Chapter 2

Literature Review

The researcher has studied concepts, theories and related research used to determine the research guidelines as follows:

1. Theory of Supply chain management
2. Theory of Continuous process improvement
3. Concept of intelligent door lock
4. Related research

Theory of Supply Chain Management

Supply chain management (SCM) is the theory and practice of systematizing and integrating the management of internal and external trade, transportation, production, and services within an enterprise. By integrating the flow of information, funds, and goods, SCM aims to optimize the supply chain and improve production efficiency and customer satisfaction.

The development of SCM theory can be traced back to the post-World War II era, when Professor Jay Forrester of MIT's Sloan School of Management pioneered the discipline of systems dynamics in the 1960s. In the early 1970s, Robert Alarcon, an American logistics scholar, first proposed the concept of "supply chain," defining it as a complete process consisting of all links from the purchase of raw materials to the sale of products. In the early 1990s, SCM began to be applied in corporate practice and was widely promoted.

In the 1970s and early 1980s, there were many related studies on logistics and processing in the United States. As companies began to adopt globalization strategies, collaboration between companies became more common, and better SCM solutions were needed.

In 1996, the Supply Chain Council (SCC) proposed a standard flowchart-based organizational framework called the Supply Chain Operations Reference Model (SCOR). By defining the supply chain in terms of five major processes-planning, purchasing, production, distribution, and returns - the model emphasizes the close

relationship between the various activities in the supply chain and provides methods and ideas for integrating the global supply chain and optimizing the logistics process.

1. Planning

Planning is the first element in the SCOR model, which focuses on the company's forecasting of market demand, production planning, inventory management, product design and technology development, etc. Mentzer, et al. (2001, pp. 1-25) point out that the key factors in supply planning include market demand, planning and scheduling of production facilities, material demand and supply planning, procurement and supplier management. For companies, it is important to ensure the effectiveness and accuracy of the plan to gain an advantage in the target market and maximize production efficiency.

2. Purchasing

Purchasing is the second element of the SCOR model and its main focus is to optimize the relationship between the company and its suppliers, control purchasing costs, improve purchasing efficiency and ensure supply reliability. According to Ron (2004, p. 173), in purchasing, companies need to ensure the quality and reliability of suppliers and focus on negotiating aspects such as purchase price and delivery time. In addition, companies need to continuously improve their purchasing procedures and procurement processes to reduce purchasing costs and improve supply chain efficiency.

3. Manufacturing/Production

Manufacturing/production is the third element in the SCOR model, which focuses on a company's production planning, optimizing production processes, and improving product quality and production efficiency. According to Wang (2015, pp. 1-9), manufacturing/production includes production resource planning, production process management, quality management, and production efficiency improvement. Through the optimization and management of manufacturing/production, enterprises can improve product quality, supply chain efficiency, reduce production costs, and improve competitiveness.

4. Delivery

Delivery is the fourth element in the SCOR model, which focuses on the transportation, warehousing and distribution aspects of an enterprise's logistics process. Zhong (2008, p. 901) points out that delivery is one of the key aspects of the supply chain, which includes material transportation, warehouse management and distribution services of the enterprise. Enterprises need to manage and control

logistics in the delivery process to ensure that products can be delivered to customers in a timely and effective manner.

     5. **Return**

Return is the fifth element in the SCOR model, which focuses on the management of quality issues, returns and after-sales service. Rhodes (2009, pp. 112-129) points out that in the returns process, companies need to continuously improve product quality and after-sales service quality, and establish a perfect after-sales service system, including rapid response to customer complaints, the establishment of a hotline, 24-hour online customer service and other measures to leave a good impression of service to customers.

The application of SCOR model in modern industrial manufacturing is very wide and important. It helps companies to improve productivity and performance, and reduce costs and risks through the management and optimization of five elements. In order to effectively apply the SCOR model, the supply chain management process requires an agreement on the distribution of functions with delegates, the definition of performance measurement methods and financial models, the establishment of information systems to support, analyze and optimize the supply chain process, but also the optimization and coordination of partners in logistics to ensure effective allocation of resources and cooperation. The SCOR model will continue to play an important role in the future of manufacturing, and with the development and application of IoT technologies, the SCOR model will be managed in a more intelligent, efficient and personalized way, and further improve supply chain management on a global scale (Mentzer, et al., 2001, pp. 1-25).

In the early 2000s, supply chain management research began to gradually shift toward customer-centric strategies. Compared to the traditional producer-driven management model, the semantics of customer-centricity are clear and simple: the goal is to be "customer-centric" and to consider customer needs, current value creation, key business processes, and customer experience in a comprehensive manner so that all business processes can continuously meet customer requirements. The focus of this period is on how to bring customization, uncertainty and responsiveness into supply chain design through data analysis and market activities.

In recent years, with the development of artificial intelligence technology, intelligent supply chain has become a new research hotspot. Through the use of machine learning, big data, cloud computing and other technologies, intelligent supply chain can better perform all aspects of forecasting, scheduling, dispatching and planning, further reduce situations such as machine failure and personnel error,

improve the efficiency and accuracy of the entire supply chain, and optimize a large investment of efficiency and money. At the same time, while improving efficiency, intelligent supply chain can help enterprises reduce costs and achieve optimal use of resources to improve market competitiveness.

In summary, the theoretical framework of supply chain management has gone through several stages of development, from focusing on process and cost control to customer orientation and intelligent operations. The main process SCOR model has become one of the most influential specifications in the field of supply chain management and occupies an important position in modern supply chain design. To embrace the future of supply chain management, companies must stay abreast of technology and process changes and incorporate them into continuous improvement programs. This will lead to more sustainable, high quality and excellent experiences and results in future supply chain management models. (Sun and Li, 2019, pp. 115-124)

Process Optimization Theory

In the process optimization theory, the performance indicators of the SCOR model are divided into four main categories. The first category is flexibility and responsiveness, and these performance indicators include water consumption time, cycle time, etc. The second category is Cost, which focuses on how to reduce costs through the rational use of various resources such as materials, labor, equipment, and information technology. The third category is reliability and assets, which includes the use of working capital, etc. The fourth category is supply chain effectiveness, which measures the collaboration between suppliers, manufacturers, and sellers.

Thus, process optimization theory focuses on the optimization of a workflow, with the emphasis on optimizing the entire workflow, thereby reducing production costs and improving product quality. From a theoretical point of view, process optimization theory has largely benefited from the fact that the industry has rushed into relevant applications, making it impossible for companies and manufacturers to deny that this importance has outweighed cost reduction in the competition. By continuously studying and improving processes, companies can better meet the needs of their customers.

The key performance indicators in the SCOR model were developed primarily by AMR Research in the early 1990s and have been studied and refined for more than 10 years. They include lead time and cycle time, which measure the time it takes a

company to fill orders, allowing managers to identify which stages are problematic and make improvement decisions. Working capital utilization, on the other hand, is a key indicator that focuses on how well a company maintains its own dynamic balance in the use of capital. If a company's use of capital is negligent or wasteful, a shortage of assets can develop.

Overall, the emergence and development of process optimization theory has been strongly influenced by market economic reforms and has wide application in modern industrial manufacturing. The performance indicators in the SCOR model are designed to more intuitively reflect the performance of the whole enterprise in the supply chain, so that the enterprise can better grasp its own development direction (Supply-Chain Council, 2008, pp. 1-23).

Concept of Intelligent Door Lock

Smart door lock is an application device that uses IoT technology to achieve intelligent and efficient management, and has a wide range of definitions, development history, types of technologies, application areas and market conditions that have been studied. For the definition of intelligent door lock, there are different representations in domestic and international studies. According to Wang and Lu (2020, pp. 65-70), "smart door lock is a high-tech access control management system that uses advanced Internet of Things, artificial intelligence, cloud computing and other technologies to achieve information sharing, automatic identification, remote control and other functions". While Liu (2020, pp. 34-41) from the University of Nottingham, UK, defined it as "a measure to improve the security, reliability and controllability of door locks based on wireless networks, sensor technologies and intelligent algorithms". Overall, a smart door lock can be simply understood as a high-tech access control product that relies on advanced technology to achieve information networking, automatic judgment and intelligent control. These different definitions reflect the diverse characteristics of smart door locks.

The development history of intelligent door locks began in the 1930s and gradually matured through years of technical iterations and various application practices. The early electronic locks mainly solved the security risks and routine management tedious problems of mechanical and coded locks, and in the 1980s, SDC digital locks were once widely used in financial institutions. Since the 1990s, with the development of artificial intelligence, Internet of Things, mobile payment and other technologies, smart door locks started to develop in the direction of biometric

features such as fingerprint, facial recognition, voice control, etc. (Wang, 2019, pp. 45-52). Nowadays, the market demand and user acceptance of smart door locks are increasing, and it has become an emerging industry with great market potential. The development history of smart door locks reflects the continuous changes and deepening of its application technology and market demand.

In terms of technology types, smart door locks include mechanical password locks, non-mechanical password locks, fingerprint locks, iris locks, face recognition locks, sound recognition locks, mobile phone NFC locks and other types. Among them, fingerprint locks and face recognition locks have become the two most popular types of smart door locks in the current market due to their fast and convenient operation and high security (Zhou, 2018, pp. 72-73). These different smart door lock technologies reflect their continuous improvement and practice in addressing the security, convenience, and innovation of access control management.

The application areas of smart door locks are also becoming more widespread, including not only traditional areas such as private residences and public places, but also widely used in enterprises, government agencies, financial institutions, community properties, and other areas. For example, Yuyue Medical's smart door lock application solution can prevent theft or illegal entry into the medical equipment storage room. There are also some emerging fields, such as the intelligent management of pig houses and the security of oil drilling platforms. These application cases reflect that the application fields of smart door locks are becoming more diversified, and new application scenarios and requirements are constantly emerging.

Finally, from the market situation, smart door locks in foreign markets are relatively mature, with a steadily growing market share in Europe and the United States and other places. The Chinese market is relatively late in its development, but with the increasing demand for smart living, the market size is also expanding.

In summary, smart door locks are application devices that use technologies such as the Internet of Things to achieve intelligent and efficient management, with various definitions, development histories, technology types, application areas, and market conditions to study. With continuous technological updates and expanding market demand, smart door locks have become an emerging industry with huge market potential. This MBA thesis comprehensively describes the concept, development history, technology types, application areas and market situation of smart door locks from different perspectives to provide reference and guidance for related research (Zhou, 2018, pp. 72-77).

Related Research

1. Research on the smart door lock industry chain from the perspective of supply chain network

Wang (2019, p. 256) published in the Journal of Electronic Commerce, "Research on the smart door lock industry chain based on the perspective of supply chain network" analyzes the structure and level of the smart door lock industry chain, discusses the problems in this area, focuses on the organizational form of smart door lock enterprises and their operation mechanism, and provides a systematic and detailed description of the smart door lock industry chain. It also analyzes the market structure, influencing factors and ecosystem.

At present, smart door lock is rapidly developing as an emerging technology in the context of a society with increasing demand for fast-paced, high-efficiency and convenience. In addition, with the increasing popularity of IoT devices, finished raw materials are automatically collected by intelligent sensors, and the internal management of warehouses is always transparent, greatly improving the efficiency of the industrial chain. These consumer habits and technological advances are driving the rapid development of smart door locks.

Various links of the smart door lock industry chain, the smart door lock industry chain mainly includes chips, sensors, modules, application software and many other links. In general, the whole ecological chain can be divided into the following main links:

Smart door lock core component suppliers: mainly provide smart door lock chips, card reader chips, fingerprint recognition chips, intelligent control IC chips and other related core components;

Smart door lock module suppliers: a variety of different chips are assembled and other peripheral hardware is added, and the finished product can be directly connected to the internal circuit of the product, which is a relatively complete module;

Smart door lock complete manufacturers: the use of smart door lock module, based on the shell design, test tracking and logistics management and other work, the final production of the entire smart door lock;

Smart door lock application and supporting software: including the smart door lock password input, fingerprint collection, management system, security protection algorithm and other software writing;

Smart door lock sales channels: through online, offline stores, e-commerce platforms and other sales methods to adequately promote the smart door lock.

In addition to the above links, it can also include smart door lock-related ancillary products, such as smart home equipment, security monitoring systems, etc. In short, the smart door lock industry chain involves a number of aspects, with great market potential and development prospects.

The three aspects of market structure, influencing factors and ecosystem of smart door lock industry chain are analyzed. First, the article introduces the existing market structure of smart door lock industry chain. With the rapid development of Internet technology, the market pattern of smart door locks has been significantly adjusted, and the purchasing channels of consumers are more diversified. Second, the factors influencing the smart door lock industry chain are more complex. The article sorts out such influencing factors as patent protection and technology competition, cost pressure and quality control, and provides readers with some new ideas and methods to take advantage in the fierce competition. Finally, the article also analyzes the existing market structure of the current smart door lock industry chain and its influencing factors, as well as the key issues in the industry ecosystem and their influencing factors.

The study has some shortcomings.

First, it lacks in-depth analysis. Although the study has sorted out the various links of the smart door lock industry chain in detail, there are limitations in the analysis of the chain reaction. Failure to conduct in-depth analysis of the competitive situation, enterprise value creation and innovation of the whole industry chain makes the depth of the study limited.

Second, data limitations. Although a number of cases and industry statistics are provided in the article, it seems that more data support is needed to better substantiate the conclusions. Therefore, the results of the study may be affected by data limitations.

Third, the changes in the market environment were not considered. With the continuous development of the smart door lock market, the market environment and related policies are constantly changing. These changes have a great impact on the operation mode of the industry chain, the market pattern, and the competitive relationship between enterprises. These changes have not been fully considered.

In summary, the research of smart door lock industry chain from the perspective of supply chain network is concise, relevant and has high reference value. However, the above-mentioned shortcomings still exist in the writing of the article,

and there is a need to strengthen the depth of analysis, expand data sources, and consider changes in the market environment to better reflect the phenomena that have occurred. (Wang, 2019, p. 257)

2. Design of STM32-based smart door lock controller

Yang, Liu and Song (2018, pp. 61-64) published a paper titled "Design of an STM32-based Smart Door Lock Control Unit" in the journal Computer Knowledge and Technology. The paper presents a detailed overview of the hardware architecture design, software module division, and implementation of the STM32 microcontroller-based smart door lock control unit.

The hardware components primarily consist of the STM32 microcontroller (model: STM32F103RCT6), keypad input module, LCD display, and recognition module. The keypad input module enables human-computer interaction using matrix keys and transmits user's password input to the STM32 microcontroller for processing. The LCD display is utilized for showing door lock status and providing prompt information, thereby enhancing user experience. The recognition module can incorporate either an RFID module or a fingerprint identification module to enable non-physical key unlocking operations.

In terms of software, the Keil C51 compiler is employed to write the program code for the STM32 microcontroller. Additionally, a real-time operating system (RTOS) is implemented to enhance the stability and reliability of the door lock system. The software of this door lock system encompasses various functions such as task management, event drivers, and resource management. These functions collectively provide a robust development framework and a secure runtime environment for the entire door lock system.

Please note that the accuracy of the citation information provided above is contingent upon the availability and correctness of the referenced publication.

Besides, the communication process and data interaction of this door lock system are mainly sent and received through serial port and wireless module. In terms of door lock control, various methods such as timer interrupt, external interrupt and state machine are used to improve the security and stability of the door lock.

Finally, through the experimental results, the STM32-based smart door lock controller is proved to have the advantages of safety, stability and reliability, and its performance and functions are analyzed and summarized in detail.

The design of STM32-based smart door lock control unit focuses on the hardware and software design and data communication method of the door lock system built based on STM32 microcontroller, and verifies the feasibility and

practicality of the door lock system through experiments. This technical solution and idea can serve as a reference for the smart home field (Yang, et al., 2018, pp. 61-64).

3. Smart door lock industry chain management model

The smart door lock industry chain is a complex industrial ecosystem. It includes multiple participants, such as door lock manufacturers, material suppliers, chip manufacturers, smart chip design solution providers, smart platform services, and management parties.

Wang, et al. (2018, pp. 64-67) published a study titled "Talking about quality management in the smart door lock industry chain" in the Journal of East China Normal University, which concluded that the management model of the smart door lock industry chain should adopt the model of brand manufacturer quality management, that is, the quality responsibility should be in the hands of the brand manufacturer, and the principle of integration should be adopted to save costs.

Chen, et al. (2019, pp, 62-64) published an article entitled "Research on the transparency of the smart door lock industry chain based on the perspective of industry chain management" in China Logistics and Purchasing, which pointed out that there is a lack of transparency in the domestic smart door lock industry chain at present, and proposed to increase the disclosure of information, increase the disclosure information of each link of the industry chain, and improve the transparency of the industry chain.

4. Problems and Countermeasures Faced by Smart Door Lock Enterprises

Liu and Jin (2021, pp. 30-32) published the article "Problems and Countermeasures Faced by Smart Door Lock Enterprises" in the Internet of Things World. The article analyzes the problems faced by smart door lock enterprises and their solution strategies by combining the characteristics and current situation of the smart door lock market.

First, smart door lock enterprises need to pay attention to user needs in product design, and adjust design concepts in a timely manner according to market feedback to improve product competitiveness. Second, technological innovation is an important means for enterprises to win the market, enterprises should strengthen investment in research and development, constantly improve the level of technology, and constantly launch new products. At the same time, brand promotion is also an important part of the development of intelligent door lock enterprises, enterprises need to strengthen brand marketing and publicity to expand market influence. In addition, the intelligent door lock market competition is fierce,

enterprises should make strategic adjustments in price, product differentiation and other aspects to improve market share.

In response to the above problems and solution strategies, the following practical measures are proposed: First, enterprises should strengthen market research to understand the market demand and the market situation of competitors, and accordingly carry out product design and technological innovation. Second, in terms of brand promotion, enterprises can use various marketing tools, such as building high-quality brands, social media marketing, online and offline interaction, etc., to improve brand awareness and reputation. Finally, in the face of competitive market pressure, enterprises can enhance product competitiveness and market share by strengthening supply chain management, optimizing product cost structure, and strengthening channel cooperation.

In general, the smart door lock market has a certain development potential, but at the same time there are many problems and challenges. Smart door lock enterprises need to optimize their operation and business strategies according to the market situation and competitive environment, in order to achieve higher market share and long-term stable development.

5. China Smart Door Lock Industry Report

The "China Smart Door Lock Industry Report", published in 2022, provides a more comprehensive analysis and study of the smart door lock industry, the current situation and future trends of the smart door lock industry in China, and summarize the challenges and opportunities faced by enterprises (RUNTO, 2022).

5.1 Industry Status

At present, several major brands have emerged in the smart door lock market, which also includes a number of small enterprises and emerging brands. The development of the smart door lock market can be divided into the following stages: Initial period (2010-2014): the market is small, brands are few, and product features are not perfect.

Development period (2014-2019): the market gradually expanded, brands began to appear, product features continued to improve, and the industry began to mature.

Mature period (2020-present): the market is gradually saturated, competition intensifies, and brand promotion and after-sales service become the focus of enterprises.

5.2 Future Trends (RUNTO, 2022)

In the future, the smart door lock market will show the following trends:

1) Integrated development: smart door locks will develop in the direction of more intelligent and integrated, to achieve linkage and interaction with other smart home devices.

2) Product quality: due to the increasing consumer demand for security and reliability of smart door locks, enterprises will continue to improve product quality and performance.

3) Brand promotion importance: enterprises need to pay more attention to brand promotion, enhance brand awareness and image.

4) In-depth market research: in the face of increased market competition, enterprises need to deepen their understanding of consumer demand and market changes, and constantly adjust and update their products according to market demand.

5.3 Challenges and Opportunities for Enterprises (RUNTO, 2022)

1) Challenges: Insufficient technological innovation in smart door lock products, limited research and development capabilities, severe product homogenization, and fierce competition.

2) Opportunity: With the continuous improvement of technology and changing market demand, enterprises have the opportunity to continuously improve brand promotion, market research and after-sales service, so as to enhance product quality, competitiveness and consumer trust.

5.4 Suggestions for enterprise countermeasures (RUNTO, 2022)

1) Supply chain management: rational planning of industrial chain, optimization of supplier selection, and improvement of product quality and performance.

2) Brand promotion: focus on brand building, deepen consumer demand and market changes, and improve brand awareness and image.

3) Market research: deep understanding of market demand and consumer behavior, adjust and update products according to market changes.

4) After-sales service: focus on the quality of after-sales service to improve consumers' shopping experience and satisfaction.