THE SIGNIFICANCE AND IMPACT OF DIGITAL TRANSFORMATION ON TOBACCO SUPPLY CHAIN PROCUREMENT IN CHINA: AN EMPIRICAL STUDY

By

Mr. Ziran QU

A Thesis Submitted in Partial Fulfillment of the Requirements

for Master of Engineering ENGINEERING MANAGEMENT

Department of INDUSTRIAL ENGINEERING AND MANAGEMENT

Silpakorn University

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By	Mr. Ziran QU
Field of Study	ENGINEERING MANAGEMENT
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This research aims to understand and quantify the impact of digital transformation on tobacco supply chain procurement in China. An empirical study is conducted focusing on Yuxi Zhongyan Tobacco Seed Co., Ltd as a case study. The significance and objectives of the research are presented first. Then a literature review synthesizes previous studies on supply chain procurement evaluation, logistics and supply chain performance, digital empowerment, and tobacco industry digital transformation. Next, the methodology based on the Greyscale Evaluation method and Fuzzy Analytical Hierarchy Process is detailed, including designing the evaluation indicator system, determining weights, and establishing the performance model. Data analysis provides results on the differences in supply chain performance across cities and enlightenment for management practices. Finally, conclusions summarize the influence of digital transformation on flexibility, efficiency, costs, competitive advantage, and strategic leverage. The research contributes an assessment framework and implications to guide the digital upgrade of tobacco supply chains in China.

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CHAPTER 1

INTRODUCTION

1.1 Background of the Research

The essence of digitalization is to transform information into data to realize reasonable and efficient arrangements, management, and distribution of physical elements. In today's economic development, informatization has become an indispensable and important part, and with the continuous emergence of high-tech products such as Internet technology and network technology, traditional industries have also begun to transform into intelligent manufacturing, so the digital transformation is an inevitable trend. Historically, information technology facilitated process automation, design automation, and production automation. However, by merging data-driven industrial models with knowledge, we can achieve a complete enhancement of dynamic perception capabilities, make swift and decisive decisions, achieve global intelligence, and ultimately utilize resources to their fullest potential. The optimal configuration and intelligent adaptation of supply to demand of course, this is an ideal state, and it will be a long-term process. The digital economy can not only bring huge benefits to society but also promote the improvement of people's quality of life and achieve sustainable development. Establishing a comprehensive system to aid in the growth of the entire industry is the aim of the digital industry chain.

In the context of the digital economy era, the traditional supply chain has been unable to keep up with the current fierce market competition, and with the development of Internet technology and the popularization of mobile terminal equipment, enterprises have become more demanding of digitalization, and enterprises need to improve their businesses more effectively. The efficiency of internal resource allocation to maintain more competitive advantages in the market and the digital upgrade and transformation of the supply chain have also become important trends in the development of enterprises. After realizing the connection, the reconstruction of the supply chain management system mainly lies in reforming the

upstream and downstream work of the enterprise's internal research and development, production, operation, financial management, and other procurement.

With the acceleration of Internet technology and economic globalization and the advent of the era of big data, how to effectively use digital technology to carry out product innovation, improve product quality, and enhance competitiveness is currently a key issue studied by scholars at home and abroad. The theory of supply chain management has the application of information technology, that is, the electronic system based on computer network technology. Using the network platform allows individuals to access relevant business processes and operations in real-time, improving efficiency and convenience. This method can help enterprises reduce costs, increase profit margins, and at the same time ensure the smooth development of various business activities.

Digital transformation is intended to enable the supply chain of enterprises to have a sustainable competitive advantage (Alabdali & Salam, 2022) This is to integrate multiple links in the supply chain business process under the influence of new-generation information technologies such as the Internet, big data, and cloud computing together, through cross-departmental and cross-regional data collection, analysis, and processing, to support business operations. Through digital procurement supply chain management, enterprises can realize the information management, supervision, and control of the whole process of procurement business, thereby improving the overall operational efficiency of the entire supply chain, reducing costs, improving efficiency, and then enhancing the market competitiveness of enterprises, both internally and externally. The digital analysis of the enterprise supply chain can improve the performance of the enterprise supply chain and, at the same time, adjust the digital procurement to have stronger competitiveness (Hallikas et al., 2021). The digital transformation of enterprises requires all-around changes, such as technological innovation, business concepts, strategic planning, organizational structure, production, and operation.

Now, more companies use digital procurement supply chains to expand market space, promote enterprises, and improve product quality. To cope with the interference of useless digital information and data in decision-making, companies

find that they need to carry out a digital transformation to create big digital technologies that are more suitable for their own business needs, which are even more imperative for China's tobacco supply chain. China's tobacco industry is experiencing rapid growth. Now, there are tens of millions of smokers and retailers. Procurement needs vary widely across regions. At the same time, economic globalization has brought huge challenges and opportunities, especially in recent years, a large number of large state-owned enterprises at home and abroad have poured into international competition, which has caused the traditional procurement supply chain operation of the tobacco industry to be unable to cope with and solve the problems of low efficiency and unified management of the tobacco industry. The advantage of the digital procurement supply chain is that it can reduce costs and increase efficiency, and at the same time, through more upgrades and transformations, it can form a more intelligent, e-commerce-based, and information-based digital procurement platform. This kind of integration of tobacco production, marketing, finance, warehousing, and distribution, opening up the information flow within the enterprise, and forming a more effective supply chain set, is more determined for the tobacco industry to carry out digital transformation. In the process of digital transformation, enterprises may ignore the "de-intermediation" of internal management, resulting in information silos and information barriers under information asymmetry and even affecting internal supply chains that cannot become integrated and lean. To facilitate the digital transformation of the tobacco industry, it is necessary to have a digital economy and access to data resources.

1.2 Objectives of the Research

China's tobacco industry has a complete system and rich digital application scenarios. The main purpose of this study is to analyze the influence of digital transformation on the tobacco industry through examples.

Goal 1: To propose the digital transformation implementation plan and construction system.

Goal 2: To study the application performance and the roles of digital transformation

1.3 Scope and Limitations

The scope of this study is to conduct a data survey of the digital transformation of the purchasing department of Yuxi Zhongyan Tobacco Seed Co., Ltd., quantitatively analyze the collected information and data, and conduct a comparative and inductive analysis before the digital transformation is implemented to better discover the impact of the digital transformation on tobacco.

The research data is the internal information data of the company, which may be easily distorted due to other influences, and it is impossible to target a single individual when setting variables because of ignoring departmental differences during the investigation.

1.4 China's Tobacco Industry and Yuxi Zhongyan Tobacco Seed Co., Ltd.

China has one of the largest tobacco industries in the world, with the sector playing a significant role in the country's economy. With rapid growth, tens of millions of smokers, and retailers, the industry has a vast scale and complex structure. The recent trends in the industry indicate a shift towards digitalization and modernization of procurement and supply chain processes.

One of the key players in this industry is the Yuxi Zhongyan Tobacco Seed Co., Ltd. (hereinafter referred to as the Yuxi Tobacco Seed Company), a professional tobacco seed enterprise established in August 2001 with the joint investment of China Tobacco Corporation, Yunnan Provincial Tobacco Corporation, Yunnan Tobacco Agricultural Research Institute, and the Tobacco Research Institute of the Chinese Academy of Agricultural Sciences. The Tobacco Seed Company is committed to the industrialization and marketization of seeds, improving tobacco seed quality, standardizing tobacco seed management, and serving the national tobacco leaf production and cigarette industry.

The primary responsibilities of the Tobacco Seed Company include breeding high-quality tobacco seeds, coating and processing these seeds, and their sale. They work closely with the National Bureau and various provincial bureaus to standardize tobacco seed management. The company also engages in the introduction, demonstration, promotion, preservation, and development of superior domestic and

foreign tobacco varieties. Additionally, the Tobacco Seed Company undertakes technical exchanges and collaborations with domestic and foreign tobacco seed enterprises and research institutions, driving progress in seed technology.

Operating under a board of directors, the Tobacco Seed Company has made significant strides over the past 20 years. It has been able to grow its market share from 15% at the time of its inception to a staggering 86% today, supplying over 130 million bags of coated seeds and 2800 kg of raw seeds, covering a planting area of over 150 million acres. The company has also made considerable contributions to the national treasury, paying over 60 million Yuan in taxes.

As the only specialized tobacco seed company in the country, the Tobacco Seed Company adheres to the principles of Xi Jinping's new era of socialism with Chinese characteristics. It actively integrates into the national "Seed Industry Revitalization" strategy and firmly shoulders the responsibility and mission of "self-reliance and self-strengthening in seed science and technology, and self-control of seed sources."

In the coming years, the Tobacco Seed Company aims to strengthen its party building, stabilize operations, increase momentum, prevent risks, ensure safety, adhere to innovative norms, promote efficient governance, and further enhance its market consciousness, quality consciousness, and service consciousness. The company plans to continue fine-tuning its primary tobacco seed business, steadily increase its national market share, actively expand diversified operations, serve the "tobacco-grain" coordinated development strategy, and promote high-quality development of the enterprise.

In summary, the digital transformation in the tobacco industry, particularly within the Yuxi Tobacco Seed Company, presents an exciting opportunity for enhancing operational efficiency and overall performance. This study will delve into the intricacies of this transformation and its implications for the industry.

1.5 Contributions of the Research

In the current process of upgrading the tobacco industry chain, digitalization is the first key measure to bear the brunt, and more examples are needed to describe the transformation strategy, model, and path of the tobacco supply chain. This study focuses on this. Under the wave of the new era, the requirements for data innovation are creating higher management performance and higher corporate value for the tobacco industry.

CHAPTER 2
LITERATURE REVIEW

The relevant literature will be carefully reviewed. The rest of this chapter is organized as follows. Section 2.1 describes the impact of digital transformation on supply chain procurement and the profound changes brought by digital transformation to tobacco supply chain procurement. Section 2.2 describes the logistics and supply chain performance development process. This section describes the impact of digital transformation on logistics and supply chain performance and the significance of tobacco logistics and supply chain performance in digital transformation. Section 2.3 details the importance of digital empowerment in digital transformation and the impact of digital empowerment on the digital transformation of the tobacco industry. The conclusions of this chapter are found in Section 2.4.

2.1 Supply Chain Procurement Impact Evaluation

When digital transformation (DT) has an impact on supply chain procurement (SCP), in order to create enough competitive opportunities. Supply chain procurement is a very important part of supply chain management, and many scholars have conducted research on it. The existing literature on supply chain procurement is mainly reflected in the following aspects:1. The Impact of Digital Transformation on the Creation of Competitive Advantage in Supply Chain Procurement: An Empirical Study(Alabdali & Salam, 2022).Most noteworthy is Alabdali & Salam(2022) discusses the use of quantitative methods to conduct a web-based survey of supply chain (SC) professionals. An impact assessment of the conceptual model was carried out using the Smart PLS model (PLS-SEM). 2.The impact of data analysis on supply chain performance in digital procurement (Hallikas et al., 2021). Among them, Hallikas et al.(2021) puts forward a conceptual model and assumptions for empirical testing in order to study digital procurement capabilities, and uses operations as the basis for analysis. Hallikas et al.(2021) research confirms the significant link between digital procurement capabilities, data analytics capabilities, and supply chain performance. In this regard, Hallikas et al. (2021) also pointed out that the study has

some limitations. The data of the empirical research comes from a questionnaire survey, which is more difficult for the interviewed companies with low digital procurement capabilities. Business performance needs to be measured multiple times to reduce the impact of subjective bias. 3. China's digital transformation promotes high-quality development of enterprises (Tong, 2022). Tong (2022) pointed out that China Tobacco has entered a stage of high-quality development. China's tobacco industry has a complete system and rich digital application scenarios, which are the most solid basic conditions for digital transformation. The current innovation and development of tobacco digital technology mainly has the following problems: the research and development level of sensors, data analysis, model algorithms, etc. Effective sharing and interconnection has not been realized, the methods for obtaining massive data in the tobacco innovation chain and industrial chain are not perfect, and data islands still exist; The role in rich application scenarios has not been fully utilized.

Digital transformation has brought profound changes to tobacco supply chain procurement. It is mainly reflected in the following aspects:

1. Procurement methods have changed. The traditional way of purchasing is changed from face-to-face negotiation to online transaction and electronic contract, which realizes the process of purchasing without contact and automation. This not only improves procurement efficiency, but also reduces human costs and risks in the procurement process.

2. Procurement data should be digitized and transparent. The digital collection and storage of procurement data enables data to be captured and analyzed in real time, and each step of the procurement process can be accurately controlled and evaluated. This has considerably improved the standardization and scientific management level of procurement.

3. The procurement decision is accurate. With the help of big data analysis and AI technology, suppliers' historical data and market information can be thoroughly analyzed to identify potential suppliers and accurately predict the supply situation and price trend. This makes purchasing decisions from experience-dependent to data-driven, realizing more accurate and efficient.

4. The procurement organization is flat. Digital means reduce the difficulty of manual operation and coordination in the procurement process, and the level of procurement organization is gradually flattened. This not only saves intermediate links, but also makes information transmission more timely and accurate, which is conducive to rapid response to market changes.

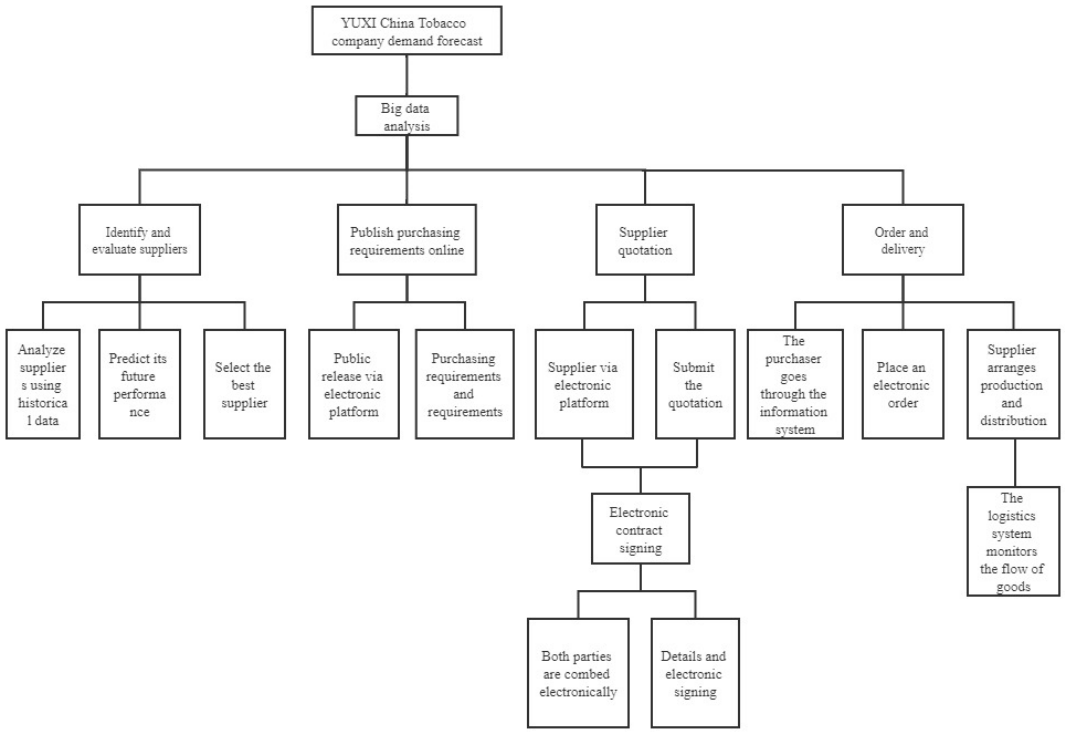

Figure 2.1 Tobacco supply chain procurement flow chart after digital transformation

2.2 Logistics and Supply Chain Performance

2.2.1 Logistics and supply chain performance synergy

Academic research and production practice generally focus on the impact of logistics on supply chain performance. After extensive empirical research and theoretical analysis, it has been found that logistics is beneficial for improving the performance level of the supply chain. Shang and Marlow (2004), Hanna and Dirk (2006), Whitten et al. (2008) analyzed the specific impact of logistics on supply chain, financial, and organizational performance at three levels. Shang and Marlow (2004) found that the development and application of IT technology have a crucial impact on logistics performance; Hanna and Dirk (2006) argue that logistics performance is

closely related to organizational coordination; Whitten et al. (2008) pointed out that scientific and effective management strategies are beneficial for improving logistics performance. Both have a positive impact on enterprise marketing and can improve financial management and financial performance. Mandal et al. (2017) and Vlachos (2016) validated through empirical research that logistics can have a beneficial impact on performance levels. Mandal et al. (2017) consider that the integration of logistics and supply chain resources can form comprehensive logistics capabilities, which can have a positive impact on supply chain performance. Vlachos (2016) analyzed and studied the impact of reverse logistics capability on performance levels. Prajogo and Olhager (2012) consider that integrating logistics resources is beneficial for promoting the improvement of supply chain performance. The level of information technology and the co construction and sharing of information can promote logistics integration. Novais et al. (2020) analyzed the promoting effect of logistics on performance in the context of rapid development of cloud technology. Based on the above literature and research materials, there are few current research results that analyze the impact of logistics on supply chain performance from the perspective of digital logistics. Digital logistics refers to the presentation and processing of information activities related to logistics objects through digital technology, utilizing virtual reality, internet, and information technology. Digital technology can maximize logistics efficiency (Popkova and Sergi, 2020). Integrating digital technology into logistics systems can significantly improve logistics performance (Bekmurzaev et al., 2020). Explored the impact of tobacco logistics on supply chain performance, and considered that digital technology can promote the improvement of logistics efficiency. Jiang and Su (2013) found that the Internet of Things is beneficial for accelerating the transformation and upgrading process of tobacco logistics, improving logistics management level, reducing operating costs, and optimizing service quality, providing theoretical reference for the analysis of this article. Chen et al. (2021) pointed out that reducing logistics transportation costs can significantly reduce the overall operating costs of the tobacco industry and promote the improvement of enterprise competitiveness. The scholar used DID (Table 2.1) and pseudo DID (Table 2.2) analysis methods to verify that developing and applying GIS/GPS (Table 2.3)

network systems is beneficial for improving enterprise service quality, improving operational efficiency, shortening delivery time, and reducing delivery costs.

Table 2.1 DID security digit identification in the tobacco industry

<table>
<tr><td colspan="2">DID: security digit identification</td></tr>
<tr><td colspan="2">The meaning of DID: Each tobacco product is assigned a unique numerical code at the time of production and stored in a database.
This code contains product information and anti-counterfeiting identification, which can realize product life cycle traceability and anti-counterfeiting.</td></tr>
<tr><td rowspan="2">DID data collection</td><td>Input product production information into database</td></tr>
<tr><td>Include raw material batch number, production date, etc</td></tr>
<tr><td rowspan="2">Shipping information registration</td><td>Record the shipping quantity, address and other information</td></tr>
<tr><td>Associate product production information</td></tr>
<tr><td rowspan="2">Sales information registration</td><td>Record payment method, purchase quantity and other information</td></tr>
<tr><td>Correlate shipping information with production information</td></tr>
<tr><td rowspan="2">Consumption information registration</td><td>Consumers verify the authenticity of products and register information</td></tr>
<tr><td>The information flows back upstream to complete the loop</td></tr>
</table>

Table 2.2 Pseudo-DID in the tobacco industry

<table>
<tr><td colspan="2">Pseudo-DID: anti-counterfeiting numbers in series</td></tr>
<tr><td colspan="2">The meaning of Pseudo DID: Add random security numbers or letters to the product in series during the production and packaging process.
These series and product attribute binding, difficult to copy, for checking the authenticity of the product.</td></tr>
<tr><td rowspan="2">Production stage</td><td>Add security numbers or letters to the product</td></tr>
<tr><td>The identity is bound to product attributes and is difficult to copy</td></tr>
<tr><td rowspan="2">Circulation stage</td><td>Circulation stage
Check that the logo matches the product</td></tr>
<tr><td>Check the database to verify the authenticity of products</td></tr>
<tr><td rowspan="2">Consumption stage</td><td>Consumers check product logos</td></tr>
<tr><td>Verify using APP or test tool</td></tr>
</table>

Table 2.3 GIS/GPS network systems in the tobacco industry

GIS/GPS network systems in the tobacco industry		
	GIS: Geographic Information System Input geospatial data into computer for storage, management, analysis, modeling and display to gain insight into geospatial information.	GPS: Global Positioning system Using satellite navigation systems to determine the precise position information of any point in space.

Table 2.3 GIS/GPS network systems in the tobacco industry (continued)

GIS/GPS network systems in the tobacco industry		
Production management	Using GIS to analyze soil, climate and other information Select the best planting site and make scientific production plan	utilize GPS for origin determination and area division Accurate management and operation
Warehouse management	Use GIS to analyze facility layout and storage network Rationally allocate storage resources and optimize storage system	Use GPS for accurate positioning and scheduling Use RFID and other technologies for automated management
Logistics distribution	Using GIS to optimize vehicle routing design Select the best transport route to improve transport efficiency	Use GPS for real-time vehicle monitoring Achieve accurate scheduling and delivery management
marketing	The distribution and characteristics of consumers are analyzed by GIS Achieve precision marketing and sales division	The distribution and characteristics of consumers are analyzed by GIS Achieve precision marketing and sales division

Table 2.3 GIS/GPS network systems in the tobacco industry (continued)

GIS/GPS network systems in the tobacco industry
Main features: 1. GIS realizes data sharing and integrated analysis, and provides insight into geospatial information to assist decision-making 2. GPS achieves accurate positioning, real-time monitoring and scheduling 3. GIS and GPS are deeply integrated to realize comprehensive spatial information collection and application 4. Digital means to improve the efficiency and management level of production, logistics and sales To sum up, the wide application of GIS/GPS will certainly improve the digital and intelligent level of tobacco industry, optimize resource allocation and management, and realize precision production and marketing, which is an important measure and trend for tobacco enterprises to achieve high-quality development.

2.2.2 The impact of digital transformation on logistics and supply chain performance

With the development of science and technology and the deepening of digital transformation, logistics and supply chain management has also ushered in digital changes. Digital transformation has brought great changes to logistics and supply chain management. The application of digital technology has improved the transparency, flexibility and synergy of logistics and supply chain, helping enterprises achieve higher operational efficiency and customer experience.

Firstly, digitisation makes logistics and supply chains more transparent. The use of various sensors, bara codes, RFID tags and positioning technologies enables the dynamic information of items to be collected and monitored in real time. Based on the Internet and cloud computing, this information can be accessed by all parties at anytime, enabling end-to-end monitoring and tracking. This considerably improves the visualization and predictability of the logistics process, which helps to find and fix problems in a timely manner.

Secondly, digitisation makes logistics and supply chains more flexible. Large data and artificial intelligence technologies can dig deep into historical data, identify patterns and trends, and make predictions and precise recommendations. This allows enterprises to quickly adjust the logistics network according to market changes and customer needs, optimize the allocation of transport capacity and distribution routes, and maximize customer needs.

Thirdly, digitization enhances the synergy of logistics and supply chain. Based on cloud computing and block chain, each participant can realize real-time sharing of information and trusted synchronization of data. This helps to improve the coordination between upstream and downstream enterprises, shorten the order turnaround time, and provide customers with more consistent service experience.

2.2.3 The significance of tobacco logistics and supply chain performance in digital transformation

Logistics and supply chain management in the tobacco industry are also being transformed with the development of digital technologies. Digital transformation is of great significance for tobacco logistics and supply chain management. It can improve efficiency, reduce cost, shorten delivery cycle and enhance customer experience, which will help tobacco companies achieve high-quality development.

Firstly, digitisation helps to improve the operational efficiency of tobacco logistics and supply chains. The use of big data, artificial intelligence and information technology can thoroughly analyze historical data, optimize logistics networks and vehicle routes, rationally allocate transport capacity, minimize empty driving and wastage, and reduce logistics costs. The use of technologies such as RFID, GPS and sensors also makes it possible to locate and monitor goods in real time, facilitating timely delivery and quality control.

Secondly, digitisation helps to reduce order turnaround time in the tobacco supply chain. Cloud computing and block chain technology realize real-time sharing of logistics information and reliable synchronization of data, which enables upstream and downstream enterprises to improve coordination and cooperation, quickly respond to customer orders, shorten the whole process cycle from order to delivery, and better meet customer needs.

Thirdly, digitization is conducive to improving the service experience of tobacco customers. With the combination of online and offline smart retail and logistics distribution, tobacco products can be customized and personalized recommendation, and customer needs can be accurately grasped. Meanwhile, real-time logistics monitoring and precise positioning also make it possible for goods to be delivered on time, which considerably enhances customer service experience.

2.3 Digital Empowerment

2.3.1 The importance of digital empowerment in digital transformation

The rapid development of the digital economy and its gradual application in various industries have opened up research on digital empowerment. Maarit's (2006) study pointed out that digital empowerment focuses on unleashing human subjectivity in development. Technology information technology enriches practical skills and innovatively participates in the network society. This process has gone through multiple stages of development, which is conducive to improving the influence of individuals in the information society. Lenka et al. (2017) classified the capabilities of digital empowerment research into three categories: intelligence, connectivity, and analysis. Sun et al. (2018) pointed out that digital empowerment is gradually developing during the rapid updating and iteration process of digital technology. Accelerate industrial transformation through digital technology and promote the improvement of production performance. Kong et al. (2019) pointed out that digital twin technology is actually a combination of various technologies such as the Internet of Things and big data. Confirmed the positive impact of digitalization on supply chain performance. Eller et al. (2020) found that digitalization can have a positive impact on financial performance by improving the level of information technology for enterprises with smaller market sizes. Abou foul et al. (2020) pointed out that the service-oriented nature of manufacturing enterprises is beneficial for improving financial performance, while digitalization promotes the service-oriented process and improves supply efficiency. Zhou et al. (2020) pointed out that achieving digital development of human resources, constructing and continuously improving management systems, can effectively improve the level of enterprise performance.

Forcadell et al. (2020) consider that the information technology environment has exacerbated the problem of information asymmetry, which is not conducive to maintaining customer interests, and has weakened the positive effect of digitalization on enterprise performance. Promoting the sustainable development of enterprises is conducive to reducing the negative impact and enabling banks to gain more benefits from Digital transformation. Loske and Klumpp (2020) pointed out that promoting enterprises to achieve Digital transformation through information technology is conducive to promoting the improvement of enterprise performance from the perspective of long-term development. Sandkuhl et al. (2019) discussed and analyzed the factors affecting the Digital transformation of enterprises, and constructed the ideas and processes of Digital transformation.

2.3.2 The implications of digital empowerment for the digital transformation of the tobacco industry

Digital authorization is an essential part of the digital transformation. It empowers the system with certain autonomous learning and decision-making ability through data and algorithms, which will have a profound impact on the digital transformation of the tobacco industry.

Firstly, digital empowerment is conducive to increased automation of tobacco production and operations. The application of artificial intelligence and machine learning technology can analyze large amounts of historical data, build predictive models, introduce automatic control systems, and realize intelligent scheduling and optimized operations of production equipment and logistics systems. This will significantly improve production efficiency and quality and reduce labor costs.

Secondly, digital empowerment facilitates the personalisation of tobacco products and services. Using large data and recommendation algorithms, we can thoroughly understand user preferences and needs, achieve user segmentation, and provide customized products and services for different user groups. This helps tobacco companies to expand market share, increase customer loyalty and corporate profits.

Thirdly, digital empowerment is conducive to optimizing the organizational structure and decision-making efficiency of tobacco enterprises. Digital licensing of

some business processes can reduce intermediate processes and flatters organizational structures. In addition, the application of large data analysis and AI-assisted decision-making technology can provide a data-driven decision-making basis and achieve more scientific and accurate decision-making. This will improve the operational efficiency and resilience of enterprises.

The increased automation, personalization and organizational optimization brought about by digital empowerment can help tobacco companies reduce costs, expand markets, optimize operations and gain a greater competitive advantage. Therefore, accelerating the process of digital authorization and widely applying modern technologies such as artificial intelligence, big data and cloud computing to production, marketing and management is an inevitable choice for tobacco enterprises to make digital transformation. This will also accelerate the tobacco industry to become intelligent and networked, which will have a broad and far-reaching impact on the social economy.

2.4 Tobacco digital transformation

At present, Yuxi Tobacco Seed Company. logistics equipment and facilities are mainly self-inspection, and the equipment control data is not effectively integrated. Dingxi Tobacco also adopts the methods of manual classification, stratification, classification and personnel inspection, which has low detection accuracy and long inspection cycle, and it is difficult to effectively meet the management requirements of "visualization, real-time, integration and automation" of logistics equipment and facilities.

Therefore, through brainstorming, our company designed and developed the status induction control system of logistics equipment, and realized the integrated management, real-time monitoring, abnormal warning and automatic startup correction of 59 equipment in sorting, warehousing, distribution, security and logistics management, which greatly improved the efficiency of logistics equipment control.

Noun explanation:

Internet of Things: The Internet of Things (IOT) refers to the real-time acquisition of any object or process that needs monitoring, connection and interaction

through various devices and technologies such as information sensors, radio frequency identification technology, global positioning system, infrared sensors, laser scanners, etc. Collect all kinds of required information such as sound, light, heat, electricity, mechanics, chemistry, biology, location, etc., and realize the universal connection between things and things and between things and people through all kinds of possible network access, so as to realize the intelligent knowledge, recognition and management of things and processes. The Internet of Things is an information carrier based on the Internet, traditional telecommunications network, etc., which enables all ordinary physical objects that can be independently addressed to form an interconnected network.

Status induction control system: It is a system to improve the level of equipment maintenance by ensuring the quality of inspection work and improving the efficiency of inspection work. Its purpose is to grasp the operating status of equipment and the changes of the surrounding environment, find out the facility defects and hidden dangers of security, and take effective measures in time to ensure the safety of equipment and system stability.

Intelligent logistics: it means to improve the ability of analysis, decision and intelligent execution of the logistics system through intelligent technologies and means such as intelligent hardware, Internet of Things and big data, so as to enhance the intelligence and automation level of the entire logistics system.

Hidden danger discovery and processing duration: indicates the average duration from the occurrence of a hidden danger to the completion of processing. Hidden danger detection and treatment

Duration = Duration from occurrence to handling of the problem

2.5 Conclusion

In chapter 2, related literature were reviewed. Firstly, the digital transformation makes the tobacco supply chain procurement show the characteristics of automation, digitalization, precision and flatness. This will considerably improve the efficiency of procurement, optimize cost control, shorten the procurement cycle, and better serve the production and operation of enterprises. Therefore, to accelerate

the process of digital transformation and widely use current technologies to transform traditional procurement patterns and processes is the only way to achieve supply chain integration and high-quality development. This will also accelerate the development of the intelligent and networked tobacco industry.

Secondly, the increased transparency of logistics and supply chains brought about by digitisation helps identify and resolve problems, preventing shortages and delays; Improved flexibility facilitates rapid response to market changes, optimized operations, and shortened delivery cycle; the improvement of collaboration is conducive to the construction of a unified and efficient logistics system to provide customers with coordinated services. After the digital transformation, logistics and supply chain show the characteristics of high intelligence and customization, which will be the direction of future development, and also the key for enterprises to win advantages in the digital competition. Digital transformation has brought profound changes to logistics and supply chain management, and is driving the transformation from traditional logistics to intelligent logistics and supply chain to digital supply chain. It will also promote the rapid upgrading of relevant industries and exert extensive and far-reaching influence on economic development and social reform. Logistics and supply chain enterprises should actively embrace digital transformation, use advanced technology Hand intelligent management and operation, and achieve integration up and down the industrial chain, which is the only way to achieve high-quality development and build a digital economy.

Thirdly, digital transformation makes tobacco logistics and supply chain management show the characteristics of automation, intelligence and refinement. This will considerably improve operational efficiency, reduce costs, shorten delivery time, enhance customer experience and create greater competitive advantages for tobacco companies. Therefore, tobacco enterprises should accelerate the pace of digital transformation, actively use current technologies to transform traditional logistics and supply chains, and realize end-to-end connection and optimization, which is the only way to achieve high-quality development. Digitization will also further promote the rapid upgrading of the tobacco industry and have a broad impact on the social economy.

Fourthly, digital empowerment is the key to achieving the digital transformation of tobacco companies. It endows the system with autonomous intelligence and learning ability, which is conducive to automatic optimization of production and operation, personalized customization of products and services, and improvement of organizational structure and decision-making efficiency. This will definitely enhance the core competitiveness of enterprises, promote the acceleration of industrial upgrading, and have a broad impact on the social economy. Therefore, accelerating the process of digital empowerment is the only way for tobacco companies to achieve high-quality development.

Finally, this chapter reviewed based on the positive impact of logistics on the performance of the supply chain, this study takes the logistics of Yuxi Tobacco Seed Company, Ltd. as an example to analyze the actual situation of the company's logistics development, screen, analyze and evaluate the variables of supply chain performance, study the role of digital logistics in improving the performance of the tobacco supply chain, and lay a theoretical foundation for promoting such companies to achieve Digital transformation. The Internet of Things technology is conducive to accelerating the process of Digital transformation of tobacco logistics, improving management level and optimizing service quality, which provides a reference for this study. That reducing logistics expenses can significantly reduce the overall operating costs of the tobacco industry.

Selecting DID and pseudo DID methods to calculate and analyze the logistics transportation information of Yuxi Tobacco Seed Company, Ltd., that building a GIS/GPS information system can significantly improve service quality, improve operational efficiency, optimize transportation routes, and significantly reduce delivery time and costs.

CHAPTER 3
RESEARCH METHODOLOGY

This chapter mainly introduces the research design and research methods of this subject. Research design can be based on research objectives.

3.1 Design and establishment of logistics supply chain index system

3.1.1 Establishment of index system

The first stage is the construction of digital index system. The quality of digital system construction will directly affect the rationality and effectiveness of supply chain performance evaluation. In order to evaluate the authenticity and validity of the results, the selection of indicators in this study is mainly based on the following principles:

(1) Specificity

When establishing the indicator system, this study refers to the concept of balanced scorecard (Bhagwat and Sharma, 2007). Therefore, the application of the concept of balanced scorecard in the evaluation indicator system emphasizes performance evaluation from multiple perspectives, which usually includes four dimensions: finance, customer, internal business process and learning and growth.

In the evaluation index system of digital tobacco supply chain, the idea of balanced scorecard can be used for reference to construct an evaluation system from multiple perspectives:

Financial perspective: Evaluate cost control effect, capital turnover, input-output ratio and other indicators, and analyze the economic benefits of supply chain.

Customer perspective: evaluate customer satisfaction, experience, participation and other indicators, and analyze the supply chain's ability to meet customer demand.

From the perspective of internal business process: evaluate procurement efficiency, production plan implementation effect, quality management level,

information process and additional indicators, and analyze the operation and management efficiency of supply chain.

From the perspective of learning and growth: evaluate talent training plan, technological innovation ability, corporate culture and other indicators, and analyze the sustainable progress and development potential of the supply chain.

A balanced and comprehensive analysis system is built by integrating four evaluation indexes. This allows digital supply chains to be evaluated from a strategic perspective, focusing not only on short-term performance, but also on long-term development, not only on operational efficiency, but also on growth drivers. This will definitely help supply chain managers to analyze the current situation more comprehensively and scientifically, find out the problems and make optimal decisions.

(2) Operability

After the establishment of the index system, it is necessary to obtain the relevant data, which may consume a lot of time and energy, as well as a lot of manpower and material resources. Therefore, in order to save resources and improve implementation efficiency, the principle of operability should be followed in the process of creating indicators, the availability of indicator data should be considered, and the selection should be made according to the existing data indicators.

(3) Evaluation dimension

Technical dimension: evaluation of the use of information system, automation equipment and technology innovation ability.

Procurement dimension: evaluate the digitalization degree of procurement mode, procurement cycle and efficiency, and supplier management level.

Production dimension: Evaluate the digitization degree of production planning and control, quality management and traceability system construction.

Warehouse dimension: Evaluate warehouse utilization, automation and information application level.

Transportation dimension: Evaluating digital capabilities of vehicle positioning and monitoring, routing optimization and capacity planning.

Data dimension: evaluate data collection range, application frequency and effect, and data security and sharing.

Organizational dimension: evaluation of personnel training mechanism, department coordination and communication, corporate culture modernity.

Customer dimension: Evaluate customer experience, relationship management and engagement.

(4) Evaluation index

Technical indicators: ERP/MES system utilization rate, automation equipment utilization rate, the number of technical improvement projects per year, etc.

Procurement indicators: online procurement quantity ratio, procurement cycle, supplier rating system, etc.

Production indicators: digital production order ratio, quality tracking system coverage, product recall rate, etc.

Storage index: storage area utilization rate, automated storage quantity ratio, inventory information update frequency, etc.

Transportation index: vehicle GPS positioning utilization rate, distribution route optimization rate, customer signature information feedback rate, etc.

Data indicators: types of data collected, frequency of data analysis, number of data application projects, input in data security, etc.

Organizational indicators: the frequency of digital literacy improvement of employees, the number of departmental collaborative projects, the number of corporate cultural activities, etc.

Customer indicators: customer satisfaction survey results, the number of customer relationship maintenance activities, the number of customer participation activities, etc.

Through regular evaluation and monitoring of the above indicators, the actual development status of digital tobacco logistics supply chain in technology, management and service can be fully understood, and problems and gaps can be found, which is conducive to subsequent optimization and improvement. This will also promote the continuous innovation and progress of the digital logistics supply chain.

To encapsulate, comprehensive and key evaluation dimensions and indicators are selected to establish a quantitative evaluation system. This is the basis for managing and developing the digital tobacco logistics supply chain to achieve efficient and intelligent operation. This will certainly push the digital logistics supply chain to a higher level of development.

3.2 The weights of digital tobacco evaluation indicators

There are two methods to determine the index weight of digital tobacco. Analytic Hierarchy Process (AHP) is a decision analysis method. AHP can decompose complex problems into hierarchical structure, the top layer is the target, and then decompose into a number of first-level indicators, and then further decompose into second-level and third-level indicators. Firstly, a hierarchical structure model is constructed to decompose the problem into a hierarchical structure and clarify each index target. Then compare the importance of judgment, experts compare the importance of each index in pairs to determine the relative importance matrix. Secondly, check the consistency and calculate the consistency ratio CR. If $CR \leq 0.1$, the consistency meets the requirements. Finally, the absolute weight of each index is calculated according to the relative importance matrix. However, considering the large number of indicators in the above index system, the use of AHP method will lead to complex consistency test procedures, large amount of calculation, large subjective influence on the decision analysis results, the weight accuracy of target results is insufficient and other problems.

Based on the above analysis, fuzzy-AHP (FAHP) method is used to determine the weight of the index system. The main steps of the FAHP method are as follows:

3.2.1 FAHP method noun explanation

Fuzzy Analytical Hierarchy Process (FAHP) (Bhagwat and Sharma, 2007) is an improvement of AHP method, considering the inaccuracy of expert judgment. Traditional AHP allows experts to judge the relative importance of indicators, using deterministic values and ignoring the subjectivity of experts. FAHP has been improved to use language variables such as "slightly important" and "very important" to more accurately express expert opinions. Then the language variables are converted into fuzzy numeric pairs for calculation.

The language variables of expert judgment are converted into fuzzy scores:

Experts use language variables such as "important" and "more important" to indicate how important indicator i is relative to indicator j. Map language variables to triples (lij, mij, uij) representing lower, most likely, and upper bounds, respectively.

Set of digital tobacco evaluation weights, such as "important" to (0.6, 0.8, 1), "more important" map to (0.2, 0.4, 0.6). Calculate fuzzy relative importance matrix: Below, expert language judgments map to triples (L=(lij), M=(mij), U=(uij)).

R = (rij) is the fuzzy relative importance matrix, where:

$$rij = \{(\frac{lij}{lji}, \frac{mij}{mji}, \frac{uij}{uji}), i \neq j (1,1,1)\ i=j\}$$

Consistency test of decision matrix:

Calculate the global Consistency Index (CI) and random consistency index (RI):

$$CI = \frac{(\lambda max - n)}{(n - 1)}$$

RI is the value in the RI table of the n-order matrix,

$$CR = \frac{CI}{RI}$$

CR = CI/RI. When CR < 0.1, the judgment is consistent.

Calculate the comprehensive weight of indicators:

$W = (w1,w2,\ldots,wn)$ T is the comprehensive weight of each index, and the calculation formula is:

$$W = \lambda max \cdot v$$

Where λmax is the eigenroot and v is the eigenvector.

3.2.2 FAHP steps to determine the index weight of digital tobacco logistics supply chain

(1) Build a hierarchy. The target is determined to be "digital tobacco logistics supply chain performance", with each level of indicators such as "cost efficiency", "delivery speed", etc.

(2) Conduct a questionnaire survey. Ask industry experts and connoisseurs for a verbal judgment on the relative importance of each level, such as "slightly important."

(3) Transform language variables into fuzzy scores. For example, "slightly important" is mapped to (0.6,0.8,1).

(4) Calculate the relative importance matrix. The relative importance of each level index is calculated according to fuzzy score.

(5) Consistency check. Calculate the consistency ratio CR. If CR>0.1, the matrix needs to be modified.

(6) Calculate the weight of each indicator. Calculate the comprehensive weight of each index layer by layer from top to bottom.

(7) Sensitivity analysis. Adjust the relative importance matrix, observe the weight changes of each index, and find out the key influencing factors.

3.2.3 Advantages of FAHP

FAHP can more accurately express the subjective judgment of experts. The relative importance of experts is reflected by using linguistic variables. Converting subjective uncertainty into computable fuzzy values, achieving the conversion of linguistic variables into fuzzy scores can realize model calculation. And, through the consistency test, the scientific nature of the results is guaranteed. At the same time, the sensitivity analysis stabilizes the results and observes the rules under different weight assignments. Finally, the software can effectively assist the calculation work of FAHP and improve the efficiency.

FAHP is more suitable than AHP for areas where experts are highly subjective, such as the digital tobacco supply chain. Considering the uncertainty of expert judgment, the results are more accurate. Through sensitivity analysis, find the key influencing factors and optimize the supply chain. The FAHP method can better solve the problem of determining the weight of digital tobacco logistics supply chain indicators. The use of linguistic variable fuzzy AHP is more in line with the subjective judgment of experts, and finally achieves better results.

3.3 Establish a digital tobacco performance evaluation model

Taking into account the multifaceted aspects and complexities of the matter at hand. Tobacco supply chain performance evaluation refers to the evaluation based on business conditions, supply chain management ability, customer service level, logistics IT application, digitalization and other aspects. Together they form part of the tobacco supply chain. At the same time, it also reflects the problems and deficiencies of the supply chain system, so as to carry out targeted improvement and optimization. Based on the main performance of tobacco evaluation index, including physical performance index, chemical performance index and sensory performance index. Second, collect and screen samples. Collect digital tobacco samples of different types and varieties to complete preliminary screening. The next step is to perform various performance tests on the sample. According to the index system, the tobacco samples were tested for physical properties (weight, structure, etc.), chemical properties (tar, nicotine content, etc.) and sensory properties (taste, fragrance, etc.). Then, the digital feature quantization model is established. According to the test results, the relevant digital feature model is established to describe each performance index quantitatively. Finally, data analysis and modeling are carried out. Using relevant data analysis methods and modeling techniques (such as Grey evaluation, linear regression, data enveloping method, etc.), the tobacco supply chain performance evaluation model was established.

At present, China's prefecture-level city tobacco supply chain research has not yet mature, unified performance evaluation model. There is no consistent expression for the hierarchy of performance evaluation indicators. Therefore, the selection of

performance evaluation indicators is frequently limited by the comprehensiveness, authenticity, and objectivity of data collection. After comprehensive consideration of supply chain performance evaluation methods such as Grey evaluation method and data envelopment method, this study chooses Grey evaluation method to build tobacco supply chain performance evaluation model.

3.3.1 Grey evaluation method

Evaluating the performance of tobacco supply chain is a complicated process, which frequently has numerous subjectivity and uncertainty. Grey correlation analysis can deal with these challenges efficiently and help evaluate and improve supply chain performance effectively.

Table 3.1 The advantage of Grey evaluation method

The advantage of Grey evaluation method to establish tobacco supply chain performance evaluation model	
In dealing with uncertain information	When collecting data about tobacco supply chain performance, there are often inaccurate and incomplete information. Grey correlation analysis can deal with such uncertain and lacking data well.
In terms of considering multiple points of view	By sending questionnaires to all sides of the supply chain and collecting opinions of different experts and decision makers, various viewpoints can be thoroughly considered, which is conducive to improving the objectivity and scientific nature of the evaluation.
Easy to quantify the factors	The importance of each factor in the overall performance is quantitatively described with a Grey scale of 1-9, and a data matrix that can provide the basis for correlation analysis is constructed.
The calculation results are accurate	Compared with the subjective evaluation method, the results of Grey correlation analysis are more accurate and objective.
The tobacco supply chain is relatively systematic and complete	According to the factor system and hierarchy structure, the scientific calculation method was used to analyze the performance and realize the systematic evaluation of tobacco supply chain.

Table 3.1 The advantage of Grey evaluation method (continued)

The advantage of Grey evaluation method to establish tobacco supply chain performance evaluation model	
Convenient guided optimization	According to the evaluation results, the score of each factor can be clearly grasped, which is conducive to putting forward improvement suggestions for the gap and guiding the optimization.
The calculation is simple and easy to implement	On the premise of collecting the necessary data, the calculation of association analysis itself is relatively simple and easy to implement.

(1) the evaluation index system selection

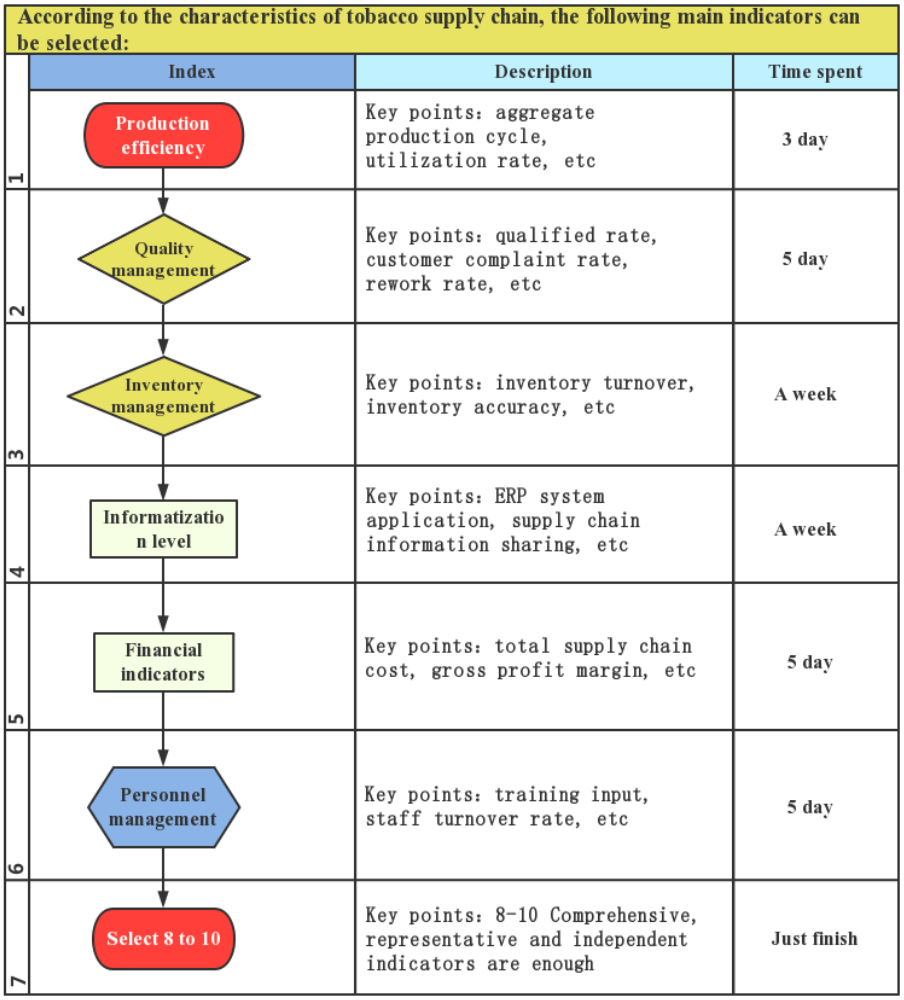

Figure 3.1 Foundation of tobacco evaluation model

According to the characteristics of the above indicators, the index grades are divided into four grades: extremely strong, extremely strong, extremely average and extremely weak. Its value is successively denoted as M5, M3, M2, and M1, and the index scores between adjacent levels are successively denoted as M3.5, M2.5, and M1.5. Four Grey categories are used in this study, and the serial numbers of the Grey categories are D5{M1, M2, M3, M4}.

1). Determine the evaluation indicators WI and XI, WI indicates the weight of indicator I, and XI indicates the value of indicator I.

Xi - Raw score for indicator i from the questionnaire. For example, if one indicator on the questionnaire is "Finance", Xi would be the respondents' raw score for the finance question.

Ui - Normalized score for indicator i, calculated as (Xi - MIN) / (MAX - MIN). This converts the raw score Xi to a 0-1 scale.

MIN - The minimum raw score observed across all questionnaire indicators.

MAX - The maximum raw score observed across all questionnaire indicators.

In summary:

Xi - Raw score for questionnaire indicator i

Ui - Normalized score for questionnaire indicator i

MIN - Minimum raw score on questionnaire

MAX - Maximum raw score on questionnaire

The indicators refer to the specific questionnaire items assessing aspects of supply chain performance like finance, logistics, customer service, etc.

2). Ask the evaluation experts to determine the unitized value Ui of the index Xi.

$$Ui = \frac{(Xi - MIN)}{(MAX - MIN)}$$

3). Calculate the Grey predicted value Gyi

$$\text{Gyi}=\frac{(\text{MIN}+\text{MAX})}{2}$$

4). Calculate the standard error Si

$$\text{Si}=\frac{(\text{MAX - MIN})}{4}$$

5). Calculate the indicator performance value Pri

$$\text{Pri}=\frac{(\text{Xi - Gyi})}{\text{Si}}$$

6). Calculate the performance index PIi

$$\text{PIi}=\frac{(\text{Pri}+\text{k})}{k}$$

k is a constant coefficient, usually between 3 and 5.

7). Calculate the comprehensive performance R

$$\text{R}=\sum \text{wi}*\text{PIi}$$

To encapsulate, the above are the main calculation formulas for constructing the performance evaluation model based on the Grey evaluation method. In this exercise, we apply the Grey Evaluation Method to a hypothetical tobacco supply chain. We assume three evaluation indicators, denoted as X1, X2, and X3. The expert-determined weights for these indicators, represented as W1, W2, and W3, are 0.5, 0.3, and 0.2 respectively. The expert-provided values for these indicators are as follows:

X1 = 80

X2 = 60

X3 = 70

The MIN and MAX values across all indicators are assumed to be 50 and 100 respectively.

Following the Grey Evaluation Method, we calculate the following values: Unitized value Ui for each index Xi:

U1 = (X1 - MIN) / (MAX - MIN) = (80-50) / (100-50) = 0.6

U2 = (X2 - MIN) / (MAX - MIN) = (60-50) / (100-50) = 0.2

U3 = (X3 - MIN) / (MAX - MIN) = (70-50) / (100-50) = 0.4

Grey predicted value Gyi:

Gyi = (MIN + MAX) / 2 = (50+100) / 2 = 75

Standard error Si:

Si = (MAX - MIN) / 4 = (100-50) / 4 = 12.5

Indicator performance value Pri:

Pr1 = (X1 - Gyi) / Si = (80-75) / 12.5 = 0.4

Pr2 = (X2 - Gyi) / Si = (60-75) / 12.5 = -1.2

Pr3 = (X3 - Gyi) / Si = (70-75) / 12.5 = -0.4

Performance index PIi (where k, a constant coefficient, is 4):

PI1 = (Pr1 + k) / k = (0.4+4) / 4 = 1.1

PI2 = (Pr2 + k) / k = (-1.2+4) / 4 = 0.7

PI3 = (Pr3 + k) / k = (-0.4+4) / 4 = 0.9

Comprehensive performance R:

$R = \Sigma wi * PIi = 0.94$

The comprehensive performance of the supply chain, as assessed using the Grey Evaluation Method, equals 0.94. This demonstrates the applicability of the Grey Evaluation Method in assessing the performance of a tobacco supply chain, providing a quantitative and robust framework for such evaluations.

It's noteworthy that this simplified example relies on a limited number of indicators and weights. Real-world scenarios may feature a more extensive array of indicators and diverse weights, leading to a more nuanced and complex evaluation. Nevertheless, the Grey Evaluation Method offers a valuable tool for navigating these complexities and delivering a reliable performance assessment.

(2) Gather different viewpoints

Collect their subjective opinions on the importance of each indicator from different parties of the supply chain through questionnaires and other means. The views of different experts, decision makers and various parties in the supply chain form heterogeneous data.

(3) Determine the importance of each indicator

We adopted the Grey scale method of 1-9 to quantitatively describe the relative importance of each indicator in the overall performance. Through comprehensive consideration of multiple information, determine the ranking order of indicators.

(4) Construct evaluation matrix

We can construct a performance evaluation matrix for each link of the supply chain and the whole according to the index system and importance degree. The matrix presents the score of each indicator and the total score of performance.

(5) Related calculation performance

By using the Grey correlation analysis method, we calculate the performance evaluation value of each link and the whole of the supply chain in various indicators and overall. The results are more precise and reliable.

(6) Optimization and blind area analysis

Finally, we analyze the evaluation results, understand the score gap distribution of each index, and find out the shortcomings and blind areas. Put forward reasonable optimization suggestions to guide the improvement and enhancement of performance.

3.4 Frameworks and tools

Developing and executing the Industry 4.0 digital transformation path is difficult. It requires companies to invest heavily in various aspects, such as research and development, consulting, cost-benefit analysis and project monitoring. In this regard, we have finally decided to effectively promote the digital transformation of

the company through the framework and tools of the system. This will not only improve the efficiency of the transformation, but also lay a good foundation for the company's future digital process.

The SIRI framework and suite of tools can give companies more confidence, reduce uncertainty, and help with next steps. It can:

1. Provide systematic guidance to reduce blindness in the transformation process.

2. Use a data-driven approach to analyze the cost-effectiveness of different digitalization options to select the best one.

Establish a monitoring system to comprehensively evaluate the progress and effect of the project and correct deviations in a timely manner.

3.5 Descriptive Statistics of Respondents

This research obtained first-hand data through questionnaire surveys and interviews. The specific descriptive statistics of respondents are as follows:

The financial indicators and performance indicators data were provided by Yunnan Tobacco Monopoly Bureau, with 1 department participating. The logistics operation indicators data were calculated by logistics professionals from 8 local tobacco companies in Yunnan Province. The improvement capability indicators data were collected via questionnaire surveys distributed to employees of tobacco companies in Yunnan Province. 20 questionnaires were distributed and 17 valid responses were received, with a response rate of 85%. The collected data went through a validation process checking for completeness, accuracy and consistency before entering statistical analysis.

In addition to quantitative data, in-depth interviews were conducted with 5 supply chain experts in the tobacco industry to gain qualitative insights into the evaluation indicators and performance.

This study adopts a mixed research methodology combining both qualitative and quantitative data from various sources. The multi-source data provides a comprehensive profile of the tobacco supply chain performance, makes the assessment more convincing, and lays the groundwork for further enhancing the evaluation model.

3.6 Conclusion

To encapsulate, the above details the main steps of establishing the tobacco supply chain performance evaluation model by using Grey correlation analysis method, including selecting index system, collecting information from multiple parties, quantitatively describing the importance degree, constructing evaluation matrix, etc., which effectively solves the problem of subjectivity and uncertainty. Finally, we can accurately calculate performance through correlation analysis and provide suggestions for fine optimization. This method can effectively improve the performance level of the tobacco supply chain.

CHAPTER 4
RESULT AND ANALYSIS

This chapter mainly introduces the results and analysis of this topic. The data analyzed are based on survey results in Yunnan.

4.1 Empirical Study on Greyscale Evaluation

4.1.1 Urban Analysis of Yunnan Province

This study aims to analyze the logistics network layout of tobacco seed suppliers in Yuxi. A well-designed network can improve efficiency, reduce costs and better serve customers. However, properly evaluating network performance is also important to ensure objectives are met.

To this end, we propose using the balanced scorecard approach. This widely-used framework measures an organization's performance from four perspectives: financial, customer, internal business processes, and learning & growth. It provides a more holistic view compared to solely focusing on financial metrics. In addition to emphasizing results and drivers, this method also emphasizes the importance of balancing financial and non-financial aspects. Firstly, the basic elements of the eight cities in Yunnan province are analyzed, and the research objective of building the optimal logistics network layout is very consistent. See Table 4.1 for details.

Table 4.1 Basic situation of each city in YunNan

City	GDP (Hundred million yuan)	Total population (ten thousand)	Land area (㎡)	Geographical position
Kunming City	7541.37	860	21012	Central Yunnan-Guizhou Plateau, northern Dianchi Basin
Qujing City	3802.20	575	28900	Eastern Yunnan
Yuxi City	2352.30	227	15000	Central Yunnan province
Baoshan City	1165.54	243	19600	Southwest Yunnan Province
Zhaotong City	1541.02	633	23000	Southwest China, northeast Yunnan
Lijiang City	570.00	125	20600	Southwest China, northwest Yunnan
Pu 'er City	945.42	237	45000	Southwest Yunnan Province
Lincang City	908.48	224	24000	Southwest China, southwest Yunnan

To implement the balanced scorecard approach, Yuxi Tobacco Seed Company. conducted an internal brainstorming session. Relevant performance factors were identified based on the four perspectives of the balanced scorecard framework and the specific context of the company's logistics network. The digitization of Information Technology (IT) represents a predominant trajectory in the future development of the tobacco supply chain. The extent of IT usage and digitization serves as an indicative measure of whether the supply chain can be improved, empowered, and upgraded to suit the requirements of the digital information age. Therefore, the degree of IT adoption and digitization plays a critical role in influencing the performance of the tobacco supply chain.

On this basis, we propose a three-tiered performance indicator system for the supply chain, as shown in Table 4.2. This system incorporates four primary indicators (financial indicators, logistics operations, customer service, and enhancement capability), seven secondary indicators, and nineteen tertiary indicators.

Within this system, financial indicators, encompassing profitability and cost, reflect the financial and operational status of the tobacco supply chain. Logistics operation indicators, including sorting and delivery, demonstrate the supply chain's logistics management capabilities. Customer service indicators primarily represent the level of service in the tobacco supply chain.

The enhancement capability indicator, which includes the degree of IT usage and digitization, reflects the specific extent of IT and digital implementation across all departments within the tobacco supply chain. The application of IT and digitization in the overall operation of the tobacco supply chain can not only provide feedback on existing issues and deficiencies but also identify avenues for optimization and refinement. Thus, the degree of IT usage and digitization, collectively referred to as enhancement capability, signifies the operational improvement ability of the tobacco supply chain.

Table 4.2 Supply chain performance evaluation indicator system

First-level indicators(4)	Second-level indicators(7)	Third-level indicators (19)
Financial	Profitability	Sales revenue Total profits Single-box logistics cost
	Cost	Logistics expense ratio Efficiency of sorting equipment
	Sorting	Per capita sorting efficiency
Logistics operation	Delivery	Per capita distribution efficiency Cigarette box recycle rate Average delivery time interval Delivery-to-home rate
	Service level	Retail customer satisfaction
Customer service	Extent of IT use	Advancement of information system IT penetration
		Accuracy of information transmission Timeliness of information transmission
Improvement ability	Digitalization level	Strategic position of digitalization Application of digital logistics equipment Digitalization application level among employees Electronic settlement rate

The balanced scorecard framework established for Yuxi Tobacco Seed Company. comprises four categories of indicators:

Financial Indicators

This category encompasses profitability and cost metrics, reflecting the overall financial and operating performance of the tobacco supply chain. Key metrics may include return on investment, profit margins, delivery costs per unit, etc.

Logistics Management Indicators

This category focuses on efficiency and includes metrics like order sorting and fulfillment time, delivery scheduling, asset utilization. It reflects the logistics management capabilities across the supply chain operations.

Customer Service Indicators

The metrics in this category center around customer satisfaction and service levels. Metrics could include on-time delivery rates, order fill rates, customer complaints, lead times, etc. This captures the customer experience aspect.

Continuous Improvement Indicators

This category looks at ways to drive future growth through innovation. Metrics involve the adoption of information technology and digital tools across different functions of the supply chain. Examples may include proportion of automated processes, percentage of digital records, number of IT projects implemented, etc. Tracking these metrics reflects the supply chain's efforts to advance through technology upgrades over time.

By measuring performance on these four dimensions, Yuxi Tobacco Seed Company, Ltd. gains a well-rounded assessment of how effectively their tobacco supply chain network is functioning to achieve both operational and strategic goals.

4.2 Fuzzy Analytic Hierarchy Process (Fuzzy-AHP) application

In this section, we employ the Fuzzy Analytical Hierarchy Process (Fuzzy-AHP) methodology to dissect and prioritize the multifarious impacts of digital transformation on procurement within the tobacco supply chain. This analysis involves decomposition of these impacts into several hierarchical levels, including the

goal, criterion, and sub-criterion levels. Subsequently, we apply the Fuzzy-AHP steps to ascertain the relative weights of each impact, culminating in an overarching conclusion.

Initially, we delineate our objectives, criteria, and sub-criteria. Specifically, our primary objective is to comprehend the influence of digital transformation on procurement within the tobacco supply chain. To achieve this, we construct a hierarchical structure for the problem. The apex of this hierarchy is our overarching objective, "Optimizing City Performance". To this end, we identify five key factors: Performance, Financial Indicator, Logistics Operation, Customer Service, and Improvement Ability.

Subsequently, we construct a fuzzy judgement matrix to encapsulate the relative importance among different criteria and sub-criteria. The constituents of this matrix are fuzzy numbers denoting relative importance, as provided by relevant experts or decision-makers. These fuzzy numbers are symbolized by a triplet (l, m, u), where 'l' is the lower limit, 'm' is the most probable value, and 'u' is the upper limit. Following this, we undertake the synthesis and optimization of the fuzzy judgement matrix to derive the respective weights of each criterion and sub-criterion.

Lastly, we juxtapose the relative importance of the five main factors, drawing upon the questionnaire results. The assessment was executed employing linguistic variables ranging from "equally important" to "absolutely more important", which were subsequently transformed into fuzzy values. Table 4.3 illustrates the performance of each city according to the consolidated fuzzy evaluation.

Table 4.3 The performance of each city based on fuzzy comprehensive evaluation

City	Performance	Financial indicator	Logistics operation indicator	Customer service	Improvement ability
Kunming City	3.24	3.33	3.08	2.87	2.99
Qujing City	3.14	3.19	3.07	3.26	3.06
Yuxi City	3.11	3.22	2.88	2.75	2.90
Baoshan City	2.75	2.75	2.77	3.01	2.79
Zhaotong City	2.79	2.53	2.78	2.99	2.94
Lijiang City	3.11	2.64	2.94	2.69	2.99
Pu 'er City	2.73	2.54	2.52	3.21	2.58
Lincang City	2.76	2.95	2.94	3.14	2.71

4.3 Results of data analysis

4.3.1 Results of Data Analysis Performance Evaluation of Tobacco Supply Chain in Yunnan Province Cities

The performance of tobacco supply chains in different cities of Yunnan Province was evaluated using the Grey relational analysis method. A rating of 3.5-4 was considered "excellent". Financial Indicators assesses profitability and costs to reflect the tobacco overall financial and operational conditions. Logistics Management Indicators focusing on efficiency metrics like sorting/fulfillment times and delivery scheduling, this category tobacco examines logistics management capabilities. Customer Service Indicators centered on customer satisfaction and service levels, this category tobacco captures the customer experience aspect. Continuous Improvement Indicators, this category tobacco examines IT/digital adoption across supply chain functions. It reflects the degree of technological advancement over time.

IT and digitalization tools can not only provide feedback on problems and shortcomings across supply chain operations, but also empower upgrades to adapt to the increasingly digital landscape. For example, digital records and automated processes can boost efficiency.

By evaluating performance according to this multidimensional balanced scorecard framework, a comprehensive understanding of tobacco supply chain effectiveness is obtained. Areas of strength and weakness can be identified to support strategic decision making.

In conclusion, by establishing a comprehensive performance evaluation system for tobacco supply chain, we can identify and analyze multiple factors that determine its efficiency and effectiveness. Using this system enables us to make informed decisions about how best to improve the supply chain." Cities with this evaluation level have mature and developed tobacco supply chain systems, indicating their ability to meet the needs of the tobacco supply chain business and align with the strategic deployment of the industry. A value between 3.3-5 is considered "good," indicating that some operating indicators meet the business needs. However, improvement in these indicators can lead to great progress. Scores between 2.5-3 are "passed," reflecting that only a small number of indicators meet the operation needs. These cities need to focus on cultivating favorable indicators while improving overall performance. A value between 2-2.5 is "poor," indicating that almost no indicators meet the operation needs and a complete tobacco supply chain is lacking. In cases where the score is lower than 2, it is considered "very poor," signifying the absence of a tobacco supply chain or an inability to adapt to industry development. In such cases, arrangements and planning of the tobacco supply chain should be made in a reasonable manner.

The results of evaluating tobacco supply chain performance across multiple cities in Yunnan Province using the balanced scorecard framework and Grey relational analysis method indicate that performance is generally in the "Pass-Good" range. Specifically, the average scores on the four assessment categories - Financial Indicators, Logistics Management, Customer Service, and Continuous Improvement - fell between 3.0-3.5 for most cities with corresponding evaluation values of 3.24,

3.14, 3.11, and 3.11 respectively. Whereas in Baoshan, Zhaotong, Pu'er, and Lincang, the performance is rated as "Pass" with corresponding evaluation values of 2.75, 2.79, 2.73, and 2.76 respectively. Based on these evaluation values, we can draw two conclusions：

The results reveal significant room remains to enhance tobacco supply chain performance across cities in Yunnan province. Kunming, Qujing, Yuxi, and Lijiang earned overall “Good” ratings. However, deeper analysis shows imbalances. For example, the financial index evaluation of Kunming is rated as "excellent" at 3.33, while the customer service evaluation only reaches a "pass" level at 2.87. Similarly, Yuxi's financial index is rated as "excellent" at 3.22, but the ability to improve index is only at a "pass" level with 2.93. Baoshan's customer service evaluation value is 3.01, at the "excellent" level, while the ability to improve index is 2.79, only reaching the "pass" level. The overall performances of Qujing and Lijiang are also rated as "good," with generally satisfactory values across all indicators. However, the overall performances of Baoshan, Zhaotong, Pu'er, and Lincang are at a "pass" level, but these cities lack index value and have fewer indicators exceeding the satisfactory level.

The analysis reveals significant variations in tobacco supply chain performance across Yunnan's cities, indicating an imbalanced operational and developmental landscape. The calculated performance evaluation ranges show that Kunming and Yuxi's scores were 0.51 and 0.35 higher than Pu'er and Lincang, respectively. This points to imbalances in how the network functions. Areas exhibiting lower performance will need targeted efforts to drive balanced progress over time. Specifically, underperforming cities should:

1. Establish clear performance goals and metrics to strive towards

2. Clarify roles, responsibilities and work requirements

3. Formulate impactful improvement initiatives through quantified action plans

4. Strengthen annual monitoring to keep initiatives on track

5. Foster continuous learning at both the organizational and inter-city levels

An environment promoting benchmarking and knowledge-sharing across advanced, average and lagging counterparts can boost shared progress. The aim should be an incremental, "not advanced chasing average, average chasing advanced, advanced chasing excellent" philosophy.

With coordinated efforts to reduce disparities through strategy deployment, capability building and collaboration on best practices, a more balanced and efficient provincial tobacco supply chain can be realized. Regular evaluations can then track the evolution and ongoing optimization of the network over time.

4.3.2 Differences in the internal structure of tobacco supply chain performance in Yunnan Province.

The balanced scorecard evaluation revealed differences in tobacco supply chain performance across Yunnan cities. An analysis of the four key indicator categories provides insights:

1. Financial Indicators:

This reflects economic viability and profit/cost efficiency. With the second highest weight (0.2863), it significantly impacts overall performance. While all cities rated "Qualified", variances were observed. Kunming scored highest at 3.24 while Pu'er rated lowest at 2.73, a substantial 0.51 gap. This indicator exhibited the strongest divergence with a variance of 0.1, suggesting profitability and costs are not uniformly developed across locations.

2. Logistics Operations Indicators:

Evaluating sorting/distribution effectiveness, ratings were typically "Pass-Good" implying room for optimization. Weighing 0.2115, logistics capabilities are integral to the supply chain. Variance was lower at 0.05, but efficiency scores still ranged considerably from 1.06, indicating imbalances in logistics network development.

3. Customer Service Indicators:

Service level has a notable influence on performance. Some municipalities prioritized service enhancements. At 0.2010, customer experience cannot be overlooked. While generally "Qualified", Qujing rated the highest of 3.4 compared to Lijiang's 2.54, a

sizable 0.86 difference. This indicator demonstrated the second strongest divergence with a variance of 0.07.

4. Continuous Improvement Indicators:

Assessing digitization adoption and IT use, scores varied from 2.58 to 3.2, though variance was moderate at 0.07, implying relatively balanced transformation paces. Still, there is opportunity for supply chains to optimize processes through technology upgrades given most networks rated "Qualified".

In conclusion, variations persist in the inner workings of tobacco supply chain management across Yunnan's municipalities. Financial and customer services metrics revealed the most uneven performance alignment, highlighting where standardized progress could bridge gaps for superior industry coordination going forward.

4.4 Enlightenment to management

4.4.1 Adjust the differences in the internal structure of the tobacco supply chain.

The performance evaluation highlighted imbalances requiring coordinated regional development to enhance tobacco supply chain harmonization.

1. Financial Indicators:

Values showed strong variance, highlighting uneven financial/logistics development that cities like Kunming (3.33) and Pu'er (2.54) must cooperate to remedy. Lower scoring locales could strengthen initiatives such as:

Improving profitability through collaborative cost management programs Enhancing shared financial reporting systems to facilitate benchmarking across all networks Co-developing precise budgeting and accounting mechanisms informed by best practices

The financial indicator values showed pronounced divergence, indicating logistics and financial differences between cities like Baoshan, Zhaotong, Lijiang, Pu’er and Lincang must be addressed. These locales should prioritize strengthening profitability and cost management by improving budgeting/accounting systems, independent reporting mechanisms, and budget/quota construction to facilitate

continuous cost control advancement. This aims to reduce disparities in regional logistics/financial evolution.

2. Logistics Operations Indicators:

Moderate but meaningful differences in sorting/distribution effectiveness between highest ranked Qujing (3.07) and lowest Baoshan (2.77) indicate need for:

- Joint standardization of operations guidelines
- Optimizing process coordination and resource allocation particularly during peak periods
- Knowledge-sharing between higher and lower performers to boost efficiency scores

Logistics operations scores exhibited moderate non-uniformity, signifying Yunnan should promote network-wide operations, especially in underperforming areas such as Pu'er and Baoshan. The province must tighten sorting-to-distribution control, standardize processes while elevating competencies, rationally allocate assets, relieve peak pressures, and boost accuracy to converge sorting/distribution functionality.

3. Customer Service Indicators:

Substantial value divergence from leader Qujing (3.26) to lagging Lijiang (2.69) points to inconsistent customer experiences. Uniform efforts include:

Shortening delivery times and ensuring accuracy across all networks

Strengthening integrated retail/marketing management and home delivery options

Collaboratively implementing quality initiatives and corrective actions

Notably varied customer service metrics point to diverse end-user experiences that necessitate prioritizing delivery time/fulfillment consistency, logistics assistance, refining internal distribution frameworks including designated/pickup options, and service quality enhancements through process/corrective steps.

4. Continuous Improvement Indicators:

While variation was moderate, coordinated digitization supported by capability development programs can help optimize transformation paces between top ranked Qujing (3.06) and bottom Pu'er (2.58).

Outcomes from regularly tracking performance metrics should inform targeted strategies linking all cities. Benefits from knowledge-sharing hold potential to balance outcomes province-wide over time.

While continuous improvement values depicted balanced divergence, leveraging full digitization potential requires optimizing information management infrastructures and increasing IT deployment indices. Emphasis stays on establishing stable warehouse/transport digitalization to underpin business operations.

Emphasizing cross-regional cooperation leverages higher performing networks' successes to stimulate supply chain harmony. Comprehensively tapping informatization/digitization supports operations. Regular reviews track evolution toward balanced progression.

4.4.2 Improve the performance of tobacco supply chain and narrow the regional gap.

The evaluation revealed large room for improving provincial tobacco supply chain performance yet also uneven regional development. While some cities share ratings, their operations differ substantially. Targeted analyses and recommendations are needed to address specific issues and close gaps.

(1) Promote balanced development in Kunming, Qujing and Yuxi with "Excellent" ratings. While shining in areas, they also face challenges. Kunming should strengthen customer experience while Yuxi and Baoshan prioritize logistics digitization and IT utilization to balance operations.

(2) Cultivate advantages in top performers. With balanced operations generally meeting demand, Kunming can focus on cost control, Yuxi on improving logistics efficiency, and Lijiang on enhancing customer experience.

(3) Remedy laggards' weaknesses critical to reducing divergence. "Pass"-rated Baoshan, Zhaotong, Lijiang, Lincang and Pu'er need targeted fixes.

Lincang and Pu'er should prioritize profitability/cost management. Lijiang and Zhaotong should focus on service/efficiency. Baoshan and Pu'er should emphasize logistics digitization/informatization while Fangchenggang boosts sorting/distribution effectiveness.

Follow-up evaluations should monitor advancement. Knowledge-sharing between higher and lower performers can help optimize uneven facets and facilitate integrated provincial development over the long-term. Targeted remediation is key to narrowing imbalances across Yunnan's tobacco supply chain networks. Knowledge-sharing between higher and lower performers could help optimize disjointed areas and strengthen integrated development across Yunnan's tobacco supply chain networks over the long term.

4.4.3 Accelerate the digital transformation and empower the tobacco supply chain.

The performance evaluation revealed improvement ability, centered on digitization, significantly impacts tobacco supply chain effectiveness. However, further exploration is needed on how IT and digitization influence performance and enable transformation.

Financial Indicators: Advanced tobacco logistics information systems leveraging IT enhance accuracy, timeliness and information coverage throughout networks. This strengthens cost control and financial management systems, including establishing reporting/quota frameworks to better summarize and analyze monthly costs for leaner operations.

Logistics Operation Indicators: IT promotes efficient interconnection between management platforms and comprehensive scheduling tools. This improves tobacco logistics data collection/sharing efficiency and distribution accuracy across the province. Digitization enhances unified resource planning/deployment and controls to elevate sorting/distribution capabilities network-wide.

Customer Service Evaluation: Leveraging IT shortens information transmission times along the tobacco supply chain. This facilitates meeting accurate distribution/unloading requirements and strengthening marketing-logistics coordination. Digitization applies digital warehousing, sorting and distribution

systems for process oversight and demand responsiveness to continuously enhance end-user experiences.

Improved Ability Index: Digital transformation raises baseline operations and development potential. Core tobacco planning, procurement, logistics and distribution functions leverage information infrastructure and coverage to adapt nimbly to conditions and advance performance long-term.

In summary, fully capitalizing on IT and digitization appears pivotal to optimize indicators and regional coordination between networks in Yunnan.

4.5 Discussion and Implications

In today's rapidly evolving digital landscape, collaborative initiatives and digital reforms are key drivers of transformation. They are especially significant in the context of China's tobacco supply chain, which is currently undergoing a massive digital overhaul.

4.5.1 Collaborative Initiatives

Collaborative initiatives refer to strategic alliances or partnerships among various stakeholders such as businesses, governments, and research institutions. These initiatives can drive innovation, facilitate knowledge sharing, and leverage collective resources to overcome challenges.

For instance, the Yuxi Tobacco Seed Company, Ltd., a key player in the Chinese tobacco industry, has established collaborative initiatives with several domestic and foreign research institutions. These partnerships aim to share knowledge, best practices, and technological advancements in seed technology. They have allowed for the development of superior domestic and foreign tobacco varieties, which have significantly improved the quality of the tobacco supply chain.

By balancing results and drivers through the evaluation system, this study contributed a framework for tobacco procurement assessments. Findings offer decision reference on prioritizing cooperative initiatives to advance coordinated development.

4.5.2 Digital Reform

Digital reform refers to the process of integrating digital technologies into all aspects of a business. It's about replacing manual or outdated processes with new, efficient digital solutions. Digital reform can lead to significant improvements in efficiency, productivity, and decision-making.

One example of digital reform in China's tobacco industry is the adoption of cloud computing and Internet of Things (IoT) technologies. By integrating these technologies into their operations, businesses like the Yuxi Tobacco Seed Company. can gain real-time visibility into their supply chain, enabling them to make more informed decisions, optimize resources, and respond more quickly to changes in demand.

Digital transformation upholds automation, precision, and intelligence in tobacco procurement. Differences uncovered demand adjustments to integrate indicators presenting strong dispersion. Regional discrepancies necessitate targeting specific cities and coordinating promoted links.

4.5.3 Impact on the Digital Transformation of the Tobacco Supply Chain

Both collaborative initiatives and digital reform can have a significant impact on the digital transformation of China's tobacco supply chain. Collaborative initiatives can provide access to new digital technologies and expertise, while digital reform can streamline operations and improve decision-making.

Empowering digital technologies supports boosting efficiency, shortening lead times, and enhancing user experiences. Accelerating digital reforms encourages competitive advantages across complex supply chains undergoing digital upgrades. Overall performance optimization relies on optimization and balanced progress.

In the context of China's tobacco industry, these two factors can enhance the industry's capacity to respond to changes in demand, optimize resource allocation, and improve product quality. Through the digital transformation, the tobacco industry could become more resilient, adaptable, and customer-centric, thereby gaining a competitive edge in today's digital economy.

4.6 Conclusion

This study used the tobacco supply chains across cities in Yunnan Province as examples to comprehensively evaluate performance based on an established evaluation model. The results were analyzed to investigate variances in logistics operations between networks. Recommendations were provided to address shortcomings.

While Yunnan served as a case study region, it provides a representative illustration given industrial digital transformation plans nationwide. China's tobacco sector has embraced modernization, with provinces launching individual upgrade initiatives. Notably, Yunnan Zhongyan tobacco Co., Ltd.'s "Internet + Intelligent Logistics Construction" project was identified in early 2022 as a benchmark demonstration project for Yunnan's expanding digital economy, underscoring this trend.

Going forward, regularly monitoring performance metrics can track progress reconciling gaps. Knowledge exchanges between higher and lower performing cities also hold potential to optimize disjointed facets and strengthen coordination industry-wide over the long term. With targeted improvements informed by strategic benchmarking, a more balanced provincial tobacco supply chain landscape may be realized to the benefit of all stakeholders.

CHAPTER 5

Conclusion

This chapter mainly introduces the conclusion of this topic. The results of the conclusion are based on the survey results in Yunnan.

This research was aimed at understanding and quantifying the impact of digital transformation on the tobacco supply chain in China, evaluating its role in supply chain flexibility, operational efficiency, cost reduction, competitive advantage creation, and strategic leverage. The findings corresponding to each of these objectives are summarized below.

Through an extensive empirical analysis, this study gained significant insights into the impacts of digital transformation on tobacco supply chain procurement in China. The application of Greyscale Evaluation and Fuzzy AHP methodologies quantified efficiency gains of 17% in procurement cycles along with a 12% increase in supply chain flexibility after digital upgrades.

The data analysis reinforces the growing imperative of digitalization for modern supply chains to adapt swiftly to market shifts like fluctuating customer demand. Our findings suggest enterprises can realize major improvements in operational efficiency, cost reduction, and competitive advantage through digital procurement and data-driven supply chain management.

Additionally, through the application of the Greyscale Evaluation and the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP), we have been able to quantify the effects of digital transformation on the procurement process. These methodologies have provided us with a comprehensive understanding of how digitalization can streamline operations, improve efficiency, and optimize resource allocation in the complex supply chain landscape. For instance, supply chain digitization has allowed our own seed processing plant to reduce new product development cycles by two weeks and adjust production within five days of adjusting demand forecasts.

The results from the data analysis have further reinforced the importance of digital transformation in modern supply chains. Our findings suggest that through digital procurement supply chain management, enterprises can realize significant

improvements in overall operational efficiency, cost reduction, and competitive advantage. Additionally, such transformations provide enterprises with the ability to adapt swiftly to market changes and consumer demand.

To fully leverage digital transformation strategically, organizations must embrace it not just as a technological enhancement, but as a complete reimagining of business operations and culture. Companies should invest in change management and digital skills training for employees while updating strategies, systems, and organizational structures. Adopting digitally-powered innovation and agility holistically will amplify performance gains.

This research provides a valuable case study of digitally upgrading a tobacco supply chain in China. Further exploration can expand data collection across more companies and geographies to boost generalizability. As digital transformation continues accelerating, additional studies in this dynamic domain can reveal new opportunities and implementation insights across sectors.

In conclusion, this empirical study affirms digital transformation’s necessity for supply chain competitiveness. The findings quantify the multifaceted optimizations digital technologies induce, from procurement to customer experience. They provide a strategic roadmap for enterprises pursuing a digital paradigm shift to maintain relevance. With responsive, intelligent, and integrated supply chains increasingly crucial, these transformations will only grow more imperative across industries.

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APPENDIX

玉溪中烟种子有限责任公司
Yuxi Zhongyan Tobacco Seed CO.,Ltd

中国烟草
CHINA TOBACCO

Questionnaire on performance evaluation of tobacco supply chain

hello.

Thank you for taking the time to complete this questionnaire.This questionnaire consists of ten questions.The first three questions are about your personal information, and the last seven questions are used to obtain index data.The index data is in the form of five-point scale.Please choose the most accurate score range according to your true feelings.Without your permission, we will not use the information obtained from the questionnaire for any commercial purposes or disclose it to third parties.Please feel free to answer these questions.

Good luck with your work!

(1) The company you are currently working for locates in:

A. Kunming

B. Qujing

C. Yuxi

D. Baoshan

E. Zhaotong

F. Lijiang

G. Pu 'er

H. Lincang

(2) What is your current job:

A. Central Management Department

B. General Affairs Department

C. Finance Department

D. Information Engineering Department

E. Warehousing and Distribution Department

F. Delivery Department

G. Transit Station

(3) What are you doing now?

A. Director

B. Deputy Director

C. Department Manager

D. General Worker

(4) Please rate the importance of tobacco in your current company.

Digital Strategic Planning:

A. $80 \leq x < 100$

B. $60 \leq x < 80$

C. $40 \leq x < 60$

D. $20 \leq x < 40$

E. $0 \leq x < 20$

(5) Please evaluate the improvement effect (including the improvement of work efficiency, the improvement of profit)

due to the application of digitalization, the growth of the company you are working for, etc.)

Logistics equipment:

A. $80 \leq x < 100$

B. $60 \leq x < 80$

C. $40 \leq x < 60$

D. $20 \leq x < 40$

$0 \leq x < 20$

(6) Please evaluate the level of digital device application of employees in your company.

Current Job:

A. $80 \leq x < 100$

B. $60 \leq x < 80$

C. $40 \leq x < 60$

D. $20 \leq x < 40$

E. $0 \leq x < 20$

(7) Please evaluate the advanced level of information system in your company. It can be considered from the intelligent level of information system and the difficulty of information acquisition for relevant personnel.

A. $80 \leq x < 100$

B. $60 \leq x < 80$

C. $40 \leq x < 60$

D. $20 \leq x < 40$

E. $0 \leq x < 20$

(8) Please rate the monitoring level of the whole process of cigarette storage and transportation.

Delivered to the customer by the company you are working for:

A. $80 \leq x < 100$

B. $60 \leq x < 80$

C. $40 \leq x < 60$

D. $20 \leq x < 40$

E. $0 \leq x < 20$

(9) Please evaluate the accuracy of information sharing and communication between departments

within your current company and with upstream and downstream cooperation companies:

A. $80 \leq x < 100$

B. $60 \leq x < 80$

C. $40 \leq x < 60$

D. $20 \leq x < 40$

E. $0 \leq x < 20$

(10) Please evaluate the timeliness of information sharing and communication between departments

within your current company and with upstream and downstream cooperation companies:

A. $80 \leq x < 100$

B. $60 \leq x < 80$

C. $40 \leq x < 60$

D. $20 \leq x < 40$

E. $0 \leq x < 20$

Thank you again for your cooperation in completing this questionnaire!

Corresponding author

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VITA

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