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Research on Supply Chain Finance and Modern Business Model Based on Internet of Things Security

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Abstract: *At present, the world economic competition is increasingly fierce. The economy plays an important role in promoting economic growth. The economy has entered a new stage of development and is facing many new situations and challenges. Wireless communication technology has been widely used in the Supply Chain (SC). Wireless communication technology has greatly improved the SC. This paper first expounded the basic concepts of Internet of Things (IoT), SC finance and modern business model, and briefly analyzed the problems of SC finance and business model under IoT. It thought about improving the development advantages and problems of SC finance and modern business model under IoT, and proposed effective solutions to problems. Fuzzy evaluation algorithm was used in the research and design of SC finance and modern business model. Finally, through investigation and experiment, the fuzzy evaluation algorithm was applied to the SC and finance to reduce the risk factors by 34%.*

Keywords: *Supply Chain Finance, Modern Business Model, Internet of Things Security, Wireless Communication*

1. Introduction

Wireless communication technology is an important technology rising in the middle and late 20th century. Its appearance has changed the original information transmission and processing methods. By improving the efficiency of information transmission, it also affects today's development and life. With the development of network technology, logistics management and quality tracking provide more convenient technical means. SC finance also brings opportunities and challenges to the development of modern financial industry. How to better serve the financial field with IoT technology is a common concern at present.

Research, development, application, promotion, and popularization of IoT technology have led to profound technological and scientific changes and spawned emerging strategic industries. The business model based on IoT technology is central to the development of the IoT industry. Du Mingxiao developed a new supply chain platform using blockchain for management [1]. Olan Femi explored supply chain network and financing theories, established a conceptual framework, and demonstrated through computational experiments that AI-driven supply chain networks provide sustainable financing flows for the food and beverage supply chain [2]. Caniato Federico managed funds from the perspective of the supply chain and proposed solutions for procurement and supply management [3]. Li Jian developed a three-layer supply chain model and used game theory to compare how blockchain financing schemes affect risk mitigation in financially constrained supply chains [4]. Martin Judith designed an exploratory multi-case study to explain the background of supply chain finance practices based on emergency response methods [5]. Geldomino Luca Mattia investigated the benefits buyers can achieve by providing solutions to suppliers, with experimental results showing that working capital requirements and financial costs are key parameters in evaluating the benefits of multiple supply chain financial plans [6]. Additionally, Geldomino Luca Mattia provided feasible revenue solutions, indicating that financial cost is a crucial parameter for adopting supply chain finance benefits [7]. Although these discussions on supply chain finance are relatively comprehensive, they do not address modern business models.

Business model is the way in which an enterprise or enterprise makes profits. Miah Shah J's research outlined that industry demand was the driving force to promote new business data analysis courses, and used open interviews with senior data analysis professionals to find new industry expectation matrix [8]. Rahman K Sabeel discussed the changing nature of capitalism and focused on the political alliances and institutional conditions to support and maintain capitalism, which

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emphasized the political forces to promote the transformation of merged companies [9]. Gil-Gomez Hermenegildo designed a modern production organization method, which involved multi-level distributed SC and included professional contract services and production [10]. Popelo Olha Maksym Dubyna revealed the essence and characteristics of the concept of financial innovation and analyzed the innovation model of banking business development [11]. Tan David studied possible forms of business partnership and cited specific examples of different enterprises in various countries, which made a comparative analysis of the application of foreign enterprises operating [12]. Kalantonis Petros studied whether corporate governance reports affected accounting information and investigated the impact of corporate governance information on financial reports [13]. Anderson Patrick L compared the predictive power of traditional and modern business decision-making methods. By using natural experiments and extensive data, it was observed that machine learning models performed poorly [14]. The above research has a more specific interpretation of the business model, but it is not related to IoT.

IoT can effectively help financial service enterprises and customers to track transactions and revenues related to regulated financial service products in a timely manner. From the current trend, IoT often plays a positive role in the field of SC financial services, but this does not mean that there are no risks in the future development. Only through IoT's own characteristics and the nature of SC finance as well as reducing risks can there be more development opportunities in the future.

2. Basic Concepts of IoT Security, Supply Chain Finance and Modern Business Model

2.1. IoT Safety Overview

The Internet of Things (IoT) is a crucial component of the new generation of information technology, marking a significant phase in the information age. Through communication methods, global positioning systems, laser scanning, radio frequency identification technology, and network systems, IoT enables real-time tracking and management of product information. With technological advancements, information security technologies have also evolved, including identity authentication, access control, data encryption, digital signatures, intrusion detection, and content verification. Identity authentication is used to identify visitors and confirm their access rights [15], thereby protecting system and data security. Access control restricts access to information or functions based on user identity and group membership [16-17], and is categorized into discretionary access control and mandatory access control. Before the advent of computers, information security mainly relied on privacy protection, with cryptography as its core. Modern information security encompasses not only computer system security but also the security of extensive information systems formed by the integration of computer and network systems (as shown in Figure 1).

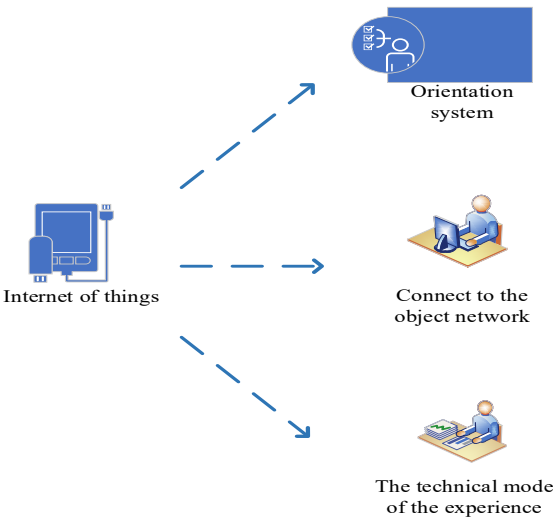

Figure 1: An IoT security overview

2.2. Overview of SC Finance

The role of small and medium-sized enterprises (SMEs) in the economy cannot be underestimated. In the supply chain product design process, the participation of enterprises is crucial. Large enterprises

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play a key role in the supply chain, ensuring the stability and development of information and logistics. In contrast, small enterprises are at a relative disadvantage. However, the development of supply chain finance allows large enterprises to collaborate with SMEs, providing personalized financial support and logistics services for specific stages or the entire supply chain. By identifying risks beyond the control of individual enterprises and their impact on the entire value chain, different types of information can be obtained, enabling the development of more scientific financial solutions for collaborative enterprises within the value chain.

2.3. Overview of Modern Business Model

Business model refers to the way in which an enterprise or enterprise obtains profits [18-19]. 1) Strategic positioning of the market: Strategic positioning means that the enterprise creates a unique and impressive product image according to the direction of the competitive market, and vividly conveys it to customers according to the consumers' attention to the specific features or characteristics of the product. Therefore, the product should be accurately positioned in the market. 2) Regional positioning: This means that enterprises must create market space for their products when implementing marketing strategies. In other words, the marketing plan can be formulated only when it is determined whether the product is oriented to the international market, Chinese market, specific market, etc. 3) Stratum positioning: The society is composed of many social strata with different consumption characteristics and needs. According to different social needs, consumers can be divided into different grades. For example, according to their knowledge level, they have high, medium and low knowledge levels. Class orientation aims to grasp the specific characteristics of the needs of specific groups and meet the needs of different levels of marketing. 4) Personal positioning: This is to consider how to sell the enterprise's products to people with specific personalities. People with the same personality orientation as the target are selected. According to their preferences, the implementation of marketing strategies can provide the best marketing results. 5) Age orientation: When formulating marketing strategies, the enterprise should also consider the target age of sales. People of all ages have their own needs. Only by fully considering these characteristics and meeting the needs of different consumers can they enjoy their preferences.

3. Problems in SC Finance and Business Model under IoT

3.1. Problems in SC Finance under IoT

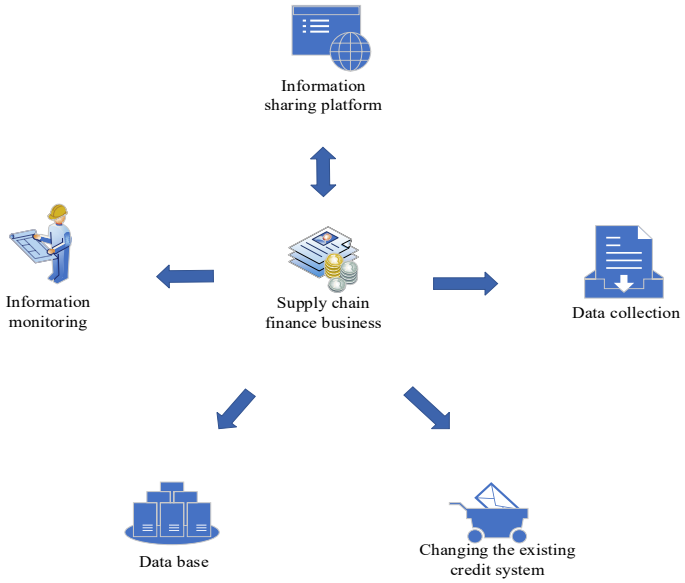

Figure 2: Problems existing in SC finance under the Internet of Things

The use of IoT technology in supply chain finance can reduce the risks associated with traditional supply chains [20]. While IoT facilitates data collection and monitoring through information systems, it also introduces risks related to internet connectivity. Firstly, there is the risk of data security and personal information leakage: IoT technology allows supply chain companies to consolidate

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information, potentially turning some into data oligarchs and putting personal information on information-sharing platforms at risk. Secondly, there is the issue of data variability: IoT applications provide quantitative information about people and objects in digital form and input large volumes of data into databases. IoT technology transforms the traditional credit system by establishing an objective credit system, integrating finance, information, and physical flow (as shown in Figure 2). This not only reduces credit risks for upstream and downstream companies in the value chain to some extent but also alleviates credit issues for some small and medium-sized enterprises.

3.2. Problems Existing in the Business Model under IoT Security

Currently, the IoT industry is still in its early stages and faces challenges such as unstable business models, lack of standardized frameworks, and inadequate resource allocation. These issues result in industry disorganization, significant waste, and hinder rapid development. As IoT grows, data volumes increase rapidly, and the demand for higher computing power rises, making existing devices insufficient. While new computing models like cloud computing and big data can meet hardware needs, they may lead to a loss of data control. Therefore, data security and protection technologies are crucial, especially in handling encrypted data. IoT security must focus on privacy protection, data integrity, and preventing unauthorized access.

4. Development Advantages and Problems Improvement of SC Finance and Modern Business Model under IoT

4.1. Scope of SC Financial Services and Cost Control As Well As Credit risk Advantages under IoT

In terms of the coverage of supply chain finance, existing models, while encompassing upstream and downstream enterprises, tend to focus mainly on large clients, presenting certain limitations. With the support of IoT technology, companies can achieve cross-border development, optimize resource allocation, and enhance information sharing, thereby expanding market opportunities for supply chain finance services. The new model improves efficiency and reduces risk by lowering the cost of information acquisition and saving human resources. Traditional financial institutions typically assess credit risk by reviewing transaction scale, financial statements, and guarantees. However, dynamic changes in information make it challenging to evaluate the risk of each business order. The application of IoT can dynamically monitor enterprises and capture the latest developments, enabling more accurate calculation of credit limits and reducing credit risk.

4.2. Deepening of Liquidity Risk Control Capability

Commercial banks should strengthen risk management and liquidity control by systematically analyzing liquidity data. Risk sensitivity should be reduced, risk-sharing mechanisms should be established, and liquidity control systems and internal performance controls should be improved. Effective fund control is necessary to ensure the sustainable development of the debt structure and to prevent excessive financing. Asset disclosure management should be established and improved to enhance the skills of professionals and provide more accurate and complex investment decisions, as shown in Figure 3.

Figure 3: Deepening the ability to control liquidity risk issues

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4.3. Strengthen the Development Strategy Improvement of IoT Security Business Model

Currently, the development of IoT technology faces challenges, including unclear network platform operations, insufficient applicability of business models, and a lack of effective management tools. To advance communication technology-based business models, it is necessary to optimize communication networks, improve service quality, strengthen the value chain, and promote synchronization between terminals and networks. The government should support the establishment of business platforms, advance IoT security standardization, and master new technologies to enhance development potential. Hardware security should be improved to protect information storage and transmission devices and prevent damage to network equipment and storage media. Software security requires that operating systems and applications do not compromise network systems and prevent illegal operations. Systems should provide accurate services, detect anomalies promptly, monitor device status, and ensure data security during storage, processing, and transmission.

4.4. Application of Wireless Communication Technology in SC

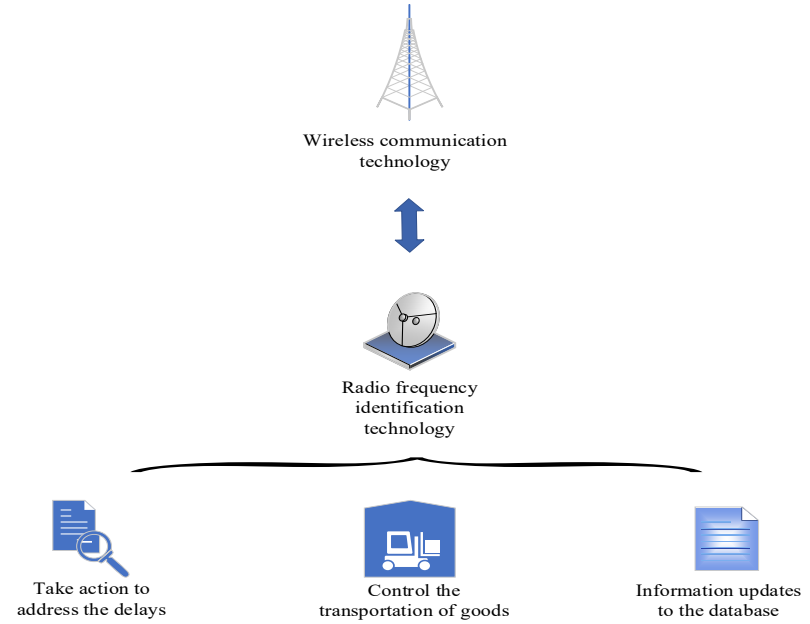

Figure 4: Application of wireless communication technology in the SC

Wireless communication technology has been widely applied in supply chains, significantly enhancing supply chain management. Each stage of supply chain management is dynamic and decentralized, with actual activities affecting the availability, timeliness, and accuracy of information. Radio Frequency Identification (RFID) technology and satellite communication applications effectively address these issues. The workflow is shown in Figure 4.

5. Application of Fuzzy Evaluation Algorithm in SC Finance

Fuzzy evaluation is used to describe the state of different nodes, and fuzzy sets are used to describe the relationships between functional variables.

Let P be an independent node. It is assumed that the state vector of node P is as follows:

$$Px = [px_1, px_2, ..., px_m]^n \tag{1}$$

Among them, $px_1, px_2, ..., px_m$ is a fuzzy set defined by vocabulary.

The frequency vector of independent node P is as follows:

$$fp = [fp_1, fp_2, ..., fp_m]^n \tag{2}$$

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Among them, $fp_1, fp_2, ..., fp_m$ is the frequency ambiguity set corresponding to each possible state in the frequency vector of node P.

The frequency matrix of independent node P is as follows:

$$Fp = (fp_1 \cdot fp_1) \cup (fp_2 \cdot fp_2) \cup ...u(fp_n \cdot fp_n) \tag{3}$$

If P is composed of m random nodes $y_1, y_2, y_3, ..., y_m$ as the immediately preceding node, and FXP represents the combination of all the immediately preceding node matrices of node p. The formula is as follows:

$$FXP = FY_1 \cup FY_2 \cup ...FY_m \tag{4}$$

If the definition GXY_1 represents the fuzzy relationship between nodes y_1 and p, the formula is as follows:

$$GXY_1 = (p_{y_{11}} \cdot p_q) \cup (p_{y12} \cdot p_q) \cup ... \cup (p_{y1n} \cdot p_q) \tag{5}$$

The frequency matrix of node P is a composite operation of fuzzy sets FXP and GXY:

$$F_P = F_{XP} \cdot R_{XP} \tag{6}$$

Finally, the membership degree of the random results of the frequency matrix F_P of the nodes is calculated to generate the risk probability distribution. The probability function of the random result is as follows:

$$F(P_i) = \frac{ux_i}{\sum_p ux_i} \tag{7}$$

6. Evaluation of the Practical Application and Experimental Results of the Combined Fuzzy Evaluation Algorithm

To investigate the current application of supply chain finance in more detail, a survey was conducted with 200 employees from Companies A, B, C, and D. The results are shown in Table 1.

Table 1: Application evaluation of SC finance by enterprise employees

	Data security	Personal information security	Data differentiation
A	62%	52%	48%
B	47%	63%	38%
C	58%	39%	51%
D	39%	32%	64%

As shown in Table 1, 62% of employees at Company A experienced data security issues in the current supply chain finance, 52% faced personal information security issues, and 48% encountered data differentiation problems. At Company B, data security issues were reported by 47%, personal information security issues by 63%, and data differentiation issues by 38%. Company C had 58% of employees reporting data security issues, 39% facing personal information security issues, and 51% experiencing data differentiation problems. At Company D, 39% of employees encountered data security issues, 32% had personal information security concerns, and 64% faced data differentiation problems.

To identify the shortcomings of traditional business models, a survey was conducted with employees from Companies A, B, C, and D, with a sample size of 400. The results are shown in Figure 5.

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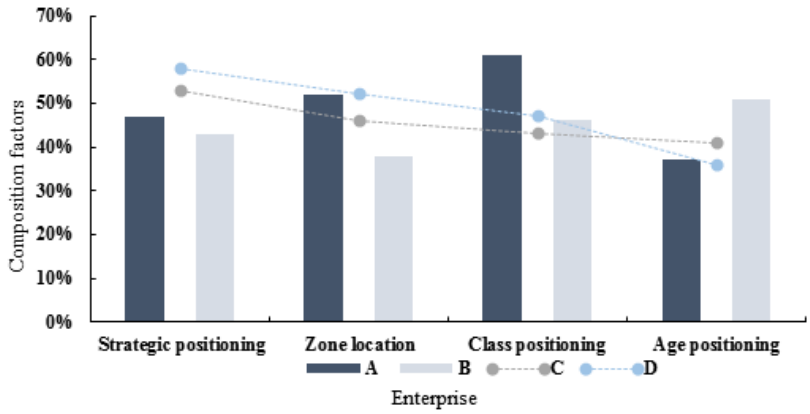

Figure 5: The direction that employees need to improve in their traditional business model

As shown in Figure 5, among the four surveyed companies, the issue identification rates for strategic positioning, regional positioning, category positioning, and age positioning for employees at Company A were 47%, 52%, 61%, and 37%, respectively; for Company B, the rates were 43%, 38%, 46%, and 51%; for Company C, the rates were 53%, 46%, 43%, and 41%; and for Company D, the rates were 58%, 52%, 47%, and 36%.

A sample survey of 200 employees from the four companies showed that the new system has made improvements in data security, personal information security, and data differentiation, as shown in Figure 6.

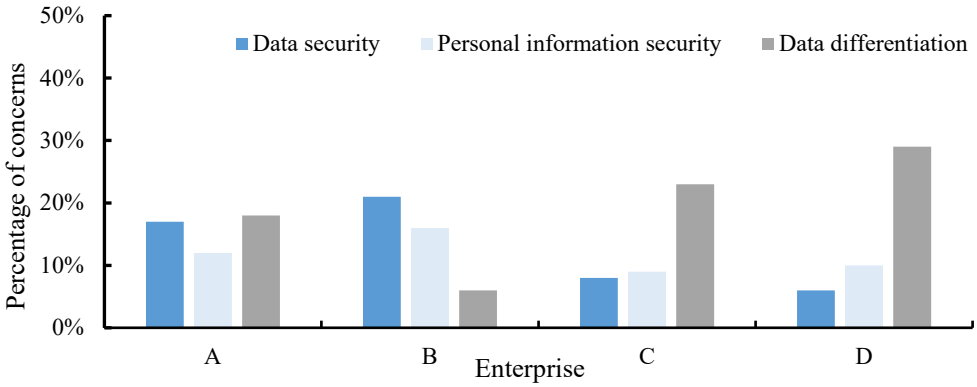

Figure 6: Evaluation the improvement effect of the new SC finance system

As shown in Figure 6, employee concerns about data security, personal information security, and data differentiation in the new supply chain finance system have significantly decreased across four companies. Specifically, at Company A, data security concerns are at 17%, personal information security at 12%, and data differentiation at 18%; at Company B, data security concerns are at 21%, personal information security at 16%, and data differentiation at 6%; at Company C, data security concerns are at 8%, personal information security at 9%, and data differentiation at 23%; and at Company D, data security concerns are at 6%, personal information security at 10%, and data differentiation at 29%. Concerns about these issues in the traditional system were at 49%, which dropped to 15% after the introduction of fuzzy evaluation algorithms, reducing risk factors by 34%. The Internet of Things enhances the efficiency and cost-effectiveness of production factors and value chains through advanced technology.

A satisfaction survey of 200 employees shows their opinions on traditional and new business models, as depicted in Figure 7.

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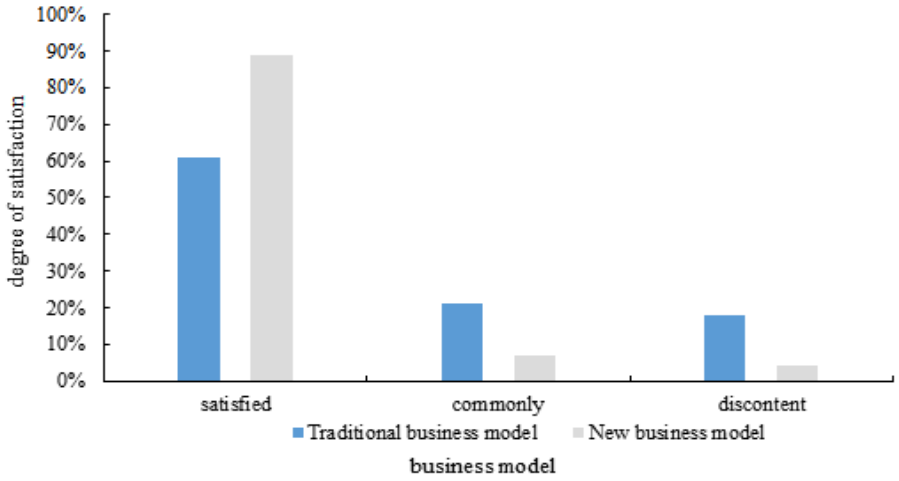

Figure 7: The satisfaction of the enterprise employees with the traditional business model and the new business model

It can be seen from the histogram in Figure 7 that the satisfaction of both business models presents different states. Compared with the two business models, the satisfaction of the traditional business model is 61%; the general proportion is 21%; the dissatisfied proportion is 18%. The satisfaction rate of the new business model is 89%; the general rate is 7%; the dissatisfied rate is 4%.

7. Conclusions

With the development of information technology, SC finance has become the innovation economy and financial innovation carrier of related entities, which provides new opportunities for financial services to the real economy. In the future, the competition in the global economy would no longer be between individual enterprises but between SC. Therefore, SC finance is becoming more and more important. The development of all sectors requires a multi-stage approach in order to eventually embark on the path of sustainable development, and SC finance is no exception. Due to the particularity of the financial system, Internet finance is growing rapidly, but its own risks and the transformation and diversification of its models deserve in-depth study.

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