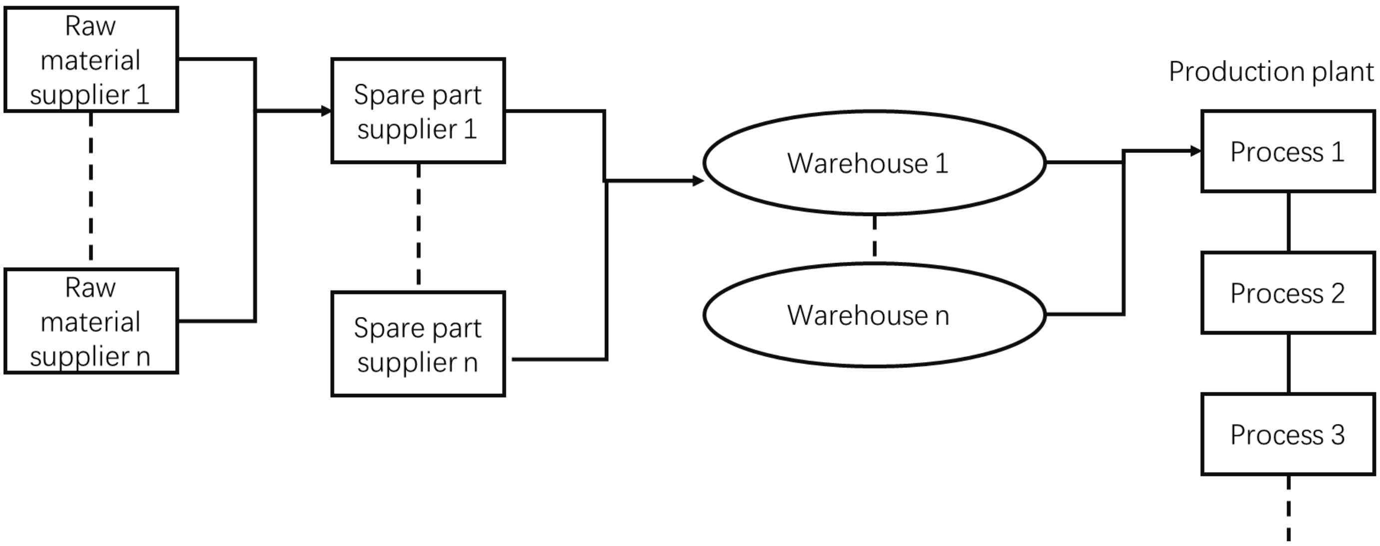

Fig.4.1 Automotive procurement supply logistics system

In the automotive procurement logistics system structure, there are three levels of logistics activities: the transportation of raw materials and spare parts by automotive transportation companies or third-party logistics, which constitute the transportation layer.

The intermediate warehouse group of various suppliers around the automotive manufacturing enterprise constitutes the storage layer. The distribution department of the spare parts supplier or the supply department of the automotive manufacturer distributes the spare parts in the intermediate warehouse to various processes, forming the urban distribution layer.

4.1.2 Parts storage management

At present, in order to pursue lean production, automakers mostly adopt just-in-time (JIT) production mode, and the inventory management of spare parts adopts vendor managed inventory (VMI).
In order to provide timely delivery services to the production line, most suppliers choose to set up intermediate warehouses around the vehicle production plants and build a warehousing system that matches their own business to manage inventory.

As shown in Figure 4.2. Since the VMI method is adopted for the inventory management of parts and components, auto manufacturers have eliminated internal parts inventory.

The control system of the assembly shop of the vehicle factory automatically generates the parts demand information and transmits the information to the parts suppliers. When the suppliers distribute the parts to the assembly line, the supply sequence and time need to be carried out in accordance with the production plan.

Some parts required for automotive assembly may not come from domestic suppliers. For example, imported KD parts cannot rely on VMI. They must be temporarily stored in the warehouse center of the assembly shop, and then the logistics department of the vehicle factory completes the inbound procedures, then delivers KD parts to the production line when needed.

After adopting the vendor managed inventory (VMI) model, the supplier must provide on-demand distribution services according to the production line plan of the OEM. The traditional large warehouse of the OEM is replaced by the small intermediate warehouses of many suppliers. The inventory of spare parts has been dispersed and transferred from the vehicle manufacturers to many suppliers, making the core competitiveness of the automotive manufacturers placed on the production business, and some resources of the supply chain itself can be fully utilized. For the entire supply chain, resources get to be allocated optimally. Because the inventory costs and accidental losses are all borne by the supplier, for the supply chain, inventory still exists, but for the vehicle manufacturer, the so-called "zero inventory" has been achieved.

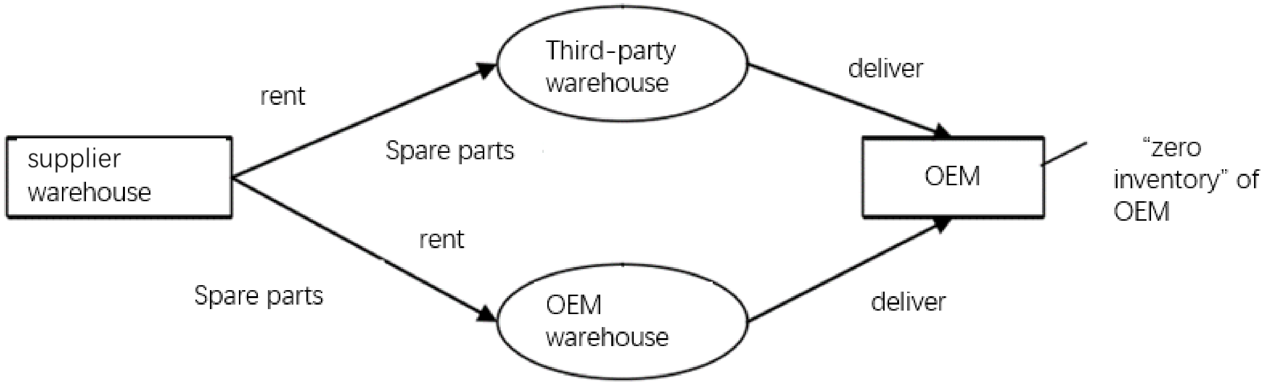

Fig.4.2 Parts storage management system

For automotive manufacturers, this warehouse management model is equivalent to outsourcing spare parts warehouse management, which not only ensures that demand avoids shortages, and ensures efficient production. Inventory is better managed to reduce the backlog rate, and it can also realize automatic replenishment. For suppliers, they can establish strategic partnerships with manufacturers. The process of manufacturers completing procurement is also the process of suppliers achieving targeted sales. This procurement and sales are efficient, low-cost, and have a good reputation. At the same time, suppliers can observe market changes when accepting manufacturers' purchase requirements, to adjust product strategies in time, and arrange the production of parts and accessories required for some new products in advance to avoid additional costs caused by sudden demand and to make the entire production flexible, once an order is placed, the demand can be met quickly. The shorter the procurement and production cycle is, the greater the opportunity there is to occupy the market.

4.1.3 Automotive production logistics

Automotive production logistics refers to the logistics activities generated according to the production process and technology after the raw materials and parts enter the production workshop of the automotive factory. It originates from the beginning of the raw materials and parts entering the production line. The parts are produced and processed step by step. Work in the link until the product leaves the finished product warehouse. Automotive production logistics generally go through four major process links:

welding, spraying, stamping and final assembly, as shown in Figure 4.3.

Starting from the distribution of parts and components to the production site, the goal of production logistics management is to first be able to seamlessly connect with procurement logistics, and then to enable the smooth and reasonable flow of materials in the production process, including raw materials, finished products and waste materials.

However, due to the small space next to the production line, the types and quantities of parts that can be stacked are limited. To ensure the fluency of production, it is necessary to ensure timely, quantitative and accurate supply. However, the accurate distribution of tens of thousands of parts is very complicated, and the information positioning and tracking of parts and production processes will provide a powerful help. At the same time, it will also help solve the key problem of production logistics, the deployment of parts.

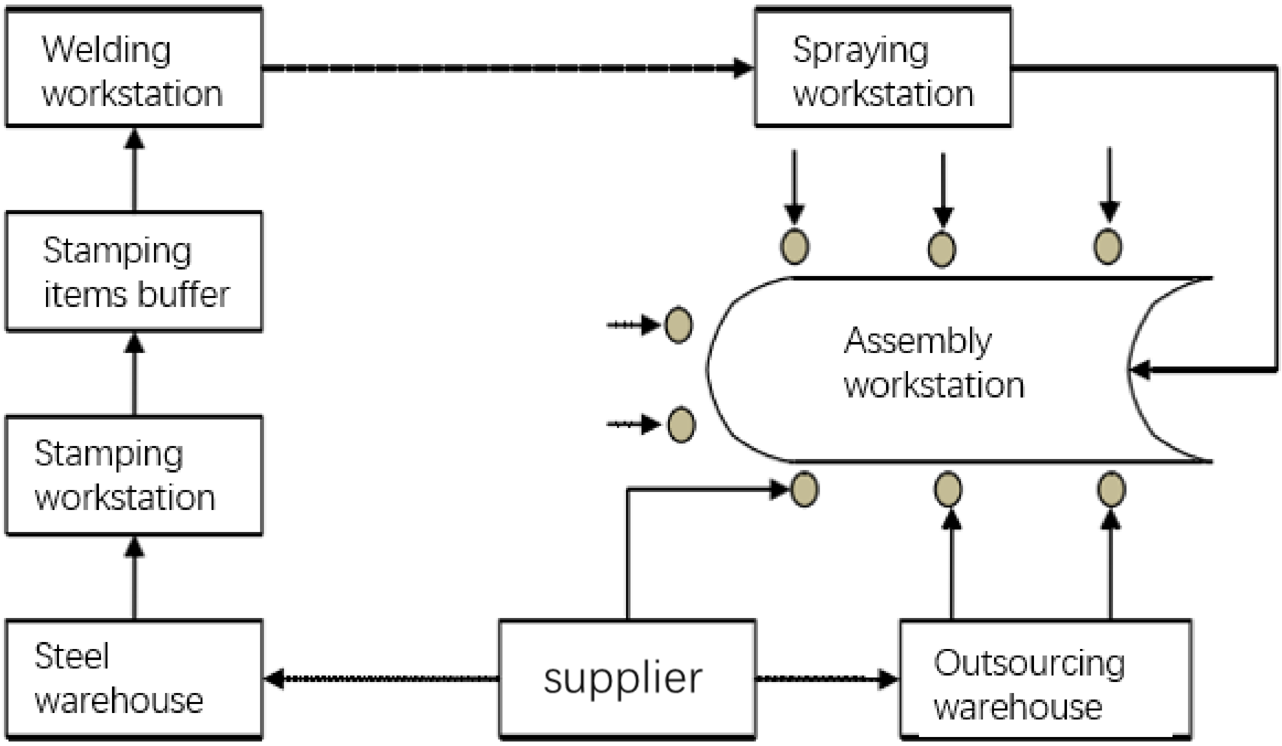

Fig.4.3 Automotive production logistics system

4.1.4 Vehicle sales logistics

Vehicle sales logistics refers to the logistics activities of the vehicle from the automotive manufacturer to the distributor or user after the vehicle is off the production line, including sales.[24] It is the process by which the automotive supply chain recovers capital and realizes profits. The vehicle logistics (sales logistics) system is:

Finished cars off the production line of the production workshop are inspected first, and those that fail the inspection will be sent to the production workshop for repair, and the finished cars that pass the inspection are transported to the finished car warehouse for pre-sale storage and maintenance, or managed by Third-party logistics through vehicle logistics, in which way turns the fixed warehouse of the production enterprise into a mobile warehouse of third-party logistics, then directly transports the finished vehicles to the distribution outlets in various places to achieve "zero kilometer" transportation. Finally, these cars will be shipped to dealers by various means of transportation. The vehicle logistics system is shown in Figure 4.4.

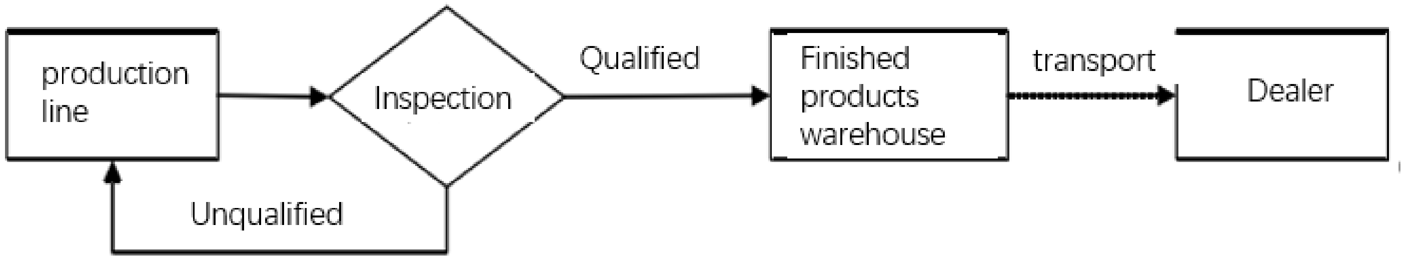

Fig.4.4 Vehicle Sales Logistics System

Vehicle sales logistics is a part of automotive supply chain logistics. The development of the entire automotive supply chain and industrial environment will affect the development of vehicle logistics. To achieve integrated management of vehicle logistics, to a large extent, it depends on the vehicle logistics management system. At present, mature vehicle logistics are mostly completed by professional third-party or fourth-party logistics companies; but in some cases, due to the lack of good management systems, there appears little information exchange between enterprises. The biggest obstacle for automakers to cooperate with third parties is that they fear that some core operating elements such as sales networks will be leaked, so they often adopt some confidential measures. Therefore, the management of vehicle logistics in this situation mostly adopts self-operated and outsourcing cooperation models. Usually, the transportation business in vehicle sales logistics is outsourced to a professional third-party transportation company, while other logistics services such as transfer, distribution or sales are completed by the production enterprises themselves.

4.1.5 Automotive spare parts logistics

Automotive spare parts logistics refers to the need for automotive spare parts after the user’s normal repairs and maintenance during use, and after traffic accidents, this demand derives automotive spare parts logistics services. Auto after-sales parts services form a complete supply chain, centered on the distribution center of "automotive parts", passing through dealers, special maintenance stations and end users and other members. Like automotive supply, the spare parts supply chain also needs the management and control of information flow, logistics, and capital flow. The particularity of automotive after-sales spare parts makes it a typical multi-level inventory structure. In order to ensure the continuity of spare parts supply, all companies in the supply chain must maintain a certain safe inventory, which constitutes a multi-level inventory. The automotive spare parts logistics system is shown in Figure 4.5 below.

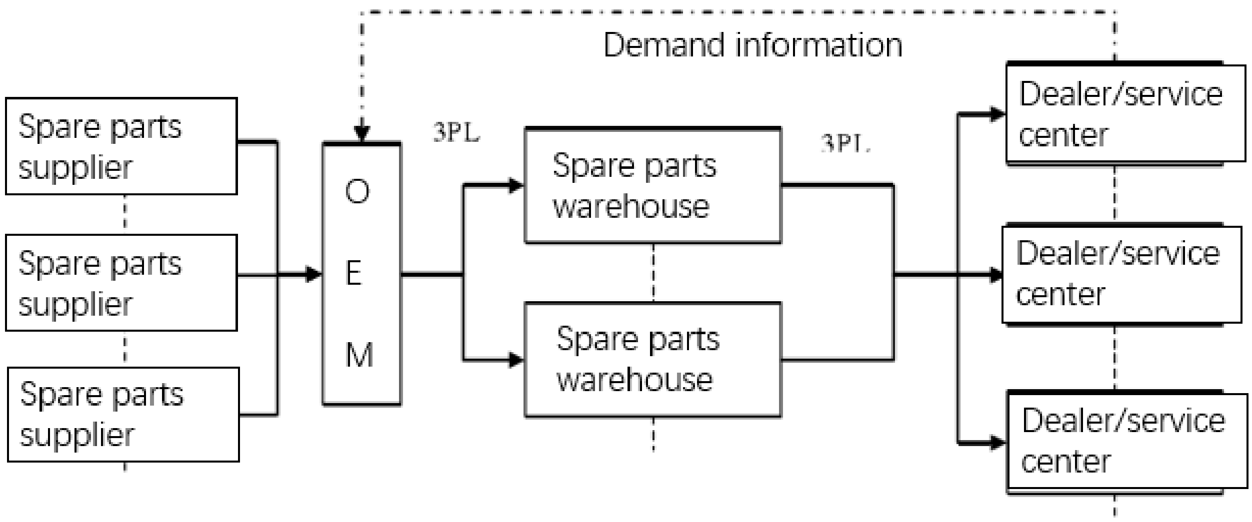

Fig.4.5 Automotive spare parts logistics system

At this stage, on the one hand, due to increasingly fierce market competition, new car sales profits will continue to shrink, and automotive after-sales service has become an important link in the automotive supply chain to increase benefits; on the other hand, the improvement of people’s living standards has made consumers pay more and more attention to the quality and efficiency of service, which makes the automotive after-sales market continue to develop.

Automotive spare parts logistics is the main body of the after-sales service market, which is as important as automotive manufacturing and sales. More and more companies are interested in extracting profits from auto spare parts logistics, which makes auto spare parts logistics an important link to enhance the value of the entire automotive supply chain.

Because the logistics demand of automotive spare parts depends entirely on the needs of customers, and each customer has individual needs, which are uncertain and random, it is difficult for the logistics operation of automotive spare parts to be carried out in a planned way like automotive manufacturing, which is also the root cause of the very complicated automotive spare parts logistics management.

4.2 Optimization demand analysis of each link of automotive supply chain logistics

As traditional automotive supply chain logistics management has some problems in terms of function and efficiency, according to the existing technology and customer needs, it is necessary to simplify and recreate some business processes or operations and management methods.
Therefore, it is necessary to analyze the lacks and demand of current automotive supply chain logistics, and to apply advanced logistics technologies.

4.2.1 Demand analysis of automotive procurement supply logistics management

The key to automotive supply logistics is to determine demand and guarantee supply. How to obtain accurate demand is the primary difficulty of supply logistics. Guaranteeing supply is to ensure that the right items are delivered to the right place in the right amount at the right time, which requires dynamic management.

The entire process of automotive procurement and supply logistics is shown in Figure 4.6. First, the purchasing department of the automotive manufacturer formulates a purchasing plan based on the demand plan made by the production department, the existing inventory information and the status of the supplier, and then informs the suppliers of parts and raw materials, inspects the situation of each supplier, and selects the company Suppliers that match the current situation of the company will sign a contract. After both parties confirm that they are correct, they will coordinate purchases. The suppliers will deliver the goods to the OEM on time, and the OEM will receive the goods after confirming the goods and notify the financial department to pay.[25]

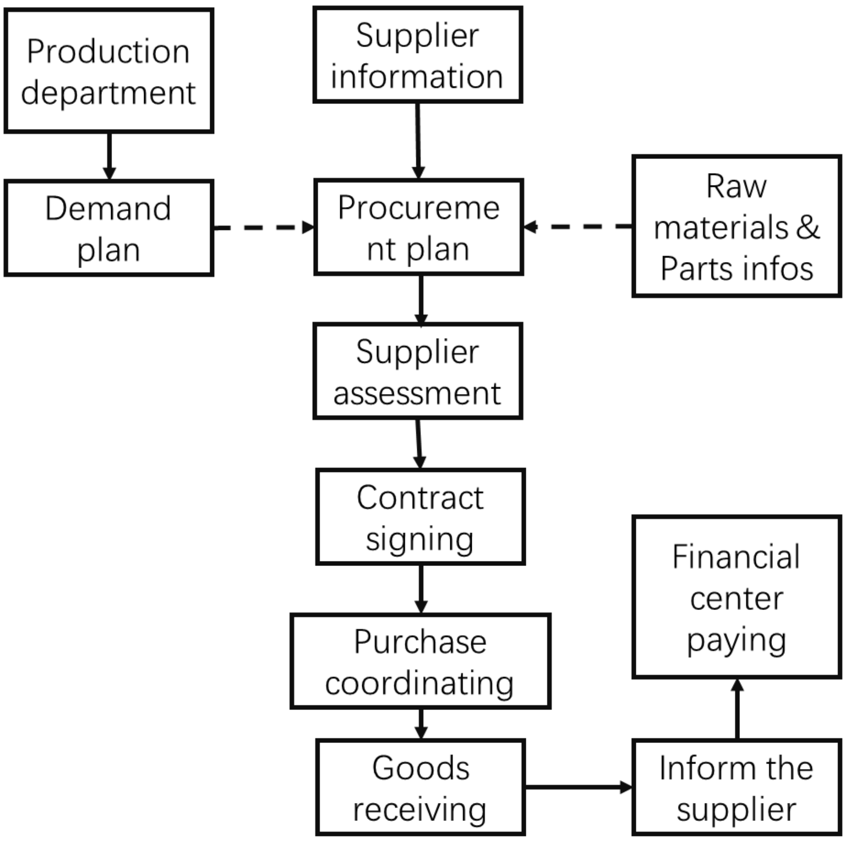

Fig.4.6 Procurement supply logistics management process

The fundamental reason for the problems of traditional procurement and supply logistics lies in its manual operation. The following three problems need to be solved by technology:

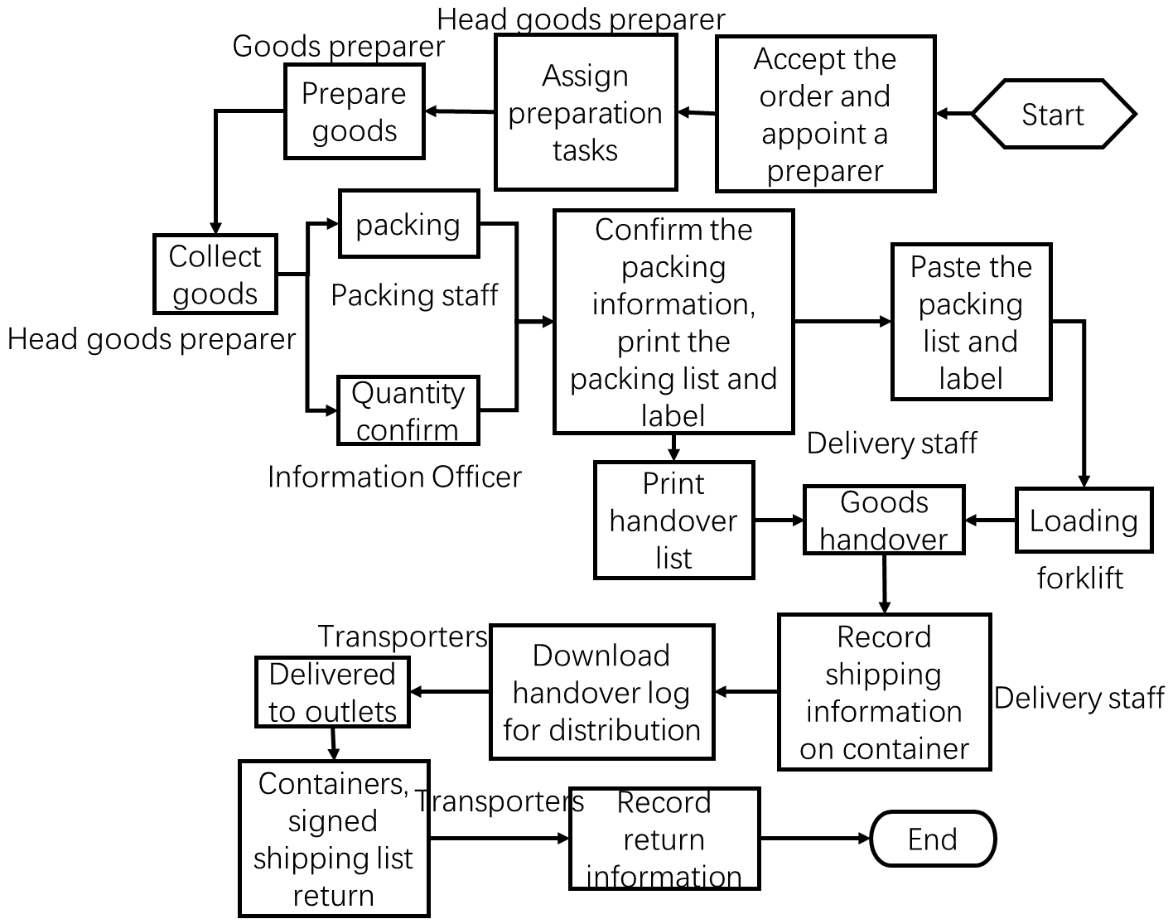

Fig.4.7 Process of the traditional auto parts stocking/delivery

(1) Weak document information processing
In the procurement of auto parts, there are many complicated and intertwined parts, involving many documents and manual accounting. The business process of the traditional auto parts stocking/delivery link is shown in Figure 4.7. Manual data collection and statistics cannot automatically generate corresponding documents, and the lack of tracking means not only causes waste of human resources, but also prone to errors.

(2) It is difficult to obtain accurate supply and demand information
In the way of manual operations, the information processing is also very backward, and it is very inconvenient to obtain the procurement plan information, which not only brings great labor costs, but also makes it difficult to guarantee the quality of delivery. If there is no advanced network platform between the automotive manufacturing enterprise and the spare parts supplier, once the production plan is adjusted and changed, it is impossible to communicate with the supplier in time, which may cause the production line to be out of stock and stop working. Delay in the transmission of demand information will also lead to a long procurement cycle and high safety stock levels.

(3) The procurement process is not transparent
This makes it impossible to monitor the work process in real time, long waiting time for work, and low labor productivity. On the other hand, when selecting suppliers of raw materials and spare parts for the entire automotive, there may be a relationship between the purchaser of the vehicle manufacturer and the spare parts supplier. Some gray transactions have also led to high procurement costs and seriously affected the economic benefits of enterprises.[26]

4.2.2 Demand analysis of auto parts storage management

Auto parts storage can realize the time value of parts, and it is also a very critical link in auto logistics. The parts purchased in bulk cannot be used all at once and need to be stored for a short period of time; semi-finished or finished products produced cannot be shipped in time and need to be stored. The storage of parts is of great significance for achieving balanced production and just-in-time production on the production line.[27]

The most common process in warehousing business is the inbound and outbound process. The traditional inbound process is shown in Figure 4.8: When the spare parts transport vehicle arrives outside the warehouse entrance, the consignee confirms the goods according to the purchased goods list and the invoice, confirms the physical properties and quantity of the goods are accurate, and arranges unloading and inbound . Follow the instructions of the warehouse manager to put it on the shelves, and then count the goods for confirmation after completion.

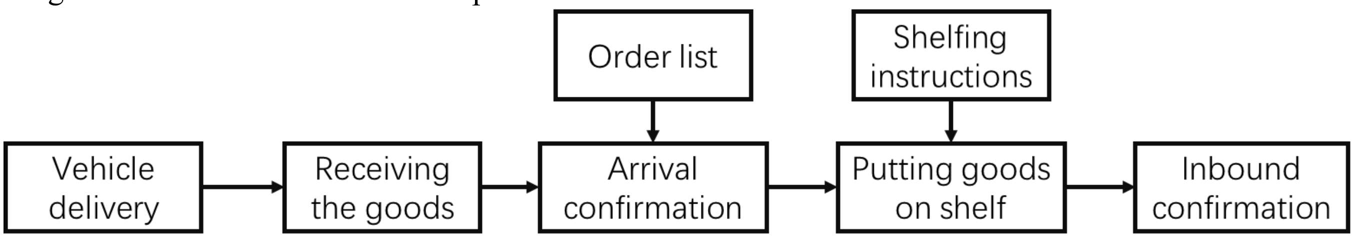

Fig.4.8 Traditional parts inbound process

The traditional outbound process is shown in Figure 4.9: First, the warehouse manager accepts the outbound instructions and arranges the personnel responsible for specific outbound operations, formulates a picking instruction sheet, and the staff selects the goods to be shipped out according to the instruction sheet, and then confirms with the order . After confirmation, start loading, and confirm the delivery after completion.

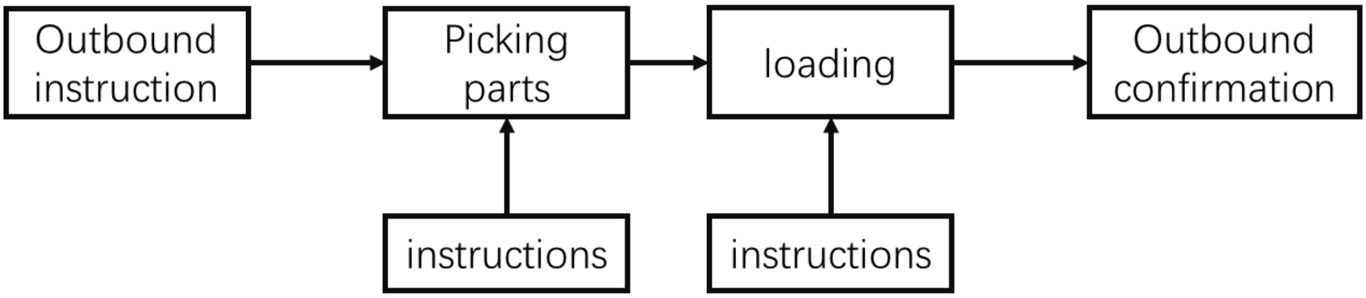

Fig.4.9 Traditional parts outbound process

It can also be seen from the above that the traditional warehousing process is quite rough. Warehousing management relies on manual operations, using paper and pen as a tool for information statistics, and manual operations are used to update the information of goods in and out of the warehouse, which is poor in timeliness and error-prone. Goods management in the warehouse often adopts: warehouse managers are responsible for certain types of goods, and each person can only be responsible for a limited variety of accessories, which causes a lot of labor costs; manual or semi-automated warehouse management operations make information transmission difficult, delayed. Errors and other situations occur frequently, and the warehouse's cargo integration and throughput capacity are quite low. It is far from being able to meet the warehousing needs of complex modern auto parts, which brings great inconvenience to the on-time production of enterprises. In summary, the problems that need to be solved with technology are as follows:

(1) Long lead time for storage operations

In manual work mode, whether it is warehousing operations, goods location search, inventory counting, or goods picking, etc., each phase takes a lot of time. In order to ensure that accurate goods are delivered to accurate customers at the correct time, it must be prepared in advance for stocking and lead time, which will seriously affect warehouse management efficiency.

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(2) Inefficient information processing

In the process of warehousing operations, each link will involve a large amount of item information. If effective management is not carried out, it is easy to be confused or lost, leading to information errors, which will bring losses to future production work. Information statistics based on paper files are not only difficult to save, but also the manual input of inventory information is inefficient and real-time.

(3) Unable to understand the inventory quantity and warehouse storage environment in real time

Relying on manual warehousing operations, data processing is slow and error-prone, manual counting cycles are long, inventory quantities cannot be updated in real time, and information acquisition is delayed. On the other hand, some high-value parts and accessories often have special requirements for the storage environment, such as temperature, humidity, etc. to avoid corrosion. If the storage environment cannot be monitored in real time, there may be certain risks.

4.2.3 Demand analysis of automotive production logistics management

The flow and processing of spare parts in each process of the production line is determined, so the production logistics process is often determined when the production line is determined. The management of production logistics is to determine the input and output of parts according to the production operation control plan. The quantity, time of production and compatibility to ensure that the products can be assembled and shipped on time. Due to frequent changes in market demand, it is difficult to make accurate sales forecasts. The production plan is relatively vague and the effectiveness of customer projections is poor. However, if the production plan is too detailed and changes frequently, it will cause inconvenience to operations such as procurement, material distribution, and production. Therefore, the production logistics management has the following aspects:

(1) Basic data is not perfect

Basic data collection is inaccurate and coding management is chaotic. On the one hand, there may be one item with multiple codes, so that there are available items in the inventory but cannot be found. Then the same items may be urgently purchased by the purchasing department but instead they would be rusted in the warehouse, which may cause excess purchases. On the other hand, there may be multiple items with one code. If the items are distributed according to the material code of the demand order, after arriving at the production site or after-sales service site, it may be found that the delivered parts do not match the required ones. This may lead to production stoppages due to missing parts, leading to increased costs.

(2) Cannot understand the production completion status and customer needs in real time
At present, automotive manufacturing companies implement order-driven simultaneous manufacturing. The production plan of the company is arranged according to customer orders. The ever-changing customer needs inevitably require real-time understanding of the production situation. Real-time understanding of the order completion in the production process can quickly respond to changes in demand, then adjust the production plan in time to make a more precise production plan to meet user needs.

(3) Product quality control is not strict enough
The production of complete automobiles is processed and assembled from a huge variety and quantity of raw materials and spare parts. This process has gone through many processes.
When the final product sold to the customer appears quality problems, it is difficult to directly find which part is causing the problem, let alone which operator is responsible for which process, which is harmful to the improvement of the production process.

4.2.4 Demand analysis of vehicle sales logistics management
Vehicle sales logistics has great value. Since the traditional model is self-operated vehicle logistics, most vehicle sales are based on a step-by-step distribution mode of operation.[28] However, this model reduces the flexibility of sales logistics and makes higher logistics costs, also lowers the logistics efficiency. At present, the Vehicle logistics mainly have the following problems:
(1) low level of control in the logistics process
The GPS global positioning system is not used during the sales and transportation of the vehicle, and the driver uses the mobile phone to report the transportation process and the delivery progress. Unilateral information reporting, once an emergency occurs during transportation, will cause slow dispatching information. The driver does not know what to do and cannot fix the delivery delay. In addition, the lack of monitoring during transportation may result in the loss of commercial vehicles.

(2) Waste of transportation resources
The demand for vehicle transportation is often a one-way flow from the manufacturer to the dealer, and in the return journey, the transportation vehicle is always unloaded and empty. This is a serious waste of transportation resources, which leads to the problem of high transportation costs, which will eventually affect the sales price of commercial vehicles.

(3) Low sales efficiency
Relying on manual sales operations, sales information of various commodities cannot be collected in real time, also retailers cannot obtain the real-time inventory quantity and accurate waiting time, resulting in low sales efficiency.

4.2.5 Demand analysis of automotive spare parts logistics management
Auto spare parts logistics is the main body of the after-sales service market. At present, auto repairs all use original parts, so spare parts logistics is a supply chain with the distribution center of the vehicle enterprise as the core enterprise. The current spare parts logistics management process is shown in Figure 4.10:

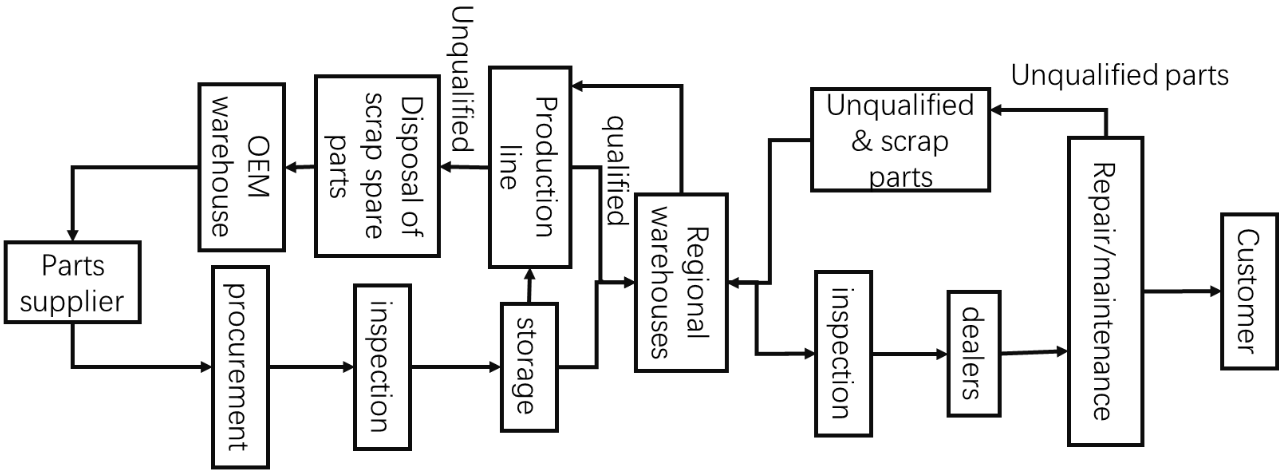


Fig 4.10 Auto spare parts logistics management process

The auto factory makes predictions based on the sales data and orders of the service department, forms a spare parts purchase order, and places orders with auto parts suppliers. When the regional warehouse receives the spare parts demand generated by the 4S shop or the special maintenance station store, it uploads the demand information to the vehicle manufacturer. The vehicle manufacturer adopts an effective vehicle spare parts distribution strategy to deliver the spare parts, and finally the regional distribution center carries out the distribution. After the auto spare parts are repaired and replaced, the original factory has to recycle the scrapped unqualified auto spare parts. Therefore, the auto spare parts logistics is bidirectional.

At present, the automotive after-sales service market has increasingly higher requirements for the efficiency of spare parts logistics management. On the one hand, consumers hope that while maintaining the quality of maintenance, the shorter the maintenance time is, the better, and the standard for the supply time of spare parts is getting higher and higher; on the other hand, many customers are willing to spend more just to require urgent repair.

Automotive after-sales service activities involve multiple companies, requiring coordination between companies and departments in the supply chain. Without an efficient collaborative operation network, it will cause a lot of waste of inventory.

Due to the small range and wide variety of automotive spare parts, spare inventory is difficult to be managed and it is easy to be out of stock. Therefore, the logistics management of automotive spare parts mainly has the following three problems:

(1) The demand for auto spare parts is difficult to predict
The specific needs of automotive spare parts logistics are determined by the number and types of parts that need to be replaced for customer maintenance services. However, the occurrence of automotive maintenance services is very accidental, and it is difficult to obtain accurate forecast data through the market.[30] The transmission of demand data is transmitted through 4S shops or special maintenance stations to the regional distribution center and then to the vehicle factory. This lag in information transmission seriously affects the efficiency of spare parts logistics. At the same time, the supply of spare parts must be at a safety stock level to ensure that accidental demand avoids shortages and waste of resources.

(2) Long maintenance service time
At present, the market has higher and higher requirements for the level and timeliness of vehicle maintenance. In the automotive after-sales service market, when there is a need for maintenance, from maintenance personnel to the scene, manual inspection of accident problems to determining a reasonable maintenance plan and arranging suitable maintenance employees, among them there may be waiting time

in every link, which makes the entire maintenance service waste time in unnecessary places. At the same time, there is a lack of spare parts maintenance history records, problems cannot be known in advance, which seriously affects the efficiency of fault diagnosis.

(3) It is difficult to select automotive spare parts quickly and accurately
On the one hand, the two-way mobility of automotive spare parts logistics forms a closed logistics loop with spare parts suppliers as the starting point and ending point. When there is a demand for automotive spare parts, it is necessary to accurately find the supplier of the problematic spare parts among the many suppliers; on the other hand, each spare part is for a specific model, there are many car models, and each model requires a huge number of spare parts. How to quickly and accurately obtain the required spare parts and avoid shortages is the key to improving maintenance service levels.

4.3 Conclusion of problems existing in traditional automotive supply chain

Statistics show that logistics costs have always accounted for a very large proportion of the operating costs of traditional auto companies, and their logistics costs account for more than 15% of operating costs, which is generally higher than that of major international auto manufacturers.

In the overall world, the automotive industry keeps developing rapidly and competition is constantly intensifying. Cost reduction has become the focus of competition. Reducing automotive logistics costs and improving automotive logistics efficiency are important means to enhance the competitiveness of automotive companies. It is also a new growth point for the profit of the automotive industry, and the control of logistics costs has become a top priority. Therefore, research on automotive logistics is also very necessary.

The application of modern information technology is one of the important effective means in modern supply chain management. In traditional automotive logistics company, the logistics management system of the automotive supply chain is still not perfect. Many procurement, production, and storage links use manual methods to manage information. As a result, the availability, real-time, and accuracy of information cannot meet the requirements, often resulting in waiting or missing parts on the production line, leading to waste of resources. Therefore, based on the analysis above in Chapter 4, automotive logistics mainly has the following weaknesses:

(1) Low investment of informatization
The most intuitive sign that reflects the level of informatization is the cost of information technology. Applying modern information technology to solve the information sharing and exchange between different enterprises and business processes is the most effective and important way to realize the efficient management of modern automotive supply chain logistics. According to the survey, the degree of informatization application of traditional manufacturing industry is generally low. Only 25% of enterprises adopt logistics on-site Kanban management, only 6% adopt lean logistics management, and 13% adopt enterprise integrated logistics system and barcode information system. The low investment in informatization seriously affects the optimal allocation of corporate resources.

(2) Lack of informatization in automotive logistics
Compared with the application of logistics technology, the informatization level of traditional automotive logistics is very low. The application of information data processing technology is insufficient, and the information system is not perfect. The computer management system including all aspects of automotive logistics (purchasing, warehousing, production and sales) is not perfect and the accuracy rate is low. Information technologies such as EDI and the Internet are not used in a high proportion. Enterprises cannot fully share information resources. The lack of interdependent partnerships among supply chain enterprises has led to poor logistics channels.

(3) Logistics distribution cannot meet the requirements
Modern automotive production is all made to order, and the needs of users are obviously personalized,

and the requirements for timeliness of supply are getting higher and higher, and higher requirements are put forward for the logistics and distribution of the entire vehicle. At the same time, the production enterprise adopts just-in-time production, and the supplier calculates the specific plan for the distribution of parts according to the production plan of the auto manufacturer, then carries out mass production on a monthly or weekly basis. The order transmission method is relatively primitive, relying on telephone or fax, and there are not enough suppliers that can fully meet the timely delivery requirements of automotive manufacturers.

(4) Standards for automotive logistics information transmission to be unified
In the automotive logistics supply chain management, on the one hand, the cross-regional logistics service standards are different; on the other hand, the information transmission and coding methods between member companies in the automotive supply chain are different, and "one label" cannot be used throughout the entire supply chain. This has increased the cost of collecting logistics information in each segment of the supply chain.[29] It hinders service exchanges across regions, companies, and platforms.

The traditional logistics management of the automotive supply chain is not highly informatized and lacks advanced technical support. As a result, the real-time material dynamic information in the upstream and downstream of the supply chain cannot be shared. Only simple and extensive planning can be carried out, and dynamic and intensive logistics management cannot be realized. It will inevitably cause a lot of waste of manpower and material resources.

4.4 Applying cases of logistics technologies in top automotive companies

The development of global automotive logistics is generally led by big auto companies in western countries and Japan, and development of automotive logistics in Europe, North America and Japan is relatively mature. Always, they are regarded as the representatives of applying the most advanced technologies in the logistics activities and leading the trends in the future automotive industry. By analyzing the information provided by these big auto companies, it is obvious to see that applying modern logistics technologies in automotive field is becoming more and more significant.

4.4.1 Applying cases in automotive procurement and supply.

The famous American auto parts supplier CARQUEST has adopted an RFID-based distribution center management system. The system was successfully put into operation in 17 distribution centers and provided support services for the access points and configuration of 22 distribution centers. It has achieved satisfactory results. The company’s accuracy in accepting and integrating orders has increased by 53%[20]. The accuracy reached 99.9%, which greatly improved productivity and quickly increased the return on investment.

German ZF Friedrichshafen is one of the world's largest independent suppliers of automotive transmission and chassis components. The company implemented the RFID container management system as part of the facility upgrade. Workers on the production line first enter the electronic order into the warehouse management system, and then the automated system puts components of various sizes in containers with RFID tags, and then puts the containers at the designated location in the production area. After the new container is added to the combination, the employee will use the handheld reader to read it. After the container is returned to the factory for identification, the system will automatically update, so that it can grasp the container entries received by a specific user within a specific time. The system reduces container handling time and makes inventory counting more accurate.

4.4.2 Applying cases in automotive production

RFID can also be used to monitor the production of cars and their important components. Ford and Hyundai have adopted RFID in their engine production lines. An RFID tag is placed on the pallet containing the engine. At the beginning of assembly, the engine is placed on the pallet and the serial number is written into the RFID tag. When the engine moves along different assembly operations, real-time production information such as the time and quality control data of each operation is written into the

RFID tag. Since 2001, Toyota Motor Corporation has used RFID to track car bodies in many of its factory paint shops. Honda Motor uses RFID to monitor the entire production process of its Italian and British companies. In addition, many automakers have also applied RFID on their production lines, such as Daimler-Chrysler, BMW, Shanghai GM, and Yulon Nissan.

4.4.3 Applying cases in automotive vehicle logistics

General Motors has been committed to the development of the business “order to delivery” in recent years. The time from vehicle to delivery has been shortened by 60%, the delivery date reliability rate has reached 90%, and the vehicle delivery rate without damage has reached 99.5%. The logistics cost has dropped by 14% on the original basis. General Motors has cooperated with railway service companies to promote the construction of double-decker railway freight cars. This double-decker railway freight car specially used for transporting cars has made progress in railway freight technology. This will reduce logistics costs and improve transportation quality, which is beneficial to automotive factories and transportation logistics companies.[21]

In order to manage the cars parked in the car factory, Volkswagen has hung the RFID tags embedded in the plastic body on the car's rearview mirror. Through the application of this RFID active tag system, the delivery process is simplified, the delivery speed is increased by about 4 times, and the available space of the parking lot is increased by 20%, and the investment is basically recovered in less than a year. Volkswagen also uses RFID to manage containers. BMW and Toyota put RFID tags on their cars and containers as well.

China National Heavy-duty Truck Corporation has also developed an intelligent electronic tag for vehicles. This electronic tag contains important information. It is not only fully compatible with the previous material bar code management system, but also shares information with the production management system, vehicle quality file management system, inventory management system, after-sales service system and GPS system, which realized the information management of vehicle production, quality inspection, inventory management and after-sales service management.

In Shanghai GM's "recycling reclaiming" project, a lot number of pallets, bins, and racks are repeatedly used. Except for special racks, these pallets and bins may be transferred to any supplier. The handover, inventory and confirmation work are very cumbersome, information tracking is quite difficult, it is difficult to find the loss or damage of bins and pallets in time, and it is difficult to guarantee the accuracy of handover. To solve these problems, Shanghai GM uses RFID labels on bins and pallets, with the help of "Radio Frequency Identification Doors", it realizes timely and accurate control and tracking of the in and out of bins and pallets. In addition, many automakers have also applied RFID in product distribution and asset management. For example, Yokohama Nissan Motor Plant uses RFID to manage forging molds, Hyundai Motor uses RFID to track parts transportation, and Taiwan Yulon Motor uses RFID to manage automobile export business.

Volvo Logistics provides a full range of logistics services for automotive logistics. It uses an independent e-commerce platform A4D (distribution software) to track and monitor the entire logistics process. It automatically calculates the delivery date from the time the customer gives the order, then plans and monitor the entire process of delivering each vehicle to the dealer. It is the world’s first distribution system that is completely integrated with the customer’s order and the production system. It gives an optimized transportation process plan and the latest information on each delivery vehicle. Through it, The entire process from order to delivery can be monitored in the most detailed way. Now by using A4D, Volvo has increased the delivery accuracy rate to 98% and greatly shorten the delivery time.[22]

4.4.4 Applying cases in automotive aftersales

The information in the RFID tag can be used to determine the status of "repair, exchange and return" during the life cycle of an automobile product at any time, providing a basis for the responsibilities, rights, and benefits of manufacturers, sellers, repairers, and users. Companies such as Guangzhou Honda and Shenyang BMW have applied RFID in after-sales services, and Yulon Nissan has also established an RFID dynamic warranty system. When a user enters a 4S shop or repair shop, the reader can immediately scan user information, maintenance history and other content, thereby providing a basis for determining the maintenance plan.

RFID tags can be encrypted and are not easy to forge, so they can also play a huge role in controlling the entry of second-hand parts into the market, distinguishing counterfeit parts, and preventing illegal assembling vehicles. According to the number of overhauls of key assemblies and the required scrapping period associated with the vehicle's VIN code recorded by the RFID tag, it can effectively prevent the use of the "five major assemblies" of scrapped vehicles for illegal assembly and overdue non-reporting of scrapped vehicles.

In the European Union, the law clearly stipulates that 80% of each car needs to be recycled, and this amount is expected to rise.[34] Fiat has designed an RFID test system for auto parts to help auto parts recycling. In this system, RFID tags are applied to the various components of the vehicle, and the electronic control unit (ECU) is used to record the status of each part. The new components affixed with RFID tags will replace the old components that are no longer working, and the ECU will also read the new tags. When the car is scrapped, the owner only needs to put the car in the repair garage and download the unit information to the computer or to the reader, through the operation of the information system the back-end system software evaluates the remaining value of the components marked by each RFID tag to determine whether the transaction can be changed.

In the recall process, for example, Michelin smart tires can narrow the scope of the recall by applying RFID. Currently, automakers are applying RFID to the life-long automatic identification of vehicles as an option for transferring data from the parts management system to the service station. The application of RFID to track auto parts between parts suppliers and Land Rover assembly plants has been funded by the British central government. Jaguar also uses RFID to improve parts supply efficiency. In Germany, automakers, component suppliers, software companies and academia formed an alliance to design a component tracking system that can be replicated and applied to the entire automotive industry in order to avoid large number of product recalls. This project won the support of the German government.

4.5 Advantages of RFID compared with other logistics technologies applying in automotive supply chain

4.5.1 RFID and traditional barcode

The application time of bar code is relatively early, and the cost is low. It already has a very complete standard system and application plan. Therefore, bar code has penetrated into every corner of our daily life and has been widely used worldwide.

Compared with it, RFID technology is only limited to a limited market. RFID technology and traditional bar codes are two different technologies and have different application ranges, so it is not necessarily better than bar codes in all aspects, but the emergence of radio frequency tags has begun to impact the long-established market position of bar codes. Compared with radio frequency tags, the limitations of barcodes are mainly reflected in the following three aspects:

(1) The information identification of the bar code is static, it can only be used once and cannot be modified. The information capacity is limited and only one type of product can be identified;

(2) The bar code is easily torn and damaged, and the reading and writing of the bar code requires manual operation and scanning, which is prone to errors and cannot be recognized;

(3) The traditional one-dimensional bar code is an index code, which must be connected to the database in real time to find complete description data from the database. A large amount of data storage and calculation are centralized. The two-dimensional bar code only expands the information identification capacity to a certain extent. The problem is that it is essentially the same as a one-dimensional barcode. Theoretically speaking, radio frequency tags and barcodes are for the purpose of quickly and accurately confirming and tracking target objects, and the main difference lies in whether ROM information can be

written and updated or not. The information of the bar code is printed once and cannot be changed, and the radio frequency tag has a rewritable ROM memory, even if it is readable, the information cannot be easily stolen, which has high security.

In short, RFID is more standardized and automated than barcodes, and it is a fully automated information management method that does not require manual management. It has great advantages in product information collection, data statistics, customer consumption analysis and statistics.

The relatively large one-time investment of RFID information equipment may lead to the situation that it is impossible to widely use RFID tags in the retail or logistics industry in the short term. However, in order to popularize RFID in the retail industry, warehousing industry and supply chain management. With the implementation, we can vigorously promote related combined technologies and reduce application costs, so that RFID technology can be widely used in the logistics management industry.

4.5.2 RFID and Infrared technology

Infrared technology is a relatively mature non-contact mobile payment technology. Founded in 1993, IrDA is a non-profit organization dedicated to establishing international standards for infrared wireless transmission connections. It currently has 160 members worldwide. IrDA uses the 980nm infrared frequency band, the receiving angle is 120 degrees, the transmission distance is directional 1m, and the rate can reach up to 16Mbps.[36]

The biggest problem with IrDA is the viewing angle. That is, if two devices with IrDA ports transmit data, there should be no obstructions in the middle. This is easy to achieve between two devices, but it is necessary to adjust positions and angles among multiple devices.

However, RFID technology does not have such problems. There are currently two major RFID standard camps in the world, namely Auto-IDCenter in Europe and America, and UbiquitousIDCenter (UID) in Japan. The leading organization of Auto-IDCenter is the EPC Universal Association of the United States, under which companies such as Wal-Mart Group and Tesco of the United Kingdom, and companies such as IBM, Microsoft, Philips, and Auto-IDLab provide technical support. UID in Japan is mainly composed of Japanese manufacturers. The European and American EPC standards mainly use UHF frequency bands (860MHz-930MHz), and the Japanese RFID standards use frequency bands of 2.45GHz and 13.56MHz.

Table 4.1 Comparative analysis of RFID and infrared technology

Technology	RFID	Infrared
Dependence on the terminal	Low	High
Power consumption	Low	High
Ease of operation	Easy	Complex
Confidentiality	High	Low
Durability	Good	Normal
Read and write stability	Good	Normal
Cost	Medium	Low
Technical complexity	Medium	Low
Typical transmission distance	Several cm- several m	< 3m
Label function	Yes	No
Transmission rate	424kbps	115.2kbps
Independent storage function	Yes	No

Through comparison, we can know that RFID technology has great advantages in terms of confidentiality, read-write stability, durability, etc., and is currently the most suitable technology for non-contact mobile item management.

4.5.3 RFID and GPS

As a popular positioning system, GPS technology meets the requirements of daily life for positioning in terms of accuracy and feasibility. It has been widely used and popularized in life, such as the use of GPS in logistics and transportation across provinces and cities, which provides multiple routes to choose from, reduces the trouble encountered in the transportation process. In ocean shipping, GPS helps ships locate the direction and position, improves navigation safety, and shortens navigation time.

The powerful positioning characteristics of GPS play a very important role in information sharing in the logistics industry. Through the three-party application of vehicle users, transportation companies, and receiving parties, information sharing is realized, and real-time information of logistics transportation is transparent and accurate. In order to obtain the best logistics process plan and achieve the greatest economic benefits, details as follows:

The transportation company shares real-time distribution information of vehicles and goods with customers by opening vehicle information, reducing the hassle of communicating with customers, increasing the efficiency of vehicle use, and reducing the corresponding workload. After the goods are dispatched, the shipper can track the operation of the vehicle and the location it has reached through the Internet or mobile phone at any time, grasp the information of the goods in transit, and ensure the timeliness of the goods transportation. Transportation companies can use GPS to manage the use of vehicles throughout the company, monitor the dynamics of vehicles in real time through the Internet, configure vehicles reasonably, reduce waste of resources, and at the same time publish these real-time information to customers, which can improve the credibility of the company, expand the company’s business, and improve the economic benefits of the company. The receiving party can arrange the receipt and parking of the goods in advance by tracking the goods information on the Internet in real time, which can save unnecessary human resource loss.

However, RFID tags also have advantages that cannot be ignored:
(1) Fixed positioning: Compared with GPS, radio frequency tags do not require satellite signals, but transmit information through radio waves, which is extremely stable. Although GPS satellite positioning can identify vehicles and other equipment, the signal is unstable, the technical indicators are not good enough, the signal cannot be absolute accurate, and the system is highly dependent. In application, GPS must be combined with GIS geographic information system, which is not suitable for small-scale fixed-point applications.
(2) Low cost: Although the cost of radio frequency tags is higher than that of bar codes, the cost of systems based on RFID technology is still very low compared with GPS, which requires expensive on-board equipment. The radio frequency tag can realize the positioning function of the same principle as GPS by installing an RFID electronic display card in each vehicle, and the investment is much less than the cost of installing GPS equipment in many vehicles. Moreover, when the vehicle tracking platform is built, since multiple lines passing through the same site can reuse one platform device, the overall implementation cost of the RFID system (vehicle tag + fixed-point signal receiver) will also be lower than that of the GPS system (vehicle equipment + base station) .
(3) Good scalability: The RFID system horizontally can be well integrated with other information systems to realize value-added functions such as non-stop cargo inspection and cargo monitoring. Vertically, other information systems can also provide software based on RFID with a complete interface for further in-depth information mining, which provides more information services for the overall system platform.

4.6 Necessity of using logistics technology in automotive supply chain logistics management

According to the content in Chapter 2.4 and Chapter 4.4, 4.5, by analyzing the logistics technologies applying cases in automotive industry and other industry like retailing, book sales, express delivery and government department, using advanced information technology such as RFID and EPC in the logistics management of automotive supply chain is necessary and brings a lot of benefits. The advantages of technology using can be summarized as follow:

(1) In the terms of cost, by concerning that it can promote the faster development of automotive logistics informatization, automate and intelligentize the information processing of all links in the supply chain, and obtain product-related information accurately in real time, which not only enables enterprises in the entire supply chain to obtain rapid and effective customer response, and improves market competition force, the investment can be regarded worthy. Moreover, compared to Bluetooth and some other technologies, RFID costs even less.
(2) In the terms of availability, the RFID system has been widely used in the fields of industrial and commercial automation, security protection, commodity sales, data management and statistics, etc. It also has rapid development in the field of transportation control management. Such as: industrial and commercial assembly line production automation, access control in the field of security protection, vehicle anti-theft, logistics and supply management in the field of commodity sales, manufacturing and assembly etc. This fully shows that RFID technology already has a relatively complete application system, not just limited to the logistics field. In order to continuously meet the new demands of the market, the current automotive supply chain logistics puts forward an urgent need for an efficient management system using advanced information processing technology. By widely applying RFID technologies can be a way.
(3) In terms of durability, many RFID tags are made waterproof, highly resistant to chemicals and shocks, and can withstand high temperature, which can be suitable for any working environment. The application of technology will not only greatly improve the professionalization and informatization of automotive supply chain logistics, promote information sharing between upstream and downstream enterprises in the supply chain, but also greatly guarantee these optimizing functions in supply chain logistics management for a long time.

5 Optimizing solutions to automotive logistics with information technologies applying

5.1 Automotive procurement and supply logistics process based on automatic identification technology

5.1.1 Optimizing design for automotive procurement logistics process

The application of smart technology in automotive procurement and supply logistics management is mainly reflected in the information collection and transmission methods, which can be realized by automatic identification technology (barcode technology, RFID), as shown in Figure 5.1:

First, the OEM checks the inventory through the enterprise management information system to determine the list of shortages; then, the intended supplier is determined through price comparison and inquiry, and the purchase order is directly passed to the supplier through the information system. After the supplier receives the order, all the purchase list items are labeled, and the physical attribute information of the items is assigned to the label according to the EPC code. [31]When these items are prepared for shipment and transportation arrives, both the supplier and purchaser can use RFID readers to scan the items, quickly and automatically collect item information, and automatically generate shipping and receiving orders, so as to communicate with the information system when entering the warehouse. To check whether the item is qualified. At the same time, the information system and identification technology are used to track the completion of purchase orders in real time, so that the production plant can better arrange the production.

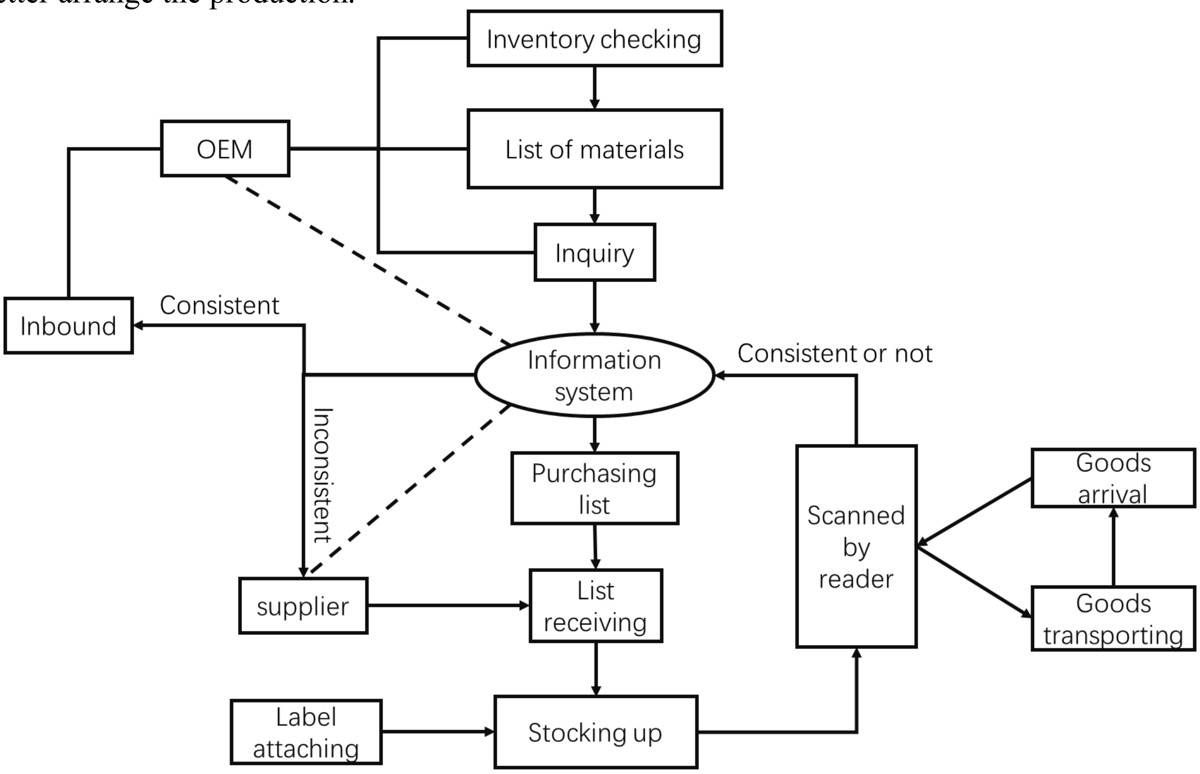


Fig.5.1 Procurement and supply logistics process based on automatic identification technology

In addition, the use of the Internet of Things technology can make accurate and timely forecasts of the demand for raw materials and spare parts, as shown in Figure 5.2.

Set up a reader at the sales terminal. The process of customers buying goods is to collect product sales information or customer reservation information to reflect market demand; at the same time, the reader at the manufacturer's production line can collect production line consumption information in real time, reflecting the real-time use of spare parts. The reader in the supplier's warehouse collects real-time inventory information of raw materials and spare parts. Suppliers can combine production line consumption information and market demand information to conduct thorough market demand analysis and scientific forecasts in time, which can promote collaborative planning between suppliers and manufacturers. In this way, the above two kinds of information are compared with the inventory information in time, and the replenishment plan is determined accurately and timely.

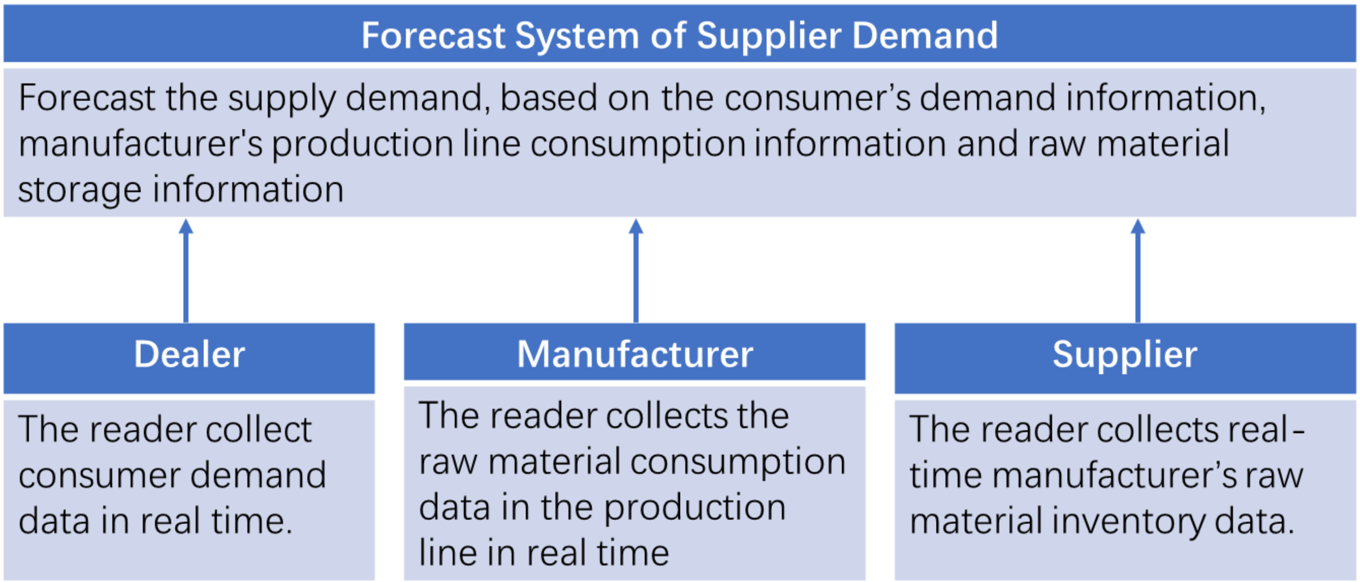


Fig 5.2 Raw material supply demand process with smart technology

5.1.2 Functional advantages compared with traditional automotive procurement and supply logistics management

The use of modern information technology can greatly simplify the process of stocking, shipping and receiving, and use the information system to intelligently process relevant information documents, which is a clear and efficient flow of information; supply and demand information can be captured at any time, and the procurement process is highly transparent. Purchasing supply logistics management using automatic identification technology can achieve the following functions:

(1) More simple operation and efficient information processing

In the steps of order information transmission, stocking, shipping, and receiving, automatic identification is used to collect item information. The operation is quite simple and the information processing is fast and accurate, which saves a lot of time and energy. Not only the business process is greatly simplified, but also the whole process can be tracked, which is convenient for us in activities of supervision and management.

(2) Quality control of auto parts

The use of RFID technology to automatically identify the auto parts inbound can not only quickly check whether the product is qualified, but also identify the source of the product at the same time.[32] For unqualified or defective products, their suppliers can be quickly known, problems can be solved through negotiation immediately, and production quality can be controlled from the source of supply.

(3) Data mining of purchasing information

After the spare parts are scanned and identified by the reader device, the reader will automatically transmit the identification information to the central computer. Then, with the help of the Internet of Things information management platform, it is easy to obtain all the information about the purchase.
Including the static physical information of the raw materials and the dynamic change information of these materials during the movement from the supplier to the "doorway" of the enterprise. The consumption rules are obtained by statistical analysis of these information, in order to provide accurate data support to optimize the material procurement plan, and more convenient the supplier management, more scientific procurement services are provided.

(4) Suppliers respond quickly to the market

With the exchange of supply and demand information, automotive manufacturers and spare parts suppliers can realize seamless information connection, obtain accurate and timely supply and demand information, and spare parts suppliers can quickly respond to the market and improve the efficiency of supply logistics.

5.2 Auto parts storage management process based on RFID and EDI technology

5.2.1 Optimizing design for auto parts storage management process

Before the goods are put into storage, it is necessary to ensure that each piece of goods is affixed with an electronic label that uniquely identifies the object. Then carry out the hardware layout of the warehouse. First, install sensors at the door of the warehouse, and install RFID door readers at the entrance and exit of the goods. When the goods pass, they will automatically sense the outbound or inbound operations and read the goods information; secondly, in fixed shelves and special locations, install electronic tags to mark the storage location; finally, the staff have corresponding RFID tags and PDA handheld readers. These devices are wirelessly connected with the back-end system, and the collected information is automatically imported into the database, then the front-end devices receive the control information from the back-end system. The most important part of optimizing the storage management of spare parts is inbound management and inventory management.

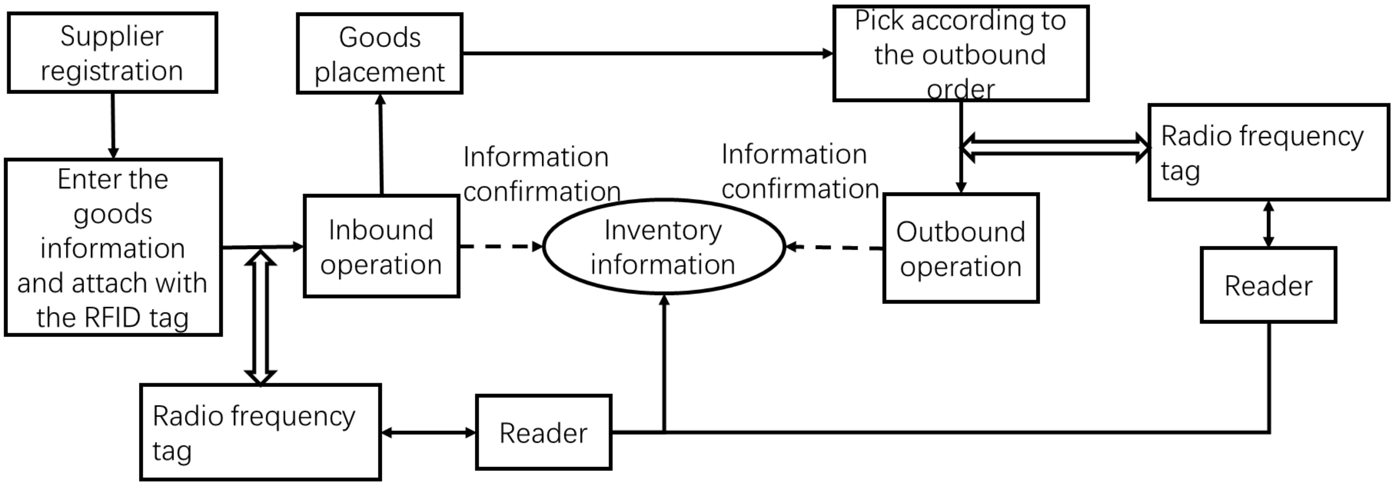


Fig.5.3 Auto parts inbound and outbound process with RFID application

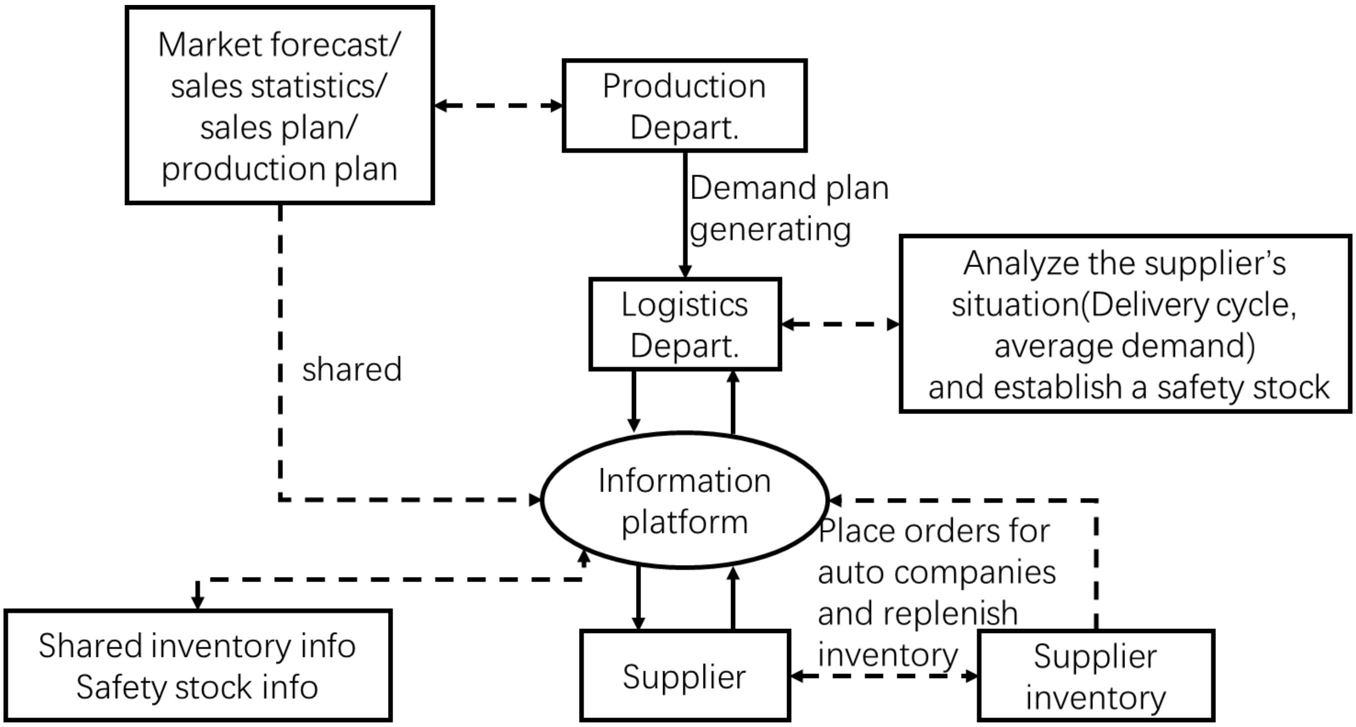
(1) Inbound and outbound management process

For the outbound business process, first, the enterprise ERP system writes the list of outbound goods into the picking list RFID tag. The warehouse staff picks the goods according to the picking list, and the picking system will prompt the location and quantity of the required goods. After the picking is completed, the reader on the access control system checks the actual outbound goods to generate an outbound order, then modify or delete related storage information in the background system. For the inbound process, the reader equipped at the receiving port will check whether the quality of the inbound parts is qualified, and automatically collect information, and then send the collected information back to the ERP system to match the information with the relevant orders and complete the storage. After the operation, put the goods in different locations according to the shelf requirements, update the storage location information to the goods label, modify the relevant storage information in the background data system. This process is roughly shown in Figure 5.3.

(2) Inventory management process

The automatic identification technology based on EPC code and RFID can solve the problem of massive data collection and recording.[33] At the same time, the EDI system and Internet are used for data exchange and transmission, which can not only ensure safety and reliability but also ensure the information standardization, this helps avoid unidentifiable cases occur in upstream and downstream steps, also VMI is designed and implemented in this optimization, as shown in Figure 5.4.

First, the vehicle manufacturer combines sales data statistics and market forecasts to propose sales targets and plans. Based on this, the production department then formulates a production plan and a material demand plan; the logistics department determines the average material demand and cycle according to the material demand plan, also confirms the safety stock; the logistics department then shares the safety stock information with the supplier. Moreover, all the stock information is shared. The supplier can automatically place an order or replenish the goods based on the safety stock and actual inventory without the involvement of the OEM.



Fig,.5.4 Auto parts inventory management process with technology applied

5.2.2 Functional advantages compared with traditional auto parts warehouse management

Auto parts warehouse management can achieve three functions after using smart technology, namely business process optimization, labor and equipment rational deployment, and environmental implementation supervision. It can improve the inbound, inventory and cargo search business, as follows:

(1) More convenient, accurate, and quicker warehouse operations. When the goods are in and out of the warehouse, it automatically matches the information of the location, the warehouse manager and the tools; each operation is based on the data prompt of the information system, which is very convenient and accurate. The use of rapid automatic identification technology greatly shortens the working time and improves work efficiency.

(2) Accurate and rapid positioning of goods

The optimized warehouse locates each shelf and installs location labels for them. When the goods are placed on the shelf, the reader reads the shelf location information and writes it to the goods label. After the local server receives the record and the access information, it modifies the database, adds information about the position of the goods, adds or deletes the inventory data. The location information corresponds to the stored items, and the warehouse management staff can not only quickly but also accurately check and search for items.

(3) Convenient and efficient smart inventory

Regular inspection is an important part in warehouse management. It can detect missing or stolen goods to obtain accurate inventory information. With today's technology, smart inventory trucks or handheld readers can be used for patrol inventory. The inventory trucks or readers go around the warehouse to automatically read the information of the goods on the shelves or pallets. When completed, the inventory report is automatically accumulated and uploaded then the system database will be compared with system data. With more advanced technology, readers and monitoring devices are set up on each shelf in the warehouse, and even real-time inventory of goods can be realized.

(4) Better inventory control

On the one hand, it allows suppliers to share sales statistics and production plans with car manufacturers, manage designated inventory for car manufacturers, and achieve the goal of automatic replenishment. On the other hand, it captures inventory information and demand information in real time, eliminates the extra cost caused by unexpected short-term product demand, reduces the high demand for safety stock, and understands the demand pattern of each product. Combined with the automatic replenishment system to replenish in time, it can greatly improve inventory turnover and reduce the costs. The accuracy of inventory information is improved, inventory management is more accurate and efficient.

5.3 Automotive production logistics process based on RFID technology

5.3.1 Optimizing design for automotive production logistics process

As shown in Figure 4.5: First, each station is equipped with a reader and an electronic dynamic screen, and each part is attached with an identifiable electronic label. The dynamic screen displays the process flow and material information of the station in real time. Therefore, the on-site staff can clearly understand the current operation of the station through the screen and complete the processing of the parts according to its prompts. After that, hold the reader and write the production operation information of this process into the electronic tag. Through the statistics of label information, the enterprise information system can track the production status and material consumption information of each station in real time, and intuitively match the required accessories with the required stations, which is convenient for the material department to distribute. The important part of optimizing production logistics management is processing procedure control and auxiliary material management.[34]

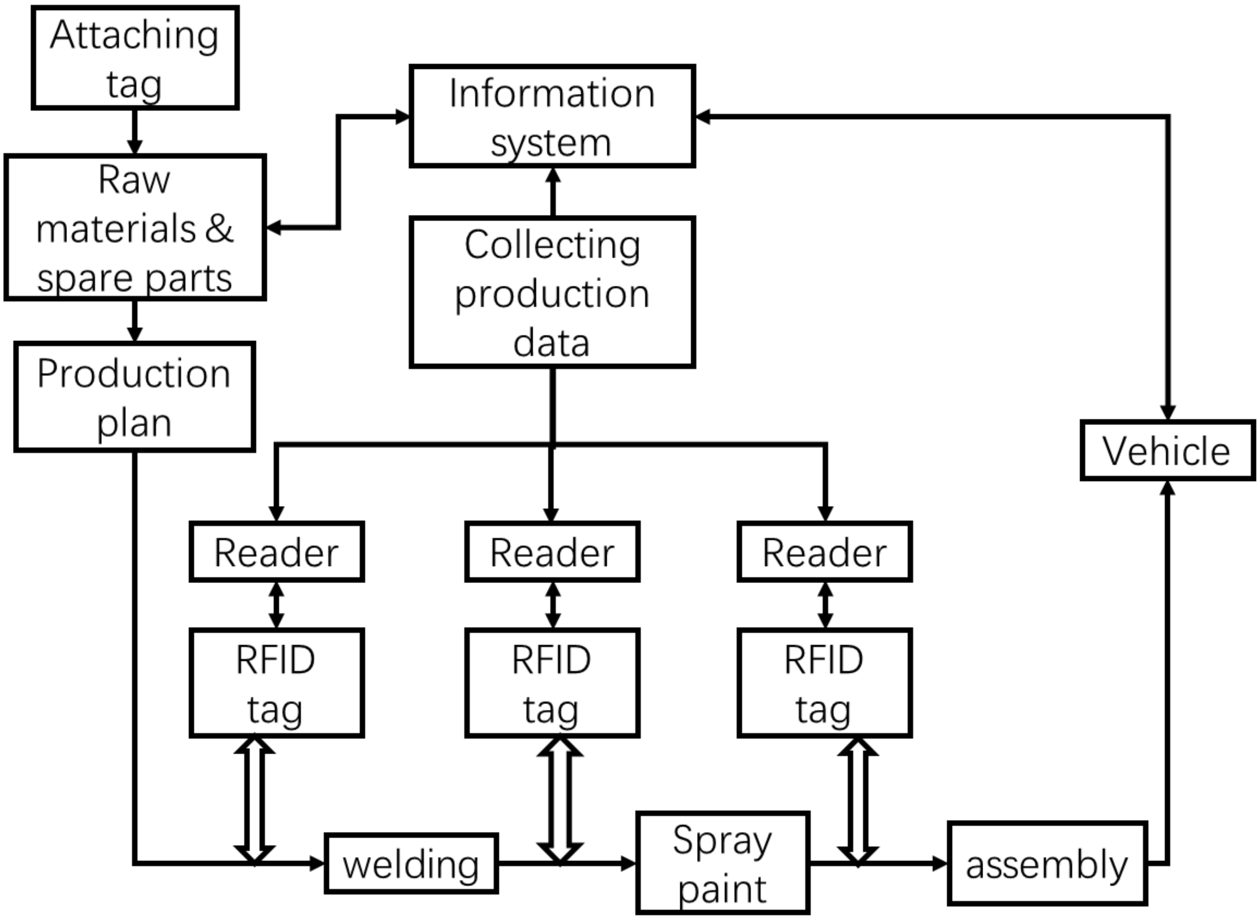


Fig. 5.5 Auto production logistics process based on RFID technology

(1) Process control

The processing procedure control flow is shown in Figure 4.6. When the product in the assembly process arrives at a certain station, the station's reader/writer automatically reads the data in the RFID tag, and the staff obtains information such as material distribution, product quality and processing requirements. After processing in accordance with the requirements, the processing information will be written into the label and transmitted to the central computer operating system via the network to collect the on-site data of the production line. If an abnormal situation occurs, it can be discovered in time. Once there is a deviation, it can be automatically analyzed immediately to provide reasonable Alternate solution. On the one hand, it can effectively prevent manual operations from failing to find errors in time. On the other hand, it can also quickly solve problems when errors occur and avoid production line shutdowns.

At the same time, the control of the processing procedure can strengthen the quality management of raw materials and spare parts: through RFID automatic identification technology, when the mixed spare parts in the mixed equipment are identified, if the added materials do not meet the processing requirements of the production line, an automatic alarm will be issued. Then suspend the production line to avoid unnecessary production errors; in addition, every time a process is completed, the semi-finished products are automatically identified and sorted. Only semi-finished products that pass the inspection can be processed in the next process, which fundamentally prevents unqualified products from entering the market. After analyzing the defective product rate of each process, a certain point where more defective products appear can be located, which is beneficial to the improvement of the production process.

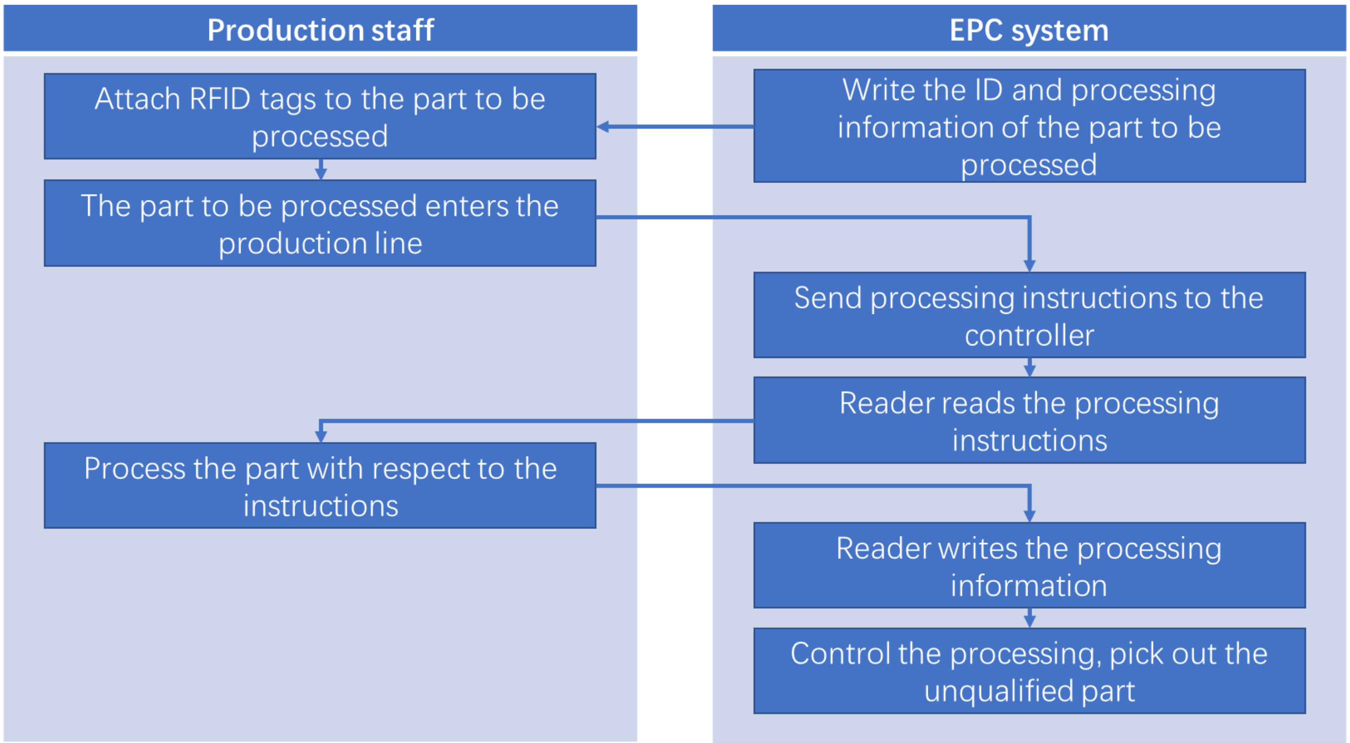


Fig.5.6 Process control based on RFID technology

(2) Auxiliary material management process

In the auxiliary material management, all parts are stored on the shelf, and the material box is transported by a conveyor belt, and the box is affixed with RFID tags to mark the parts in the box. According to needs, the shelf storage area can be divided into several small areas, and each small area is equipped with two secondary material conveyor belts.

One is the conveyor belt from the main line to the auxiliary line, and the other is the conveyor belt from the auxiliary line into the main line, and the auxiliary line accessory areas are connected by the main line conveyor belt. Set up a reader at each fork of the conveyor belt, read the EPC code on the passing box, automatically determine whether the box should enter or skip the secondary line, thereby generating route instructions, and picking up according to the ordering instructions. The process is shown in Figure 5.7.

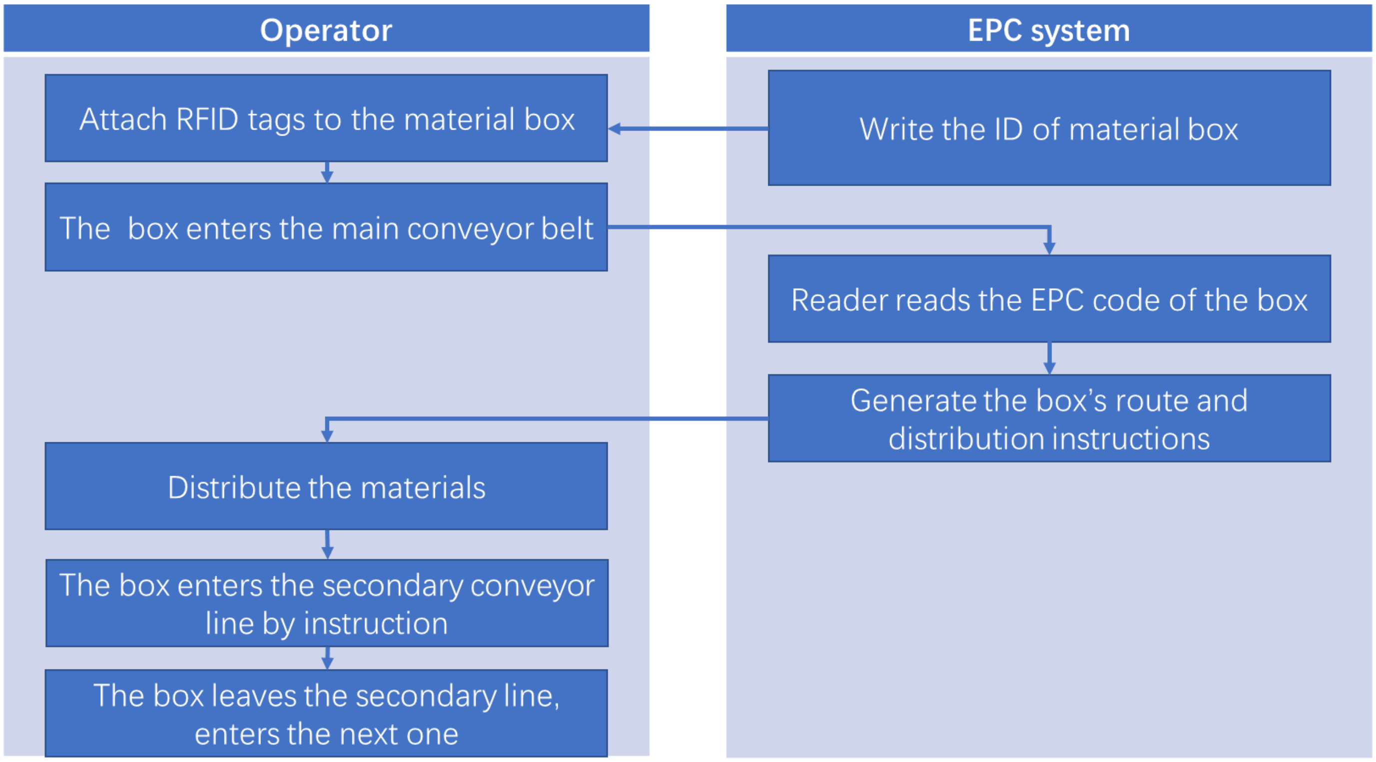


Fig.5.7 Auxiliary material management process based on RFID technology

5.3.2 Functional advantages compared with traditional automotive production logistics management

Through the automatic identification and tracking of items flowing in the entire production line, and real-time capture of production status and material consumption, you can prepare for problems that may occur in production, reduce labor costs and error rates, and improve production efficiency and corporate benefits. It is embodied in the following aspects:

(1) Inquiry about the execution and completion of orders

Through the identification of the electronic tags of the items in each process, the working status of the production line can be obtained in time, and it is clear how many finished products have been manufactured and how many materials are processed in which process. Based on the order execution and completion information, the delivery date can be predicted, and reasonable production in the later period can be arranged.

(2) Production progress tracking and control

Based on the understanding of the order execution and completion status, examine whether the current production schedule is reasonable, and provide information to support schedule adjustment when it is unreasonable. The production schedule control is more flexible. On the one hand, timely delivery must be ensured; on the other hand, the production capacity of the production line must be considered, and the production line must be stable and balanced. This logistics management system can also allow to know the inventory level at any time, and send replenishment information according to the production progress, respond to other companies quickly.

(3) Production quality control

In the production process, the information of the person responsible for the operation is written into the electronic label. Once there is a quality problem, it is convenient for the product to be traced to a certain worker in a certain link, strengthen responsibility management, and reduce waste. In addition, each production link is automatically sorted to prevent unqualified products from flowing into the next process and strengthen the control of product quality.

(4) Improve production automation level

The application of RFID technology in the production process can guide the workers on the production line to operate correctly according to the processing requirements on the electronic tags. The system automatically collects and counts product and material data, identifies and tracks the materials, accurately locates the production process and operators, which improves the level of automated production.

5.4 Auto sales logistics process based on RFID and GPS technology

5.4.1 Optimizing design for vehicle sales logistics process

After the vehicle is off the line and put into the warehouse, its model, color, configuration, production batch and other factory information and manufacturing date are recorded in the form of EPC coding and written into RFID tags. As shown in Figure 4.8: Reading and writing sensing devices are installed at every entrance and exit of the vehicle storage center and transit nodes (which can be temporary parking spots or transit warehouses), starting from the delivery of the vehicle to the final seller then to users, the RFID data of vehicles must be tracked and read throughout the entire process. During transportation, GPS is used to track the status of each vehicle. If an abnormal situation occurs, the problem will be discovered and resolved immediately. In addition, the arrival and return date of each transporting trunk will be calculated based on this, and appropriate sales strategies will be adopted to ensure the good vehicle sales. In this process, an information flow loop is formed. First, when the vehicle departs from the manufacturer's storage center, through the identification of EPC and RFID equipment, the automotive manufacturer sends the delivery information to the automotive seller to notify that the vehicle is about to arrive; then, when the vehicle is sold to the end user, the seller then uses the RFID device and EPC network to send back sales-related information to the vehicle manufacturer; in this way, the data information transmission loop between the manufacturer and the seller is completed.

For vehicle manufacturers, the relevant information of these end-sale users can provide a useful reference for product strategy. An important part of the optimization of vehicle sales logistics is replenishment management and customer demand management.[35]

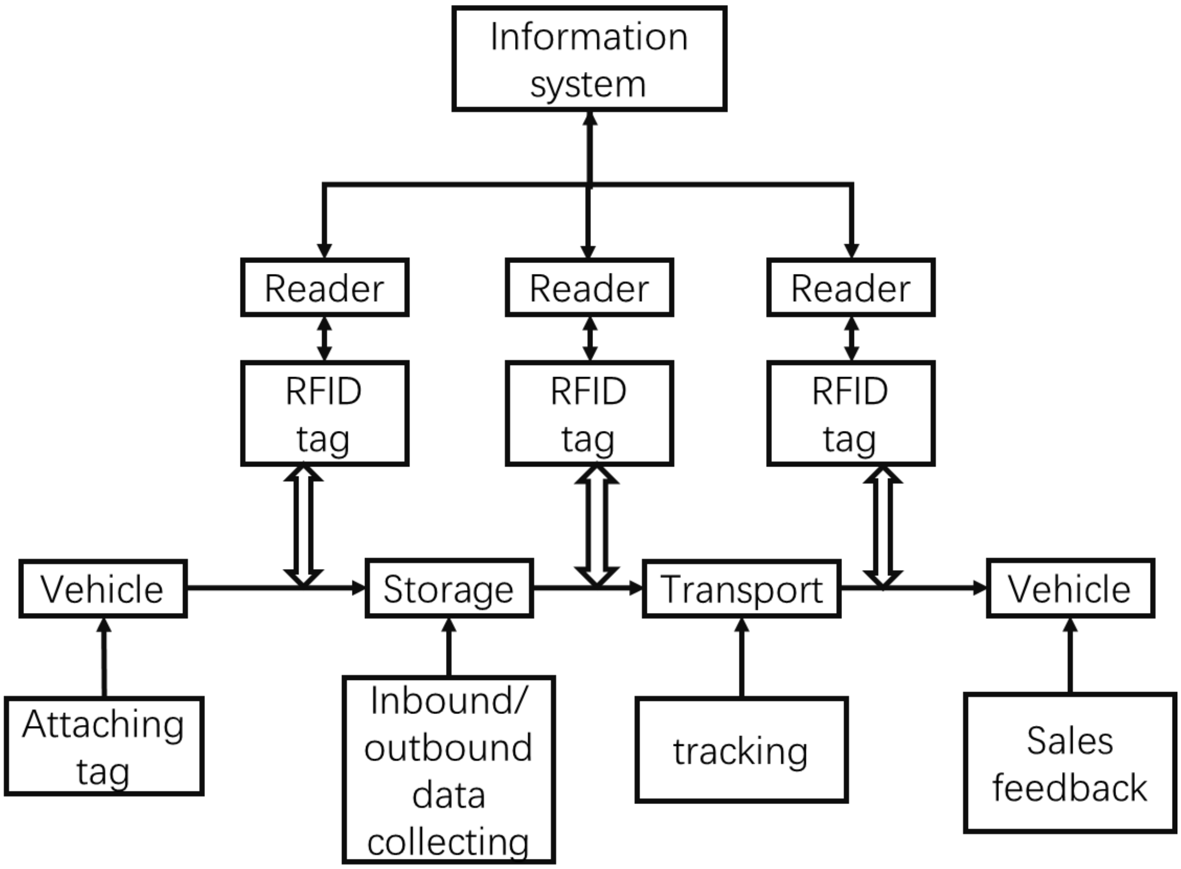


Fig.5.8 Auto sales logistics process based on RFID and GPS technology

(1) Vehicle sales and replenishment management process

Establish a logistics information management system at the center of automotive manufacturers, and link various dealers together through this platform.
Combine the vehicle inventory in the entire distribution network to form an inventory pool. All dealers can check each other's inventory and sales information through the system, keep abreast of the sales, observe market trends, and choose more market-competitive products for sale. Each dealer can also replenish or exchange goods with each other to meet user needs faster and avoid the loss of sales opportunities due to temporary shortages. Also, it is necessary to check whether the joint inventory is enough at any time, if not, send a replenishment signal to the manufacturer. The vehicle sales replenishment management is shown in Figure 5.9.

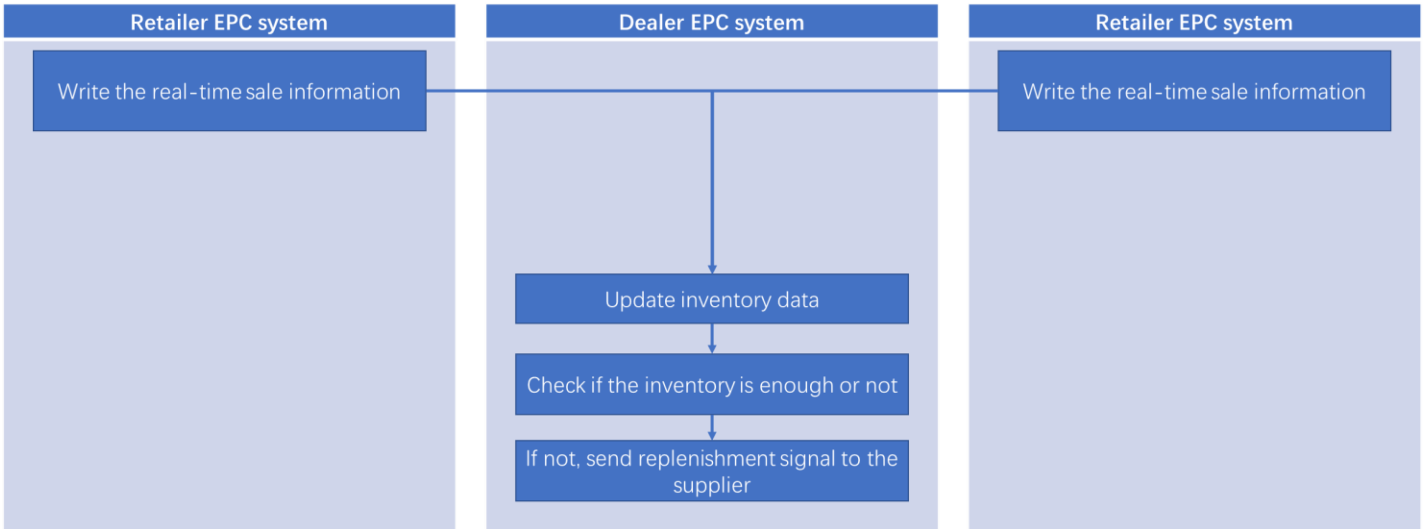


Fig.5.9 Vehicle sales and replenishment management process

(2) Customer demand management process
Using smart technology can more accurately and conveniently record customer specific demand information such as product selection, purchase, return, maintenance, and complaints. It is convenient for customers and avoids manual input errors, and it is more convenient for retailers to collect and analyze demand information. As shown in Figure 5.10.

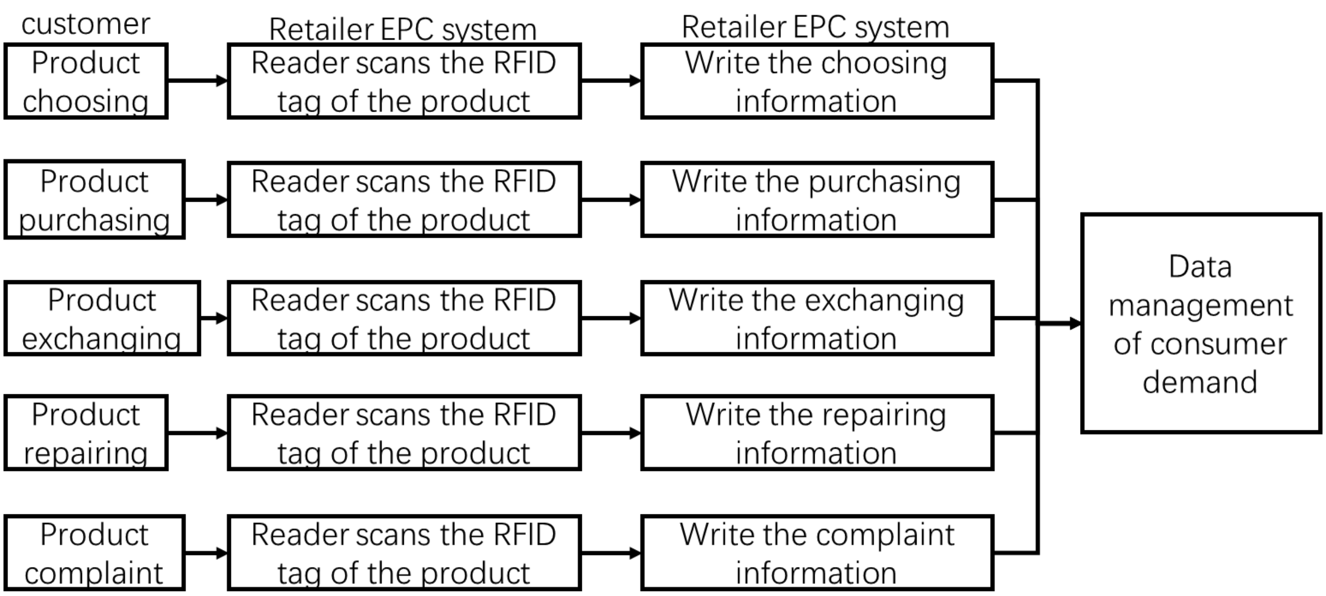


Fig.5.10 Customer demand management process

5.4.2 Functional advantages compared with traditional automotive sales logistics management
The application of RFID technology and GPS can improve the inventory management of retailers and

realize timely replenishment; effectively track transportation and inventory, improve efficiency, and reduce errors. Suppliers or distributors can clearly understand the current status of goods during transportation. When the position of the tagged item moves and the quantity changes, the reader can identify it and report it to the system, and it can also play a role in preventing theft of the goods.

(1) Tracking of vehicle logistics process
Real-time monitoring of the status and location of all vehicles in transit, tracking the status of each vehicle in transit, not only can make necessary optimal route adjustments based on real-time dynamic traffic conditions, but also update the cargo information transmitted by the transport vehicles in the logistics information system , Use this as the guidance data for the next logistics activities, and provide logistics status information data support to customers inquiries, and take reasonable sales decisions based on the arrival and return dates of the transport vehicles.

(2) Inventory and sales process control
Through the joint inventory established by the logistics management information system, under the coordination of the vehicle manufacturer, the dealers form an agreement to exchange goods, promising that the dealers can complement each other under certain conditions, and pay a certain remuneration to avoid missed Sales opportunities greatly improve sales service levels. On the other hand, joint management of dealers can effectively regulate the market, transparent management and accurate scheduling of the entire sales process, effective control of the sales process, and avoid channel conflicts.

(3) Improve sales efficiency
After the products in the sales link are purchased by the customer, RFID automatic identification is used to count the sales details of the product and automatically report to the management system; in the sales settlement, after the RFID technology is used to automatically identify the product, the relevant documents are automatically generated to improve the speed of settlement ; Use the automatic identification system to record customer reservation information and automatically produce purchase orders, which is faster and more accurate than manual operations. The labeling system can also record the flow of goods, so that companies can grasp the details of the use of the goods.

5.5 Automotive spare parts logistics process based on GPS, GIS and PDA technology

5.5.1 Optimizing design of automotive spare parts logistics process

Spare parts logistics can form a multi-level inventory supply chain by itself. The use of smart technology cannot simply be reflected in a certain process, but to build an automotive spare parts logistics management system to complete the visual and automated management of automotive spare parts logistics.

As shown in Figure 5.11. According to the main business and functional requirements of automotive spare parts logistics, the spare parts logistics management system is mainly aimed at three aspects: spare parts tracking and transportation, spare parts inventory control and spare parts maintenance management. The integrated information platform has two main advantages: one is to realize the efficient transmission and sharing of spare parts logistics information in the entire supply chain; the other is to realize the intelligent and visual management of spare parts logistics business processes to meet the requirements of transportation, distribution, inventory control and also meet the information service requirements for operations such as maintenance management.[36]

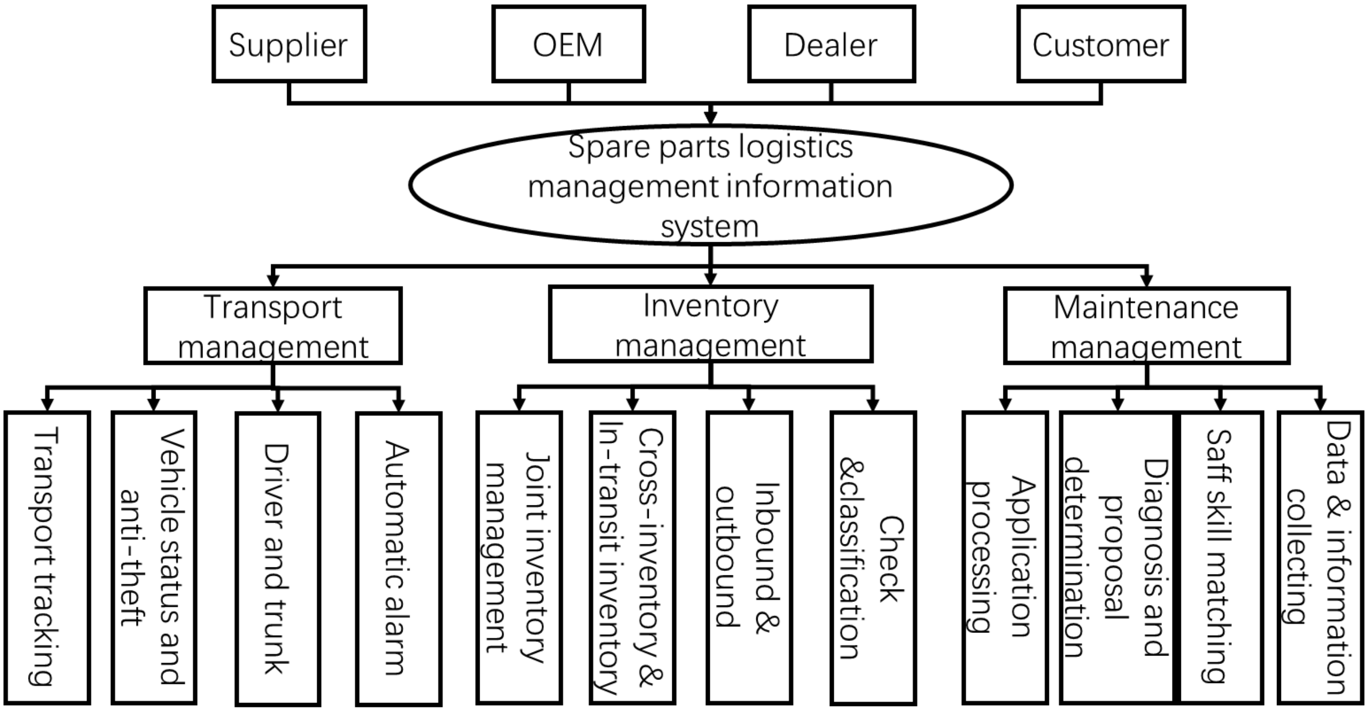


Fig.5.11 Auto spare parts logistics process based on GPS, GIS and PDA technology

(1) Spare parts transport tracking
After the truck is loaded with spare parts, GPS is used to locate the vehicle, and the location information is updated to the on-board PDA to realize the tracking of the vehicle. The status, location, and loading and unloading information of the spare parts are automatically collected by scanning the RFID tags of the goods through the reader. The tracking information of the transportation vehicles and the collected cargo information can be connected to the computer system of the dispatch center through the wireless network, and the transportation status of the vehicles can be visually displayed on the GIS electronic map. The dispatch center can exchange data information with the on-board PDA to realize the management and regulation of transportation vehicles. Through the whole process of monitoring the spare parts in the transportation process, the inventory information of the spare parts in transit can be obtained to prepare for the after-sales service.

(2) Spare parts inventory control
In order to achieve efficient and rapid management of urgent spare parts, distributors in various regions need to have a certain amount of regular inventory. Using technology to manage spare parts inventory can collect parts demand from auto repair stations in real time, and the information system predicts the demand for parts through analysis. This enables advance purchase and real-time scheduling of spare parts inventory in various regions. Spare parts warehouses in various regions can exchange and replenish goods with each other. When the inventory is insufficient, spare parts orders can be issued to the vehicle factory in time. As shown in Figure 5.12.

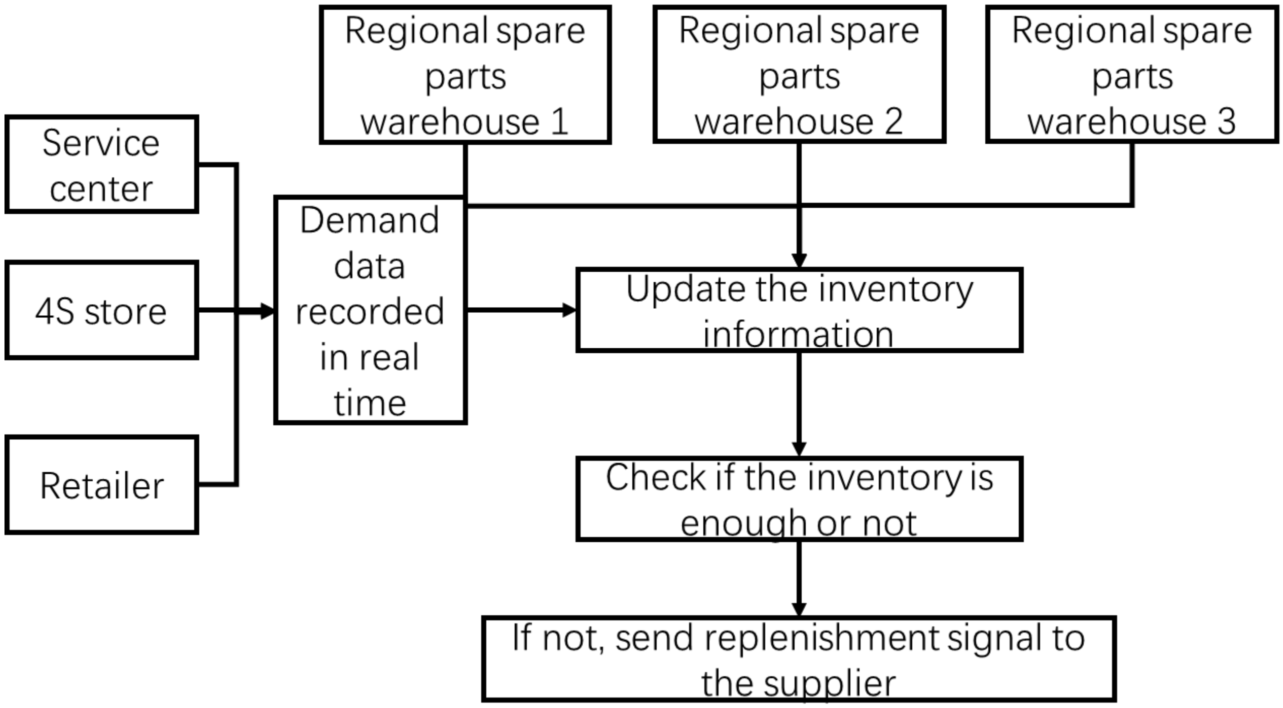


Fig.5.12 Spare parts inventory control flow

(3) Spare parts maintenance management

After the maintenance site receives the maintenance application submitted by the customer, the maintenance personnel can conduct a preliminary diagnosis through the IoT terminal. By reading the EPC tag information on the damaged spare part, the maintenance personnel can help the maintenance personnel understand the vehicle maintenance records and quickly and accurately diagnose the vehicle fault , And choose the best vehicle troubleshooting plan from the mass storage of fault repair plans on the automatic fault diagnosis platform, and match employees with appropriate repair skills for repair services. The repairer can quickly find suitable parts by reading the contents of the spare parts EPC label. Thereby speeding up the repair speed; and writing the repair record into the spare parts label, so that the historical repair record can be directly obtained for the next repair.[37] After each maintenance service is completed, it is necessary to record the repaired spare parts information, fault classification and solution, generate a fault inspection report, and store it on the automatic diagnosis platform for future maintenance service inquiries. Recording the repair and maintenance information of vehicles and spare parts can show the quality status of the product throughout its life cycle, which is conducive to the quality analysis and technical improvement of the product by the vehicle manufacturer. The business process of spare parts maintenance management is shown in Figure 5.13 below.

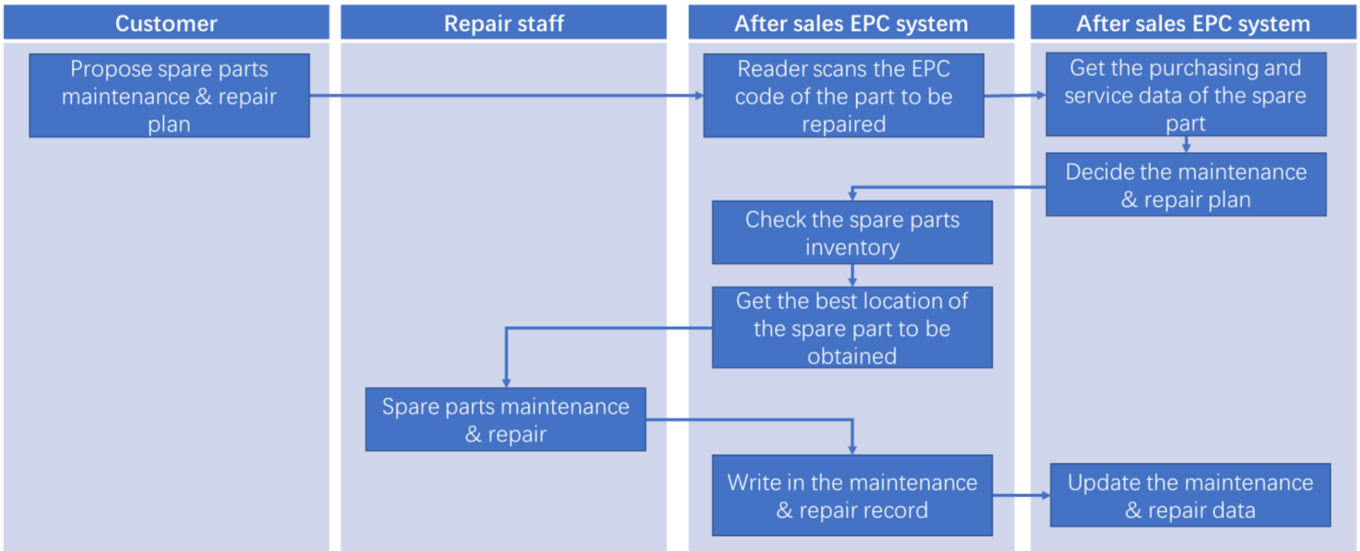


Fig.5.13 Spare parts maintenance management process

5.5.2 Functional advantages compared with traditional automotive spare parts logistics management
Auto spare parts logistics management using the above technologies can realize the automation, intelligence and transparency of business processes such as auto spare parts logistics transportation tracking and distribution, inventory control and maintenance diagnosis. The details are as follows:

(1) Whole process tracking of spare parts transportation
Through GPS positioning technology, real-time tracking of vehicles and spare parts to achieve punctual delivery; not only can understand the status of spare parts in real time, but also achieve the purpose of spare parts theft prevention. The vehicle condition and the driver's condition are monitored, and an alarm can be automatically reported once an abnormality is found.

(2) The inventory turnover capacity of spare parts is improved
It combines optimized information technology and existing inventory control technology to implement joint inventory control, establishes strategic cooperation among various regional distribution warehouses, and then considers the joint control of in-transit inventory. It helps make reasonable spare parts order forecasts and decisions by knowing the inventory information of each warehouse. This improves the manufacturer's inventory planning and material management level, as well as inventory turnover.

(3) The delivery rate of urgent orders is improved
When there is an urgent order, you can quickly search for the warehouse nearest to the required spare parts, and select the best transportation route, transportation vehicle and driver. Comprehensive monitoring of the transportation of automotive spare parts, coupled with efficient inventory management technology, reduces the out-of-stock rate, so it will inevitably increase the delivery rate of urgent orders.

(4) The efficiency and accuracy of spare parts maintenance is improved
When a customer has a maintenance request, he can first register an appointment at the network terminal and describe the problem of the vehicle. The maintenance staff can roughly know the cause of the failure in advance, then quickly diagnose the failure of spare parts and obtain historical service records during maintenance. The maintenance can be operated more accurate and the time can also be shortened. Due to the reservation in advance, the maintenance time and personnel can be specifically arranged, and the customers can be served quickly and well, which improves the maintenance efficiency and service quality. After the repair, customers can check the repair or replacement spare parts information through the identification terminal, which can improve customer satisfaction as well.

5.6 The effect of implementing RFID applications
The extensive use of RFID technology in automobile logistics can realize the intelligence of the entire

supply chain of product production, storage, transportation, and distribution.

(1) Automating production and reducing labor cost. The application of RFID technology in the production process can track the process progress of raw materials, parts, semi-finished products and finished products on the entire production line at any time to complete the operation of the automated production line, reduce the error rate and labor costs caused by manual identification, improve production efficiency and corporate benefits. According to CARQUEST company, the company's accuracy in accepting and integrating orders has increased by 53%. The inventory accuracy reached 99.9%, which greatly improved productivity and quickly increased the return on investment.[34]

(2) Inventory reduction and inventory checking time reduction. The application of RFID technology in warehouse management can also improve management capabilities and reduce inventory levels for enterprises. Because RFID technology allows companies to grasp the inventory information and warehousing rules of goods in real time, understand the demand pattern of inventory goods, replenish them in time to reduce storage costs. For example, LITI clothes company reduced 75% of the inventory checking time by applying RFID technology, while J Crew Group increased 5-8 times of the goods picking speed.[36]

(3) Transportation loss reduction. In the transportation phase, RFID technology combined with GPS and GIS can be used to optimize the transportation process like preventing and solving problems in time in transportation. According to the information provided by GM, the time from vehicle to delivery has been shortened by 60%, the delivery date reliability rate has reached 90%, and the vehicle delivery rate without damage has reached 99.5%. The logistics cost has dropped by 14% on the original basis.[27]

(4) Improving customer service. The use of RFID technology can also enable companies to effectively integrate business processes, improve market resilience, provide customers with more personalized services, and improve customer service. Mini USA, a subsidiary of BMW, has carried out a pilot project to select Mini drivers to issue key rings with RFID tags. When the driver carrying the key ring passes the electronic billboard, the reader fixed on the billboard can read the RFID tag in the key ring to obtain the unique ID number and transmit this ID number to the central server. The server reads the individual information collected in the previous car owner's questionnaire and considers the current season or date to determine which piece of personalized information is displayed.[36]

The mobility of goods in the automotive logistics field is very high, and the monitoring and management of moving objects formally reflects the advantages of RFID technology. Therefore, RFID technology has also attracted more and more people's attention. In the open-loop logistics management, the RFID system becomes more and more complex, but the development and application of RFID technology are becoming more and more common, and the threshold is getting lower and lower. Its precise management will extend to all aspects of logistics management. It is becoming an important technical means of modern logistics management.

6 Conclusion

6.1 Research conclusion

This work takes automotive supply chain logistics as the research object, applies modern logistics technologies to the practice of automotive supply chain logistics. First, through the analysis of the current situation, determine the necessity and demand for applying logistics technology in each link of automotive supply chain logistics. Then, design the technology-based automotive supply chain logistics process, and finally analyze the functions realized by the optimization process. Specifically, the following research conclusions are obtained:

(1) Based on the analysis of the current situation of the logistics management system of the automotive supply chain, it is pointed out that the problems that require the use of logistics technology in each logistics link include:
Weak document information processing in automotive procurement and supply logistics, difficulty in obtaining supply information and demand information, and opaque procurement process. In auto parts warehouse management, there are problems such as long lead time for warehousing operations, chaotic and inefficient information processing, and inability to understand the inventory quantity and environment in real time. Automotive production logistics has problems such as imperfect basic data, inability to grasp the completion of production orders and customer needs in real time, and insufficient product quality control. There are problems such as low control of the logistics process, waste of transportation resources and low sales efficiency in automotive sales logistics. Automotive spare parts logistics has problems such as difficulty in predicting the demand for automotive spare parts, long maintenance service time, and difficulty in selecting automotive spare parts quickly and accurately.

(2) Design the logistics process of the automotive supply chain using logistics technology, including: procurement logistics process and raw material supply demand forecast; auto parts warehousing and storage management process and inventory management process; automotive production logistics process, processing control process and auxiliary material management ; Vehicle sales replenishment management process and customer demand management process; spare parts transportation management process, spare parts inventory control process and spare parts maintenance management process.

(3) Analyze the realization functions of automotive supply chain logistics process using logistics technology. Purchasing supply logistics can realize simple operation and efficient information processing, control the quality of auto parts from the source, and data mining of purchasing information. The parts storage management realizes more convenient, accurate and fast storage and exit operations, rapid and precise positioning of goods, efficient intelligent inventory and better inventory control. Production logistics realizes the functions of order execution and completion status query, production progress tracking and control, production quality control and production automation level improvement. Vehicle sales logistics realizes the functions of vehicle logistics process tracking, inventory and sales process control, and sales efficiency improvement. Spare parts logistics realizes the functions of tracking the whole process of spare parts transportation, improving the inventory turnover capacity of spare parts, the delivery rate of urgent orders, and the efficiency and accuracy of spare parts maintenance.

6.2 Research outlook

This paper analyzes the demand for the use of logistics technology in each link of the automotive supply chain logistics, then designs the automotive supply chain logistics process based on modern logistics technology, and then analyzes the optimization functions of the automotive supply chain logistics management system. It has certain research results. However, due to my limited knowledge and ability, this paper still has some shortcomings: this paper uses logistics technology to design the logistics process of the automotive supply chain under an ideal situation. In actual application, it is necessary to deal with the relevant business of the involved enterprise. Conduct a more comprehensive investigation and analysis of the actual situation. In view of the superiority of technology, it is necessary to give full play to the role of technology in automotive supply chain logistics and effectively improve the efficiency of enterprise logistics operations. In the future, further research will be conducted in the following three aspects:

(1) The actual application program design that meets the specific business operations of each enterprise requires further in-depth research.
(2) The ability of logistics technology to achieve efficient logistics operations depends on the data processing capabilities of the logistics information system. The key is to design and develop a comprehensive logistics information management system that combines logistics technology and conforms to enterprise application operations.
(3) In the actual application of logistics technology in enterprises, only the use of unified data interfaces and unified data transmission standards can achieve information sharing between enterprises, so standardization is required.

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