Smart supply chain innovation model selection

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Smart supply chain innovation model selection: exploitative innovation or exploratory innovation?

Abstract: More and more companies are actively building smart supply chains, but the process of building them is tortuous due to the lack of suitable innovation models for their own companies, and no scholars have yet explored the selection of smart supply chain innovation models to obtain a general theoretical framework. In this paper, we propose a theoretical framework on the factors influencing the selection of smart supply chain innovation models by using a multi-case study approach and taking four companies from China that are engaged in smart supply chain innovation as the research subjects through field research and interviews. Several important findings emerged from our study: Firstly, internal factors such as strategic orientation, supply chain network structure, and supply chain control system, and external factors such as competition intensity and national policies will have an impact on the choice of supply chain innovation model; the application of smart technology and market environment regulate the relationship between internal and external factors on the choice of innovation model; secondly, we further found that due to the industrial differences, the distance between manufacturing enterprises and suppliers, the supply chain integration differences in distribution enterprises will have a greater impact on the choice of smart supply chain innovation model; finally, we summarize the theoretical framework of the factors influencing the choice of smart supply chain innovation model for core enterprises, which can be used to guide enterprises to better realize smart supply chain innovation.

Keywords: Smart supply chain; innovation model; multiple case studies; exploratory innovation; exploitative innovation

1. Introduction

With the rapid emergence of smart supply chain in China, the awareness of Chinese society about smart supply chain is deepening, and the network environment for developing smart supply chain in the domestic market is gradually optimized (Cai, 2019). With the depth of supply chain innovation and application pilot, enterprises around the world are becoming more and more active in building smart supply chain innovation, for example, Haier, Suning Appliance, Jingdong, etc. are typical representatives. Smart supply chain is a comprehensive integrated system of

technology and management that combines technologies such as big data, cloud computing and modern supply chain management theories and methods to build in and among enterprises to realize the intelligence, networking and automation of supply chain (Wu et al., 2016). Smart supply chain innovation is a targeted innovation activity for the business operation of smart supply chain, aiming to innovate and develop new concepts, new technologies and new modes of supply chain, efficiently integrate various resources and elements, improve the level of industrial integration and collaboration, and meet the goal of efficient operation of smart supply chain (Liu et al., 2020).

The smart supply chain innovation model is a planning and fundamental response to achieve the strategic goal of smart supply chain innovation, which is the overall goal planning and deployment of enterprise innovation made by enterprises based on the correct analysis of their own internal conditions and external environment (Wen and Zhou, 2019). The rapid development of technology, knowledge and networking has put enterprises in an era of disruptive change, and innovation can respond to and drive change, which is critical to the survival and growth of organizations. Companies need to leverage existing information and capabilities to ensure the success of innovation, i.e., they can choose an exploitative innovation model for innovation (Morgan et al., 2008). An exploitative innovation model is characterized by innovation that builds on an existing body of knowledge or range of services, i.e. extends current knowledge and skills, improves established designs, develops current products and services, builds on current knowledge and enhances current skills, processes and structures (Lin et al., 2015). For example, RiRi shun offers a wide range of services based on the large-item logistics service, from "home delivery" to "delivery and installation" to "delivery of full-scene solutions", continuously innovating its service model and leading the in the bulky logistics market. At the same time, companies can also choose the exploratory innovation model for innovation (Miguel et al., 2011), which is different from the exploitative innovation model and is characterized by developing new service models or new markets, i.e., providing new designs, creating new markets, developing new sales channels, and requiring new knowledge or departing from current knowledge (Zhao et al., 2019), e.g., while continuously improving its logistics services, Shunfeng explores new models to open up The "FengXiu" business provides customers with multi-industry, cross-category, integrated after-sales supply chain industry solutions. However, it is often difficult for companies to make both exploitative and exploratory

innovations at the same time, and resource constraints force companies to choose between exploratory and exploitative innovations (Wu, 2019).

In the enterprise practice, although many enterprises want to actively build a smart supply chain, but the lack of an innovative model suitable for their own enterprises has led to a tortuous construction process. Take Suning as an example, Suning, as a domestic retail giant, is famous for its main wisdom supply chain in the construction of supply chain. The chairman of Suning Group said, "In 2019, Suning will focus the construction of the smart supply chain on exploring the development of open platforms and scenario internet operations around technology-driven, and vigorously promote the development of dual-line (online and offline) open platforms and scenarios, but the process is not smooth. Due to the complex structure of the supply chain network, many logistics information platforms and information systems follow the specifications set by each, which makes it difficult to achieve information exchange and sharing between enterprises, platforms and organizations, and it is difficult to achieve compatibility between the entire supply chain network. For a long time, Suning has been exploring and summarizing a smart supply chain innovation model suitable for its own enterprise." (Sohu, 2019). Therefore, it is necessary to explore the theoretical framework about the factors influencing the choice of smart supply chain innovation model to guide the practice.

At the academic level, research on smart supply chain innovation is mostly focused on the innovation research of a certain technology, such as big data (Wolfert et al., 2017), Internet of Things (Abdel et al., 2018), and cloud delivery (Yan et al., 2014), or on smart supply chain innovation models, such as fresh agricultural products (Nakandala and Lau, 2019), oil and gas mines (Mato and Hall, 2016), etc. However, there are research gaps in the theoretical framework of the factors influencing the selection of smart supply chain innovation models, and there is a lack of a theoretical framework of smart supply chain innovation models that can reflect industry differences. We believe that there is an urgent need to conduct exploratory research to help companies better selects the smart supply chain innovation models that are suitable for them. To this end, this paper conducts a multi-case study based on first-hand interview data from four smart supply chain enterprises in China, and addresses the following two main questions: (1) What are the factors that influence the selection of smart supply chain innovation models from three aspects: internal, external and regulatory roles of enterprises? (2) How do these factors affect the selection of innovation models in enterprise practice? (3) Based on the above factors,

how to construct a theoretical framework of the factors influencing the selection of smart supply chain innovation models?

There are two main reasons for selecting Chinese smart supply chain companies for this paper. First, with the development of economic integration, China is occupying an important position in the global competition and has become the second largest economy in the world. Chinese supply chain firms have made rapid progress and developed steadily in recent years and more and more scholars have started to focus on the Chinese context. Second, innovation has brought disruptive changes in all aspects of business, and supply chain is no exception. Many Chinese companies are actively engaged in smart supply chain innovation, and many typical cases have emerged, such as Haier and Jingdong (Liu et al., 2020). The development of smart logistics innovation has become a new driving force for the transformation of China's supply chain, given what the industry has encountered in terms of its potential during the COVID-19 outbreak (Liu et al., 2020). Therefore, it is appropriate to select the corresponding case companies from which to carry out the research in this paper.

In this paper, through the field research and interviews with four enterprises, we get three important research conclusions. Firstly, internal factors such as enterprise strategic orientation, supply chain structure, supply chain control system, and external factors such as market demand and national policies will have an impact on the choice of supply chain innovation model. Secondly, through field interviews and research, we further found that due to industrial differences, the distance difference between manufacturing enterprises and suppliers, and the supply chain integration difference between distribution enterprises will also have a greater impact on the choice of smart supply chain innovation model. Finally, based on the above research, we give the key points that core enterprises should pay attention to when designing the smart supply chain innovation model, so as to better realize the smart supply chain innovation.

Our study has two main contributions to the existing literature. On the one hand, previous scholars' studies on innovation models have mostly focused on traditional supply chains (Abdelkafi and Pero, 2018), lacking a theoretical framework of factors influencing the selection of innovation models of smart supply chains considering the different characteristics of different industries. This paper, on the other hand, proposes a new theoretical framework based on the characteristics of smart supply chain innovation model selection, which extends the research of traditional supply chain theory. On the other hand, the findings of this paper provide important management inspirations for the practice of smart supply chain enterprises, which should consider

the above-mentioned influencing factors in the process of smart supply chain construction and explore the innovation model suitable for their own enterprises in conjunction with their own development.

The rest of the paper is organized as follows: section2 discusses the literature review; section3 gives the research methodology of the paper, and in section4 discusses the multi-case comparative study of smart supply chain innovation models. Finally the article discusses the conclusion as well as future research and also highlights the limitations of the article.

2. Literature Review

The main research objective of this paper is to explore the theoretical framework of the factors influencing the selection of smart supply chain innovation models. Around this goal, this paper is closely related to two main areas of research: 1) smart supply chain, and 2) supply chain innovation model selection and its influencing factors. We will discuss them separately next.

2.1 Smart Supply Chain

"Smart supply chain" was first proposed by IBM in 2008 as part of the "Smart Planet". Smart supply chain is a combination of modern technology and scientific management methods to achieve information sharing and interactive collaboration among enterprises in the whole supply chain and between enterprises and customers (Wu et al., 2016). Compared with traditional supply chains, smart supply chains require higher technology, can understand customer preferences in real time based on big data, predict customer demand more accurately, realize personalized and customized services for each customer, and have the characteristics of faster market responsiveness and higher intelligence (Gupta et al., 2019).

Scholars' research on smart supply chain construction is mainly carried out from different aspects such as theory and empirical evidence. In terms of theoretical research, scholars mainly analyze the idea of smart supply chain construction and believe that the concept of smart supply chain is inclusion and openness, the key is integration and optimization, the core is synergy, the goal is mutual benefit and win-win, the direction is wisdom and intelligence, and the essence is value creation (Cai, 2019), and in terms of empirical research, they mainly explore the evaluation of smart supply chain performance (Li and Xing , 2017; Xu et al., 2017), as well as explored smart supply chain innovation and application using multiple cases (Liu et

al., 2020). In conclusion, the current research on smart supply chain innovation focuses mainly on the areas of technology and engineering implementation, and there is a lack of research on smart supply chain innovation models and their influencing factors.

2.2 Supply chain innovation model selection and its influencing factors

At present, there are few papers directly studying smart supply chain innovation models at home and abroad, but a number of scholars have studied supply chain innovation models. Due to the different research perspectives and viewpoints, there are many different classifications of supply chain innovation models in academia. According to the output of supply chain innovation, innovation can be divided into product innovation and process innovation (Zhong et al., 2019); according to the innovation subject, innovation can be divided into autonomous innovation and cooperative innovation (Maroofi, 2015); according to the intensity of technology involved in the innovation process, innovation can be divided into incremental innovation and mutation innovation (Long and Zhou, 2015). In the current context of supply chain innovation, scholars can divide the innovation models into exploitative innovation models and exploratory innovation models according to the different focus of the firm's innovation model and they have received extensive attention (Wu et al., 2015; Liu et al., 2020). Exploitative and exploratory innovation models better reflect an organization's ability to harness its existing knowledge and resources and to proactively adapt to changes in the external environment, thus better reflecting the strategic initiative of the organization (Gao, 2014). Based on the above literature analysis, this paper classifies smart supply chain innovation models into exploitative and exploratory innovation models.

As for the research on the factors influencing the choice of innovation model, early scholars found that the application of new technologies can change the business activities of enterprises, changing their production methods, management methods to profitability, and certain key technologies can also become the core resources of enterprises, discovering new market opportunities, and the innovation model of enterprises will certainly follow the change (Hippel and Krogh, 2003; Chesbrough, 2010). As research continues, more and more scholars divide the influencing factors into internal and external factors, with internal factors stemming from the organizational form of the firm, its various systems, and changes in capabilities, including corporate culture, organizational learning capabilities, innovative talent, supply chain management, and organizational structure processes (Guiso et al., 2015;

DiBella, 1996); while external factors come from the market and social environment, including changes in consumer demand, impact of external competitors, changes in market rules, changes in the social environment, and various uncertainties in the external world can affect the innovation patterns of the supply chain (Jansen et al., 2006; Charue et al., 2010). The combination of the above views shows that there are many kinds of factors that influence the innovation model, and distinguishing from traditional supply chains, smart supply chains have characteristics such as more technical, more synergistic and supply chains tend to be reticulated, which are crucial for the selection of the innovation model, and therefore, there is an urgent need for research.

2.3 Summary of the literature

From the above literature review, it can be seen that there are currently some studies on smart supply chain, supply chain innovation model selection and its influencing factors. Table 1 shows the comparison between this study and the most relevant literature. It can be seen that the current influencing factors for supply chain innovation model selection are mainly in qualitative research, lacking the support of empirical data, and are not realistic and relevant enough to be accurately applied to the smart supply chain. In order to fill this theoretical research gap, this paper explores a theoretical framework for innovation model selection in smart supply chains, which will be used to answer the research questions raised in this study and can provide a valuable reference for relevant managers and practitioners to make decisions.

[Insert Table 1 here]

3. Research Methodology

3.1 Multi-case study approach

The factors influencing the selection of smart supply chain innovation models are a complex research problem. When the problem under study is characterized by complexity, it is necessary to systematically grasp the essence and the whole picture of the problem as a whole in order to enhance the understanding of the full range of the problem, a task that quantitative research methods are often unable to undertake. In contrast to the shortcomings of the statistical analysis method, case studies enable researchers to discover practically relevant knowledge and construct theoretical

frameworks with general explanatory power through a more comprehensive and in-depth contact between the researcher and the interviewed subjects, e.g., through face-to-face communication with managers, thus enabling them to better solve practical problems in management. The advantages of multiple case studies over single case studies are that the findings are more reliable and accurate, more easily oriented toward quantitative analysis and more helpful in increasing our understanding of the diversity of the empirical world (Huang, 2010). Multiple case studies overlap to support the findings of the study, provide a more comprehensive understanding and reflection of the different aspects of the case, lead to a more complete theory and increase the validity of the study. Therefore, this paper adopts a multi-case study approach.

According to the functions, multi-case studies are divided into three types: exploratory, descriptive and explanatory, and one or more case design methods should be selected according to different research purposes (Aaboen et al., 2012). The main research purpose of this paper is the factors influencing the selection of smart supply chain innovation model, and its research path can be divided into four stages: preparation stage, case acquisition and preliminary analysis to refine theories, construction of theoretical framework and validation of theories or refining new theories, and integration to form a management innovation theory system. Among them, refining theories through case acquisition and preliminary analysis belongs to the category of exploratory case studies, and constructing theoretical frameworks and validating theories or refining new theories belongs to the category of explanatory case studies (Eisenhardt, 1989).

3.2 Case Selection

The Ministry of Commerce of the People's Republic of China announced on October 16, 2018, the list of 266 national supply chain innovation and application pilot enterprises. From them, we screened out 20 enterprises with smart supply chains, and among these 20 enterprises, our case companies were selected based on the following criteria.

(1) The selected case company should have at least three years of experience in the development of intelligent supply chain, with a clear intelligent supply chain construction in the last two years, and in the intelligent supply chain belongs to the field typical of the relatively leading enterprises in the field of segmentation.

(2) The selected case companies should have some differences in their service areas,

service targets, organizational models and other characteristics, so that the conclusions obtained through comparison will be more valuable and universal.

(3) The purpose of this paper is to explore the innovation model suitable for the development of enterprises themselves, so this paper also selects enterprises with similar backgrounds and relevant research themes to conduct further in-depth interviews, so as to obtain more accurate analysis results.

(4) The selected enterprises have already invested or are investing in the construction of smart supply chain, and the information provided about the technology and supply chain structure is available and true. The data sources of the case study should include observations, interviews, questionnaires, secondary data, etc. The rich data sources can assist the researcher in "triangulating" the evidence for the interview results, so as to better support and interpret the research proposition.

The approval of four companies was obtained through telephone interviews and email correspondence. According to the request of the interviewed companies and considering the confidentiality of the information of the research companies, we called the four companies as Company A, Company B, Company C and Company D. Through the analysis of the smart supply chain innovation model of these four companies, the events were analyzed and summarized in an organized manner, and then their specific situations were organized, and then the correlation between the events was found out. The basic situations of the four case companies are as follows.

[Insert Table 2 here]

3.3 Data collection

In this study, interviews were conducted with the top management of the four companies mentioned above, and the data sources included three main areas:

(1) We make full use of publicly available data to understand the background of related industries, the dynamics of related manufacturers, and the development history and strategies of case companies by collecting writings of company leaders and media interviews, company annual reports, newspaper articles, websites, and research unit reports.

(2) Through field observations of the case companies and interviews with

practitioners in the industries they belong to, the purpose of this interview was to understand the smart supply chain innovation model of the interviewed companies, focusing on the influential role of each factor in the process of smart supply chain construction and the interconnection of each factor. Semi-structured in-depth interviews were conducted with one to three executives of each case company who had a comprehensive understanding of the company's development history, in order to grasp the factors influencing the selection of its smart supply chain innovation model. A research outline for in-depth interviews was designed for each of the four companies, which consisted of 20 questions with no fixed answers. The semi-structured interviews were conducted in person, and the interviews usually lasted between 90 and 120 minutes, with a maximum of 150 minutes.

(3) Organize the interview data and conduct another interview for unclear answers or additional questions. After the interview, the interview information was organized, including the questions in the outline and the questions added on the spot. Through the organization of the information, the questions that were not clearly answered by the other party and other questions that needed to be added were identified and additional interviews were conducted, and if fewer questions needed to be added, they were sent to the interviewee by email.

3.4 Data Analysis

In this paper, after analyzing and organizing the case data of the above four enterprises, we identify common influencing factors and form a preliminary theoretical framework concept by comparing multiple cases. The preliminary theoretical propositions and interview data are finally derived from a universal theoretical framework through continuous comparison and mutual argumentation.

We use a combination of open coding and spindle coding to process the interview transcripts. Based on the summary of the interview results fed back from four enterprises, we find that the influencing factors considered by enterprises in the selection of smart supply chain innovation model include: enterprise strategy, supply chain structure, supply chain control, industry competition, user experience, differentiated services, policy support, and the degree of application of smart technology, etc. We refine and define based on this, and lay the theoretical and practical foundation for exploring the relationship among the above elements later. Open coding is the first "tagging" process of the four companies' data, i.e., naming each word or segment in the data (Ren and Zhang, 2017). Spindle coding is the

process of recoding the open coded data after the open coding by focusing on the important categories formed in the previous coding stage and comparing them in a recursive cycle (Douglas and David, 2003). The results of open coding are shown in Table 3.

[Insert Table 3 here]

The task of Axial Coding is to state the nature of the relationship between the sub-categories and the phenomenon, to conceptualize the hypothetical relationship between the sub-categories and the main categories, and to examine whether the hypothetical relationship is supported by the actual data (Zheng et al., 2011). In this paper, seven main categories, namely, strategic orientation, supply chain network relationship, supply chain control system, market demand change, national policy, smart technology application and peer competition. The results of the spindle coding are shown in Table 4.

[Insert Table 4 here]

3.5 Reliability and Validity

In order to improve the quality of the case study, this paper controls and tests the quality of the study based on four quality evaluation criteria: construct validity, internal validity, external validity, and reliability, respectively, in the design of the study.

(1) Construct validity. Evidence triangulation and evidence chain strategies were used in the data collection phase, and data were obtained through in-depth interviews, fieldwork, literature, corporate websites, and internal and public media sources, with multiple sources of evidence providing multiple proofs of the same phenomenon.

(2) Internal validity. The hierarchical interpretation and modeling methods were used in the data collection and case analysis stages, and the collated case data were fed back to the enterprise personnel for verification to ensure the correctness of the data extraction; the logical relationships summarized were explained and illustrated in a hierarchical manner according to the research structure; and the theoretical framework of the factors influencing the organizational efficiency of the smart logistics ecosystem was established based on the existing literature.

(3) External effects. In the research design phase, the four cases were summarized to refine the relevant logic and add universal analysis and discussion.

(4) Confidence level. Based on relevant literature and case materials, the basic

theoretical framework is constructed, and induction and deduction are carried out based on multiple case materials; in terms of the process of the case study, a draft case study is designed, and in order to avoid subjective perceptions brought about by the knowledge structure of the coders, the coding teams code individually and discuss together when there are differences of opinion until they agree; the data in the case analysis are obtained through in-depth interviews, fieldwork, internal enterprise information, etc. Multi-channel acquisition.

4. Proposition formulation and case study

We have identified internal influencing factors, external influencing factors, and moderating factors based on company research, interview content organization and analysis. This section will present the relevant propositions and multi-case interview evidence in detail and establish a theoretical framework for the selection of smart supply chain innovation models.

4.1 Internal factors

4.1.1 Differences in corporate strategic orientation

Companies wanting to innovate in smart supply chains must use their resources effectively and find the right strategic orientation as well as business guidelines that are appropriate to the environment (Sony, 2020). The strategic orientation of a company mainly represents the strategic direction for the future development of the company or organization, which can lead to rational and effective actions to ensure good performance and long term growth (Chatzoglou et al., 2011). Different types of strategic orientations lead to different interpretations and differences in the way companies approach their competitive advantages for comparison, as well as a reflection of the value of companies looking at their customers through diverse perspectives in order to develop how to achieve their strategic goals and realize their business scope (Doz et al., 2010).

Whether the overall strategy of smart supply chain innovation is aligned with or integrated into the overall development strategy of the enterprise will have an impact on the development of smart supply chain innovation. The different types of strategic orientations chosen by companies will lead to differences in their overall smart supply chain innovation and model selection (Lin et al., 2010). There are also various classifications of strategic orientations, such as entrepreneurial, technological, market, product, and sales orientations (Da et al., 2019; Ansaari, 2015). In terms of smart supply chain innovation model selection, firms focusing on entrepreneurial orientation,

product orientation, and technology orientation are more willing to take risks, are good at discovering and satisfying customers' needs that have not yet been revealed, and improve various innovative behaviors in the firm as well as on creative activity generation (Schlüter et al., 2017), and are also more attentive to the dynamics of the environment and therefore prefer to (Wu et al., 2015), while market-oriented and sales-oriented firms are more encouraged to develop and improve existing products to meet the needs of existing customers (Huang et al., 2018), in the sense that the resulting firm innovations are mainly aimed at satisfying current customer and market needs, rather than at developing products with a better degree of innovation to target new market needs in the future (Sun et al., 2015). Therefore, firms tend to engage in an exploitative innovation model. Therefore, the choice of smart supply chain innovation model is affected when firms have different strategic orientations. Hence, we propose the Hypothesis 1(a) and (b).

H1(a) *Entrepreneurial, product, and technology orientations drive the choice of exploratory innovation models for smart supply chain firms*

H1(b) *Market orientation and sales orientation lead to the choice of exploitative innovation model for smart supply chain companies*

During the interviews, the interviewed companies indicated that the difference in the strategic orientation of the company has an impact on the choice of the innovation model. Specifically, Company A indicated that the strategic orientation of the company first influences the formulation of policies, and then facilitates the choice of innovation models; Company B directly indicated that the corporate strategy is a plan of action to achieve future goals, and the company itself favors technology orientation and gives direction to the choice of innovation models; Company C Company C indicates that different corporate strategies have a greater impact on service requirements and technology choices, which in turn affects the choice of innovation models; Company D indicates that different strategic orientations lead to different operating models, which in turn lead to different innovation models. The detailed formulation of the differences in firms' strategic orientations is shown in Table 5. Therefore, we believe that hypotheses 1(a) and 1(b) are supported in this multi-case analysis.

[Insert Table 5 here]

4.1.2 Differences in Supply Chain Network Relationships

Smart supply chain innovation organically organizes and combines various industry stakeholders through information technology tools such as the Internet and the Internet of Things to form a multi-party network-like structure. Supply chain network relationships essentially include both structural and relational aspects (Sabri et al., 2018).In general, network structure mainly emphasizes the distribution and composition of elements and relationships existing in the network, while network relationships mainly emphasize the strength of network relationships, which is the concept of a set consisting of four dimensions of contact time and frequency, emotional strength, mutual trust and reciprocity between nodes in the network (Chang et al., 2012). Inter-organizational communication ties in supply chains result in different relationship strengths: strong and weak relationships (Lin, 2018). The "strong relationship" refers to multiple social relationships with high frequency, intensity, mutual trust and information sharing between network nodes (Williams et al., 2007); while the "weak relationship" refers to network nodes that are The "weak relationship" refers to a single social relationship in which the network nodes are less emotionally connected and less frequent (Delbufalo, 2012). Strong relationships are more conducive to the choice of smart supply chain exploratory innovation model because they are a prerequisite for network members to acquire social capital (Huang et al., 2018), while strong relationships imply frequent communication, strong ties and mutual trust among network members, which are more conducive to efficient transfer and sharing of information and knowledge. On the contrary, "weak" relationships restrict the expansion of network boundaries and are prone to knowledge and resource redundancy, which is not conducive to exploratory innovation mode, and companies tend to choose exploitative innovation mode. Therefore, differences in supply chain network relationships affect the choice of smart supply chain innovation models. Hence, we propose the Hypothesis 1(c) and (d).

H1(c) *Strong supply chain network relationships drive the choice of exploratory innovation models for smart supply chain firms*

H1(d) *Weak relationships in the supply chain network lead to the choice of exploitative innovation models for smart supply chain companies*

For the detailed formulation of the differences in supply chain network

relationships Table 6, during the interview process, the interviewed companies all indicated that the differences in supply chain network relationships would have an impact on the choice of innovation model. Specifically, Company A indicated that the strong relationship of supply chain can bring continuous and stable supply and demand to the enterprise, and the enterprise should choose the suitable innovation mode according to the difference of supply chain network relationship; Company B indicated that the supply chain network relationship of its industry is relatively complex and a relatively closed space, and different enterprises have different relationship structures, so the choice of innovation mode should consider the construction of the whole supply chain network relationship. Company C indicates that there will be a direct impact, in the process of innovation, the supply chain network relationship is an important factor to be considered, which is also the process of supply chain relationship reshaping. For example, if the supply chain network is not closely related, then the overall scheduling capability of the organization is more demanding, which may increase the difficulty and complexity brought by innovation. Therefore, we believe that hypotheses 1(c) and 1(d) are supported in this multi-case analysis.

[Insert Table 6 here]

4.1.3 Supply chain control system differences

With the changing competitive situation in the industry, enterprises are forced to change their strategies to adapt to the new competitive situation, and the change of strategy drives the evolution of supply chain control system (Liu, 2019). The main content of the supply chain control system is to monitor, optimize and improve the supply chain activities, and the management objects are "capital flow", "logistics" and "information flow" between supply chain organizations at all levels. The main objective of the supply chain control system is to monitor, optimize and improve supply chain activities, and the management objects are "capital flow", "logistics" and "information flow" between supply chain organizations at all levels and between them, and the applied methods are integration and collaboration(Zeng and Pan, 2017). The smart supply chain is a complex system with more participating members, which requires the core enterprise to establish a global and systematic view in the whole operation process of the smart supply chain, give full play to the leading role of the core enterprise, and strengthen the flexibility of control over the upstream and

downstream enterprises in order to make the control more effective and enable the upstream and downstream enterprises to play their own dynamics more reasonably and achieve the overall goal of the supply chain (Ivanov et al., 2010), when the enterprise adopts a centralized management style, each department in the supply chain organization has relatively formalized roles and responsibilities, relatively centralized procedures and functional structures, highly specialized operational processes, and strong manufacturing and sales capabilities, the enterprise is more inclined to choose the exploitative innovation model (Wang et al., 2010), and when a company adopts a decentralized management style, with a simple hierarchy, more internal communication, a sensitive structure and shorter decision-making time, and the ability to respond more quickly to changes in the external environment, it is more inclined to choose the exploratory innovation model, whereby propositions 1(e) and 1(f) are proposed.

H1(e): *The decentralized control system will lead to the choice of exploratory innovation model for smart supply chain companies*

H1(f): *The centralized control system will prompt smart supply chain companies to choose the exploitative innovation model.*

The detailed description of the supply chain control system is shown in Table 7. During the interview, the interviewed companies all indicated that the difference of the supply chain control system would have an impact on the choice of the innovation model.

Specifically, Company A indicated that different supply chain control systems would have differences in the choice of innovation models, and that decentralized control systems would enable more efficient information communication, resource reorganization, and deployment of related technical capabilities; Company B directly indicated that different control systems in different industries would lead to differences in the choice of innovation models; Company C and Company D also indicated that there would be some influence, such as centralized control systems. Company C and Company D also indicate that there are certain effects, for example, the centralized control style may inhibit innovation, and companies should develop appropriate control systems to help the development of innovation. Therefore, we believe that Hypotheses 1(e) and (f) are verified in this multi-case analysis.

[Insert Table 7 here]

4.2 External factors

4.2.1 Peer competition intensity

The intensity of peer competition refers to the extent to which competitors in a firm's industry are involved in competitive activities (Liu et al., 2018). In the process of smart supply chain innovation, the role of peer competition in driving smart supply chain innovation cannot be ignored (Liu et al., 2020). In a competitive supply chain environment, peer members, especially competitors providing homogeneous services, tend to provide better products or services under external pressure in order to fight for limited resources and markets (Ha et al., 2011). When facing high intensity peer competition, in order to attract customers, companies tend to compete among new products, services, and prices, and at this time, their activities are more inclined to technological innovation breakthroughs, which can enable them to greatly improve the performance of their products and effectively consolidate their competitive position in the market (Liu et al., 2018), so companies will choose the exploratory innovation model. However, when the intensity of peer competition is small, due to the characteristics of breakthrough innovation such as high investment and high risk, enterprises will incur huge losses if the innovation fails and may also lose their original market position as a result, so enterprises are often reluctant to take risks and choose the exploitative innovation mode instead. Based on the above analysis, we propose the following hypothesis.

H2(a) *Higher intensity of peer competition drives the choice of exploratory innovation models for smart supply chain firms*

H2(b) *Lower intensity of peer competition will prompt smart supply chain firms to choose the exploitative innovation model*

As shown in Table 8, Company A indicates that when the competition is fierce, we must actively develop new products or services to occupy more market share; Company B indicates that peer competition is also a mutual learning and exchange, of course, companies always want to do better than their rivals, and the fiercer the competition is, the more it can promote the technological innovation of the company; Company C indicates that it will innovate according to some Company C said that they will innovate according to some different business points in the peer competition, for example, from technology or from service, they will find some differentiated

service points in a certain business, so as to be closer to the users and understand their demands, which will undoubtedly have an impact on the innovation mode; Company D said that peer competition will definitely produce the phenomenon of benchmarking, in terms of innovation, the competition between enterprises is actually built on the process of learning from each other. Company D indicates that peer-to-peer competition will definitely produce the phenomenon of benchmarking, and in terms of innovation, the competition between companies is actually based on the process of learning from each other. Therefore, H2 is supported in multiple cases (a) and (b).

[Insert Table 8 here]

4.2.2 State policy support

There are numerous policies supporting the development of smart supply chain in China, which provides clear policy guidance and policy support for the development of smart supply chain innovation. The support of national policies will bring better development opportunities to the related industry chain and help promote the development of enterprises' businesses (Herstad et al., 2010). To some extent, national policies can be regarded as the business strategy of the external environment of the enterprise (Li et al., 2017), and the innovation model is the precondition and logical starting point for the analysis and selection of the strategy of the internal and external environment (Ju et al., 2016), so it is especially important to match the selection of the innovation model with the policy support in the context of smart supply chain development. By collecting, studying and disseminating national policies, enterprises can strengthen their perception and response to government policies and regulate their innovation behavior, which can help promote supply chain innovation from the implementation level. At the same time, the more linkage factors between enterprises and government policies, the more government policies in financing, industrial planning, talent attraction, etc., can provide direction for enterprises to choose their smart supply chain innovation models and timely guide them to adjust their own strategies and innovation models. Some scholars have shown that when the level of national policy support is low, enterprises tend to choose exploitative innovation (Liu et al., 2020), and when the level of national policy support is high, enterprises are more likely to choose exploratory innovation, and the strength of national policy support is more significant to its evolutionary speed. Accordingly, it is proposed that:

H2(c) *A high level of national policy support will prompt smart supply chain*

companies to choose exploratory innovation models

H2(d) *Low level of national policy support will prompt smart supply chain companies to choose the exploitative innovation model*

As shown in Table 9, all four firms indicated that national policies have an impact on the choice of supply chain innovation model, and these statements support our hypotheses H2(c) and H2(d).

[Insert Table 9 here]

4.3 Moderating factors

4.3.1 Moderating role of the level of application of smart technology

The penetration of emerging technologies in the supply chain is increasing, and the technological support system of smart supply chain including Internet, Internet of Things, big data, cloud computing, artificial intelligence, 5G network, etc. has been basically formed (Cheng et al., 2016). The level of wisdom technology application is an important weighting factor of enterprise wisdom supply chain innovation and the most widely applied moderating factor in organizational management research (Yang et al., 2017).

In the process of smart supply chain innovation, enterprises need to constantly adjust their strategies, network relationships and control systems in order to respond effectively to different levels of technology application. In terms of corporate strategic orientation, the level of smart technology application affects the choice of corporate strategic orientation; the higher the level of smart technology application, the more likely a company's strategic orientation will favor technology orientation and develop new products or services to be put into the market (Chang et al., 2019), and therefore will choose an exploratory innovation model; companies with a low level of smart technology application are more likely to use technology-following strategies, i.e., to follow other firms' strategies and imitate them, while reducing production and R&D costs, and to achieve gains by technology imitation, which will bring a sense of security (Valkokari et al., 2010), and therefore prefer the exploitative innovation model. In terms of supply chain network structure, the degree of application of smart technology can regulate the information interaction among network members, which greatly improves the efficiency of smart supply chain and helps companies find the innovation model that suits their development faster (Prause et al., 2019). In terms of the supply chain control system, core enterprises with high technological requirements mostly focus their main efforts on technological development in order to

strengthen their competitive advantage through continuous technological innovation, and thus it is appropriate to implement decentralized control over them. For subsidiaries with low technological requirements, the focus of the control of the dominant firm at this time is on the overall scheduling of shareable resources to reduce costs because their products and processes are already mature, and thus a centralized model is preferred (Büyüközkan et al., 2018). Accordingly, H3 is proposed.

H3 *The level of smart technology adoption positively moderates the relationship between internal factors and innovation patterns*

As shown in Table 10, Company A indicates that companies can better respond to the changes in the environment by using technological innovation capabilities. There are many modern information technologies, but not every company is good at and uses them, so they will go for technological innovation according to their own situation, and the application of smart technology will also have an impact on supply chain efficiency, optimize the supply chain structure and influence the innovation model of the company; Company B, as a technologically innovative company, takes smart technology as its strategic orientation, which means that the supply chain structure or operation mode of the company is still different, and the requirements for technology are also different, for example, some focus on information technology, some focus on equipment renewal, so there is actually an impact; Company C and Company D also indicate that the application of smart technology affects smart technology by Company C and Company D also indicate that the application of smart technology influences the choice of smart supply chain innovation model by regulating the internal factors of the company. These statements support our hypothesis 3.

[Insert Table 10 here]

4.3.2 Changes in the market environment

Market demand is usually considered as the co-creator of enterprise value, and the R&D, production, marketing, and logistics activities of enterprises will take market demand as the driving force and decision basis. The diversification of market demand will reshape the link between brand owners and consumers, so that the smart supply chain will transform to consumer-driven, the internal supply chain of

enterprises will iterate itself, and the specialization and service capability of the smart supply chain will be enhanced (Li et.al. 2018). In the process of smart supply chain innovation, the focus should be on the market and consumers, and changes in market demand will have an impact on the business content of the enterprise, which will affect the change of the innovation model (Yao, 2011). When market demand is volatile and changing, firms will pay more attention to government policy guidance and learning from the successful responses of their peers, and are more inclined to choose exploratory innovation models to shape the distinctive features of breakthrough innovation simple, convenient, and inexpensive to win market share (Gao et al., 2019), while when market demand is stable, competition among firms tends to be between price and service aspects. At this time, it is more inclined to choose the exploitative innovation model, which targets low prices, ease of use, and the ability to meet customers' basic needs. Accordingly, H4 is proposed.

H4 *Changes in market demand positively moderate the relationship between internal factors and innovation patterns*

During the interview process, the interviewed companies all indicated that the change of market demand would have an impact on the choice of innovation model. Specifically, Company A directly said that the market demand can be considered as the orientation of the enterprise, and the enterprise definitely takes customer satisfaction as the purpose; Company B said that intelligent supply chain innovation requires a lot of capital and energy investment, and if it is said that the market is particularly low on demand, then there will be less investment in technology or equipment accordingly; Company C said that their current service The innovation model is to provide consumers with the ultimate logistics experience, and at the same time make consumers perceive and sticky to the experience, attract delivery users to the platform and become lifelong users, these innovation models are based on market demand decisions; Company D needs to constantly adapt to the market demand, according to the market to always adjust, but from the adjustment to the maturity of the process, it requires a great transformation, and It takes a lot of time to adjust the innovation model or operation model to keep up with the market demand. These statements support our hypothesis 4.

[Insert Table 11 here]

5. Impact of Industry Differences

Company A and Company B are manufacturing companies and Company C and Company D are distribution companies in the case selected for this paper. Manufacturing companies have clear functional aspects such as market positioning, product development, forecasting, production planning, logistics planning, purchasing planning, finished goods shipping planning, inventory and logistics information control (Lima et al., 2019), while distribution-oriented firms are more of one of these links or functions. During the interviews, we also summarized the factors influencing the choice of smart supply chain innovation model based on industrial characteristics.

5.1 Factors influencing the choice of manufacturing-oriented smart supply chain innovation model

In the smart manufacturing environment, creating a smart and efficient supply chain is the key for manufacturing companies to gain an advantage in the market competition. From the interviews, we found that manufacturing companies Company A and Company B would pay more attention to the difference in their proximity to suppliers, which has a significant impact on the manufacturing companies' resource access, business decisions, choice of supplier management practices, and performance outcomes (Kusiak et al., 2108). Manufacturing firms with a central location in the supplier network will have more access and opportunities to access network resources, thus enabling manufacturing firms to integrate more of their suppliers' innovations to develop new products (Tao et al., 2018). At the same time, the geographical proximity of suppliers to manufacturing firms can effectively avoid information transmission distortion and increase the speed of acquiring new knowledge by manufacturing firms (Davis et al., 2012). Therefore, the difference in distance between manufacturing firms and suppliers affects the choice of smart supply chain innovation models. Accordingly, H5 is proposed:

H5 *The difference in distance between manufacturing companies and suppliers affects the choice of smart supply chain innovation models by manufacturing companies*

As shown in Table 12, Company A indicates that the closer the distance to suppliers, the more it can lead to mutual sharing of resources among supplier network members through rights, and also increase the loyalty of suppliers to keep the supplier network

stable, which has a positive impact on innovation; Company B indicates that the smaller the difference in distance to suppliers, it can create good conditions for generating new technologies or models in the network, thus enables manufacturing companies to leverage network capabilities to obtain more of the resources they need for their own product innovation. These statements support our H5.

[Insert Table 12 here]

5.2 Influencing Factors of Circulation-based Smart Supply Chain Innovation Model Selection

The smart supply chain in the circulation field is an important support for the development of the tertiary industry. At present, in the large circulation field, the smart supply chain with distribution companies as the core is focusing on meeting consumer demand, actively carrying out Omni channel operation, highlighting service characteristics, and fully applying information technology to achieve continuous innovation and optimization (Li et al., 2018). Through the interviews we found that the distribution companies Company C and Company D would pay more attention to the supply chain integration approach. As a bridge between product producers and consumers, distribution companies can link and integrate upstream and downstream resources in the supply chain, and deepen collaboration among supply chain participants by sharing the use of logistics resources of each company under the principle of synergy and sharing. The supply chain integration in the distribution field can start from the theoretical and practical innovation of distribution management, system construction and business operation, and promote the innovation of the form and structure of trade logistics with the adjustment of production and marketing relationship (Xie et al., 2013), and the difference of supply chain integration refers to the different focus of supply chain integration of different enterprises, for example, some distribution enterprises focus more on being able to effectively connect goods For example, some distribution companies focus more on being able to effectively connect suppliers and manufacturers and establish close partnerships with retailers in major markets (Chao, 2015); some distribution companies focus more on leveraging their existing strengths while developing online sales models to achieve offline and online omni channel integration (Le et al., 2017). Therefore, differences in supply chain integration approaches can have an impact on the choice of supply chain innovation models. Accordingly, we propose H6:

H6 *In distribution-oriented enterprises, supply chain integration differences affect the choice of smart supply chain innovation models*

As shown in Table 13, Company C indicates that now the distribution industry is not only price and product competition, but also supply chain competition, and for us the most critical information flow integration, the focus of supply chain integration is different, and the innovation model will be different; Company D indicates that now the main focus is to strengthen the information technology support for integration development, and our integration is not only a certain Our integration is not only the development of a particular link, but must be the overall integration of the whole supply chain development. These statements support our H6.

[Insert Table 13 here]

5.3 Theoretical Framework for Influencing Factors of Smart Supply Chain Innovation Model Selection

This study explores the factors influencing the selection of smart supply chain innovation model, investigates the correlation between these influencing factors and obtains six propositions. Figure 1 presents the theoretical framework and describes the relationship pattern among the six propositions of this study.

[Insert Figure 1 here]

6. Conclusions and management insights

6.1 Conclusion

This paper adopts a multi-case study approach to obtain a more realistic theoretical framework of factors influencing the choice of smart supply chain innovation model with a strong reference value by taking four companies from China that are engaged in smart supply chain innovation as case study objects. The research of this paper draws the following conclusions: First, this paper innovatively proposes the internal and external factors influencing the choice of smart supply chain innovation model. Based on the results of enterprise interviews and generalization, we identified three

internal factors and two external factors that affect the choice of smart supply chain innovation model, namely, enterprise strategic orientation, supply chain network relationship, supply chain control system, peer competition and national policies. Second, at the same time, we also found the positive moderating effect of the application of smart technology and market demand on this process. Third, we examined the influence of enterprise types and found that different industries have different focuses on the selection of supply chain innovation models. Manufacturing companies will pay more attention to the distance difference with suppliers, while the distribution industry pays more attention to the focus and way of supply chain integration, and these differences will have an impact on the choice of exploitative and exploratory innovation models.

6.2 Management insights

Based on the findings obtained from this paper, the following management insights can be provided to supply chain business managers.

First of all, when choosing the utilization and exploratory innovation models, companies should first analyze both internal and external factors. The research in this paper shows that internal factors include corporate strategic orientation, supply chain network relationship, and supply chain control system; external factors include peer competition intensity and national policies will have an impact on the choice of exploitative and exploratory innovation models, thus managers can consciously identify the above influencing factors in the process of innovation.

Secondly, managers need to explore the innovation model suitable for themselves according to the differences of industries. Managers need to reasonably position their own supply chain, then analyze the position of enterprises in the supply chain, deeply understand the main members of the supply chain, consider the distance difference between manufacturers and suppliers and the supplier integration difference in distribution enterprises, and make accurate judgments and predictions on internal and external understanding, so as to better realize intelligent supply chain innovation.

Finally, the framework of factors influencing smart supply chain innovation model proposed in this paper is not only applicable to companies building smart supply chains, but also can be extended to other industries that need innovation, and can provide necessary reference for managers in these industries when they carry out innovation activities.

There are still some limitations in this paper. Firstly, we have made a relative

comparison of the degree of smart supply chain construction of four enterprises, but we have not built a detailed index system to evaluate them, which can be improved in the subsequent study, so that we can better compare the degree of smart supply chain development of each enterprise. Secondly, the internal and external influencing factors selected in this paper failed to consider more influencing factors. Thirdly, since the case samples in this paper are taken from local logistics enterprises in China, the conclusions may be more applicable to logistics enterprises in China. Future research can be extended to other countries to conduct more extensive studies.

References

Cai Jin. The only way to develop a smart supply chain towards high-quality development[N]. Learning Times, 2019-03-29(003).

Wu, L., Yue, X., Jin, A., & Yen, D. C. (2016). Smart supply chain management: a review and implications for future research. The International Journal of Logistics Management.

Weihua Liu, Jiahui Zhang, Shuang Wei, Di Wang. Factors Influencing Organizational Efficiency in a Smart-Logistics Ecological Chain under e-Commerce Platform Leadership. International Journal of Logistics: Research and Application. 2020.

Wen Danfeng, Zhou Penghui. 2019. Smart Supply Chain: Supply Chain Management and Reform in the Intelligent Era. Electronic Industry Press.

Morgan, R. E. , & Berthon, P. (2008). Market orientation, generative learning, innovation strategy and business performance inter-relationships in bioscience firms. Journal of Management Studies.

Lin Chunpei, Yu Chuanpeng, & Wu Dongru. (2015). Research on the impact of exploratory learning and exploitative learning on enterprise disruptive innovation. Research and Development Management, 27(06), 23-32.

Zhao Jianyu, Liao Wenqi, & Xixi. (2019). The relationship between entrepreneurial orientation and exploratory innovation: a dual intermediary effect model. Management Science, 32(2), 33-49.

Wu Yingying. (2019). Research on the impact of organizational foresight on exploratory and exploitative innovation (Master's thesis, Xi'an University of Technology).

Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M. J. (2017). Big data in smart farming – a review. Agricultural Systems, 153, 69-80.

Abdel-Basset, M., Manogaran, G., & Mohamed, M. (2018). Internet of Things (IoT) and its impact on supply chain: A framework for building smart, secure and efficient systems. Future Generation Computer Systems, 86, 614-628.

Yan, J., Xin, S., Liu, Q., Xu, W., Yang, L., Fan, L., ... & Wang, Q. (2014). Intelligent

supply chain integration and management based on cloud of things. International Journal of Distributed Sensor Networks, 10(3), 624839.

Nakandala, D., & Lau, H. C. (2019). Innovative adoption of hybrid supply chain strategies in urban local fresh food supply chain. Supply Chain Management: An International Journal.

Matos, S., & Hall, J. (2007). Integrating sustainable development in the supply chain: The case of life cycle assessment in oil and gas and agricultural biotechnology. Journal of Operations Management, 25(6), 1083-1102.

Weihua Liu , Yanjie Liang , Xing Bao , Juanjuan Qin & Ming K. Lim (2020): China's logistics development trends in the post COVID-19 era, International Journal of Logistics Research and Applications, DOI: 10.1080/13675567.2020.1837760

Abdelkafi, N., & Pero, M. (2018). Supply chain innovation-driven business models. Business Process Management Journal.

Wu, L., Yue, X., Jin, A., & Yen, D. C. (2016). Smart supply chain management: a review and implications for future research. The International Journal of Logistics Management.

Gupta, S., Drave, V. A., Bag, S., & Luo, Z. (2019). Leveraging smart supply chain and information system agility for supply chain flexibility. Information Systems Frontiers, 21(3), 547-564.

Li Yufeng, Xing Linlin. Construction of performance evaluation index system for smart supply chain. Statistics and Decision, 2017 (3): 183-185.

Xu Xinxin, Guo Huanhuan. Research on smart supply chain performance based on fuzzy comprehensive evaluation. Smart Factory, 2017 (8): 67-69, 72.

Zhong Genyuan,Zhang Xian,Chen Zhihong. (2019). Dynamic analysis of product innovation and process innovation of upstream and downstream enterprises under negative externalities. Journal of Systems Management, 28(03): 440-447+456.

Maroofi F. 2015. Examining the dynamics of cooperation between competing firms in their R&D activities (R&D co-Opetition) . The South

East Asian Journal of Management.

Long Yong, Zhou Jing. (2015). Collaboration ability and its influence in supply chain collaborative technology innovation. Soft Science (1), 47-52.

Wu Xiaobo, Chen Xiaoling, & Li Jingyan. (2015). Research on the impact mechanism of strategic orientation and innovation mode on corporate performance. Studies in Science of Science, 33(001), 118-127.

Gao Yunfeng. (2014). Balance strategy between exploratory innovation and utilization innovation. Operation and management.

Hippel, E. V., & Krogh, G. V. (2003). Open source software and the "private-collective" innovation model: Issues for organization science. Organization science, 14(2), 209-223.

Chesbrough, H. . (2010). Business model innovation: opportunities and barriers. Long Range Planning, 43(2-3), 354-363.

Guiso, L., Sapienza, P., & Zingales, L. (2015). The value of corporate culture. Journal of Financial Economics, 117(1), 60-76.

DiBella, A. J., Nevis, E. C., & Gould, J. M. (1996). Understanding organizational learning capability. Journal of management studies, 33(3), 361-379.

Jansen, J. J., Van Den Bosch, F. A., & Volberda, H. W. (2006). Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. Management science, 52(11), 1661-1674.

Charue-Duboc, F., Aggeri, F., Chanal, V., & Garel, G. (2010, May). Managing exploratory innovation. In Back to the Future.

Arlbjørn, J. S., de Haas, H., & Munksgaard, K. B. (2011). Exploring supply chain innovation. Logistics research, 3(1), 3-18.

Ribau, C. P., Moreira, A. C., & Raposo, M. (2019). The role of exploitative and exploratory innovation in export performance: an analysis of plastics industry SMEs. European Journal of International Management, 13(2), 224-246.

Huang Zhenhui.The difference and approach arrangement between multi-case and single-case studies: theoretical discussion and case analysis[J].Management Case

Studies and Reviews,2010,3(02):183-188.

Aaboen, L. , Dubois, A. , & Lind, F. . (2012). Capturing processes in longitudinal multiple case studies. Industrial Marketing Management, 41(2), 235-246.

Eisenhardt, K. M. (1989) . “Making fast strategic decisions in high-velocity environments.” Academy of Management journal, Vol. 32 No.3, pp. 543-576.

Ren, F., and Zhang. P. (2017). “The relationship between entrepreneurial team heterogeneity, team interaction, and decision performance: a multi-case study”, China Human Resources Development (4)

Douglas, and David. (2003). “Grounded theories of management: a methodological review”, Management Research News, Vol. 26 No. 5, pp. 44-52.

Zheng, C., A. Xu., and J. Zhao. (2011). “Research on business model structure model based on cross-case rooted analysis”. Management Science, Vol. 04, pp. 3-15.

Sony, M. . (2020). Pros and cons of implementing industry 4.0 for the organizations: a review and synthesis of evidence.

Chatzoglou, P. D., Diamantidis, A. D., Vraimaki, E., Vranakis, S. K., & Kourtidis, D. A. (2011). Aligning IT, strategic orientation and organizational structure. Business Process Management Journal.

Doz Y L, Kosonen M. 2010. Embedding strategic ability：A leadership agenda for accelerating business model renewal [J].Long Range Planning, 43(2-3)：370-382.

Lin, Y., Wang, Y., & Yu, C. (2010). Investigating the drivers of the innovation in channel integration and supply chain performance: A strategy orientated perspective. International Journal of Production Economics, 127(2), 320-332.

Grawe, S. J., Chen, H., & Daugherty, P. J. (2009). The relationship between strategic orientation, service innovation, and performance. International Journal of Physical Distribution & Logistics Management.

Al-Ansaari, Y., Bederr, H., & Chen, C. (2015). Strategic orientation and business performance. Management Decision.

Schlüter, F., & Hetterscheid, E. (2017). Supply chain process oriented technology-framework for Industry 4.0. In Digitalization in Supply Chain Management and Logistics: Smart and Digital Solutions for an Industry 4.0

Environment. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 23 (pp. 275-299).

Wu Xiaobo, Chen Xiaoling, & Li Jingyan. (2015). Research on the impact mechanism of strategic orientation and innovation mode on corporate performance. Studies in Science of Science, 33(001), 118-127.

Huang Chengcheng, Ye Chunsen, Wang Xuexuan, & Shi Zhangman. (2018). Research on the Construction of Smart Supply Chain System. Value Engineering, v.37; No.499(23), 129-131.

Sun Yonglei, Song Jing, Xie Yongping. 2015. The impact of corporate strategic orientation on innovation activities: a case study from Apple. Science of Science and Management of Science and Technology. 36(02):101-110.

Sabri, Y., Micheli, G. J., & Nuur, C. (2018). Exploring the impact of innovation implementation on supply chain configuration. Journal of Engineering and Technology Management, 49, 60-75.

Chang, C. W., Chiang, D. M., & Pai, F. Y. (2012). Cooperative strategy in supply chain networks. Industrial Marketing Management, 41(7), 1114-1124.

Lin Han. (2018). Research on the influence of supply chain network form, network capability and enterprise service innovation performance. (Doctoral dissertation).

Williams, Z., & Moore, R. (2007). Supply chain relationships and information capabilities: the creation and use of information power. International Journal of Physical Distribution & Logistics Management, 37(6), 469-483.

Delbufalo, E. (2012). Outcomes of inter-organizational trust in supply chain relationships: a systematic literature review and a meta-analysis of the empirical evidence. Supply Chain Management: An International Journal, 17(4), 377-402.

Ivanov, D., Sokolov, B., & Kaeschel, J. (2010). A multi-structural framework for adaptive supply chain planning and operations control with structure dynamics considerations. European journal of operational research, 200(2), 409-420.

Liu Baohong. (2019). Complex supply chain control - an example of commercial large aircraft and automotive industry. China Industry and Information Technology (07), 40-44.

Zeng, Fangping & Pan, Xin. (2017). Research on cost control in retail industry based on supply chain model. Research in Business Economics (10), 27-28.

Wang G, Liu K & Wang YL. (2010). A methodological and empirical study on supply chain control of enterprise groups. Productivity Research (12), 244-245+252.

Liu, W., Wang, D., Shen, X., Yan, X., & Wei, W. (2018). The impacts of distributional and peer-induced fairness concerns on the decision-making of order allocation in logistics service supply chain. Transportation Research Part E: Logistics and Transportation Review, 116, 102-122.

Ha, A. Y., Tong, S., & Zhang, H. (2011). Sharing demand information in competing supply chains with production diseconomies. Management science, 57(3), 566-581.

Herstad, S. J., Bloch, C., Ebersberger, B., & Van De Velde, E. (2010). National innovation policy and global open innovation: exploring balances, tradeoffs and complementarities. Science and Public Policy, 37(2), 113-124.

Li, B., & Li, Y. (2017). Internet of things drives supply chain innovation: A research framework. International Journal of Organizational Innovation, 9(3), 71-92.

Ju, K. J., Park, B., & Kim, T. (2016). Causal relationship between supply chain dynamic capabilities, technological innovation, and operational performance. Management and Production Engineering Review, 7.

Cheng, G. J., Liu, L. T., Qiang, X. J., & Liu, Y. (2016, June). Industry 4.0 development and application of intelligent manufacturing. In 2016 international conference on information system and artificial intelligence (ISAI) (pp. 407-410). IEEE.

Yang Dapeng, Cai Ning, & Pan Songting. (2017). The differential impact of strategic orientation on enterprises' dual technological innovation-the moderating effect of technological environment. Technological economy (2).

Chang, S. E., Chen, Y. C., & Lu, M. F. (2019). Supply chain re-engineering using blockchain technology: A case of smart contract based tracking process. Technological Forecasting and Social Change, 144, 1-11.

Valkokari, K., Kansola, M., & Valjakka, T. (2011). Towards collaborative smart supply chains–capabilities for business development. International Journal of Enterprise Network Management, 4(4), 380-399.

Prause, G. (2019). Smart contracts for smart supply chains. IFAC-PapersOnLine, 52(13), 2501-2506.

Büyüközkan, G., & Göçer, F. (2018). Digital Supply Chain: Literature review and a proposed framework for future research. Computers in Industry, 97, 157-177.

Li, L. , T. Chi , and T. Hao .2018. "Customer demand analysis of the electronic commerce supply chain using Big Data." Annals of Operations Research 268(1-2):113-128.

Yao,J.M,2011,"Supply chain scheduling optimisation in mass customisation based on dynamic profit preference and application case study".Production Planning and Control22(7):690-707.

Gao Yunfeng. (2014). Balance strategy between exploratory innovation and utilization innovation. Operation and management.

Lima, C. F. D. , Elst, L. A. V. D. , Koraganji, V. N. , Zheng, M. , & Gumennik, A. . (2019). Towards digital manufacturing of smart multimaterial fibers. Nanoscale Research Letters, 14(1), 209.

Kusiak, A. (2018). Smart manufacturing. International Journal of Production Research, 56(1-2), 508-517.

Tao, F., Qi, Q., Liu, A., & Kusiak, A. (2018). Data-driven smart manufacturing. Journal of Manufacturing Systems, 48, 157-169.

Davis, J., Edgar, T., Porter, J., Bernaden, J., & Sarli, M. (2012). Smart manufacturing, manufacturing intelligence and demand-dynamic performance. Computers & Chemical Engineering, 47, 145-156.

Xie, Lijuan. (2013). The distributor-led supply chain model and its realization - A comparative transformation perspective of similar distribution channels. Economic Theory and Economic Management (07), 103-112.

Le Xiongping & Wei Guochen. (2017). Review and prospect of supply chain development in China's trade circulation industry. China Supply Chain Development

Report (00), 135-148.

Table 1 Comparison of this paper with existing literature

Literature	Liu et al. (2020)	Arlbjørn et al. (2011)	Ribau et al. (2019)	This article
Topics	Research on Path Design of Smart Supply Chain Innovation	Exploring supply chain innovation	Research on exploitative versus exploratory innovation	Factors influencing the choice of smart supply chain innovation model
Method	Exploratory research	Case Studies	Empirical analysis	Multiple case studies
Smart Supply Chain	✓	×	×	✓
The choice of innovation model	×	×	✓	✓

Table 2 Basic information of the four case companies

Types	Company	Founded	Enterprise scale	Enterprise innovation advantage	Service object	Construction of smart ecological chain
Manufacturing companies	A	1987	Larger（170000）	Insist on independent innovation, including chips, 5G technology, artificial intelligence, digital platform	Individuals and consumers	Released the "Digital Platform" and proposed a new positioning of the enterprise to realize "Ubiquitous Connectivity + Digital Platform + Omnipresent Intelligence".
	B	1953	Larger（140000人）	Enterprise innovation is concentrated in four major fields: new energy, intelligent network connection, new materials, and artificial intelligence.	Individuals and consumers	Continuously strengthen the information construction and complete one-stop online procurement and digital management of matching, order placing, approval, execution, delivery and settlement through a unified portal.
Circulation-based companies	C	1999	Medium（12000人）	Self-developed OMS, TMS, WMS and other technical services, EDI data docking and other services, with intelligent logistics warehouse base of 2.2 million square meters	Chinese brand companies such as Haier, Jingdong, Ali and Cainiao work with second and third tier brands on franchising and distribution issues.	Large logistics, IoT scenario logistics ecological platform, providing the whole chain and whole process services for brand owners and users.
	D	1999	Larger（221775人）	R&D data-driven and application of advanced technologies such as IT+process, unmanned libraries, artificial intelligence, Internet of Things, blockchain, wireless RF, mobile Internet, etc.	Mainly serves all kinds of comprehensive logistics companies and cargo owners such as warehousing, transportation and freight	Combined with the value model of intelligent logistics, the basic path of "digital transformation, intelligent operation, network reconstruction and disruptive change" has been formed.

					forwarding.	

Table 3 Open coding variables

Category	Description
Corporate Strategic Orientation	Company C: "Corporate strategy indicates the direction of the future development of the enterprise, and the supply chain innovation model is decided according to the direction of the enterprise development". Company D: "Whether it is corporate innovation or supply chain innovation, the first thing to consider is the positioning of corporate strategy".
Supply Chain Structures	Company B: "The structure in the smart supply chain is more complex, and different companies should choose the innovation model according to the characteristics of their own corporate supply chain". Company A: "Supply chain innovation involves three structural dimensions: horizontal structure, vertical structure and the horizontal position of the company in the supply chain, then the difference of these three dimensions will have a direct impact on the innovation model".
Supply Chain Networking	Company A: "Networking is the basis of our smart supply chain innovation, and automation is all carried out based on the network structure". Company C: "The future supply chain structure is definitely a network, and each of our links will be rebuilt and reassembled, which will help to achieve accurate management".
Supply Chain Control	Company C: "The innovation of smart supply chain is based on the good relationship between upstream and downstream of the supply chain, but due to the different status and voice of enterprises in the supply chain, the control mode of the supply chain is different, such as Apple, Samsung and other innovation models will be different". Company D: "In the process of smart supply chain innovation, many problems are caused by unclear positioning of supply chain members and fragmented functions, so supply chain control is very important".
Industry Competition	Company A: "We will learn from the successful cases of related companies and refer to their innovation models". Company B: "It is very important to summarize the successes and failures of other peers, and then explore our own innovation model".
Customer Needs	Company C: "Innovation is to meet the diversified needs of our customers, and we will adjust the innovation model of our company according to the needs of our customers". Company D: "Consumer demand is becoming more and more scenario-based, and in the segmentation of the population, we understand user needs in a timely manner through 100,000 cars and micros, and feed their needs back to our

	platform, after which we provide a total solution to the user, ultimately realizing smart supply chain innovation".
Differentiated Services	Company B: "For consumer demand, we have to provide more differentiated and refreshing services to consumers, which will also lead to different innovation models". Company C: "Referring to the innovation model of peers, in order to occupy the market and provide differentiated services, companies will explore the innovation model according to their own situation".
Policy Support	Company A: "National policies determine the general direction of the overall development of the industry and will have a greater impact on the innovation model". Company C: "We will refer to the national policy, as well as make decisions on the supply chain innovation model of the company according to the projects supported by the government".
Information Technology Applications	Company B: "The technology revolution is redefining the supply chain, from the Internet of Things, cloud computing, big data, artificial intelligence, technology has become the main engine driving the development of the logistics industry, and the degree of application of innovative technologies affects the choice of innovative models". Company D: "The use of innovative Internet information technology has created efficient end-to-end full network direct distribution solutions, which are also changing the innovation model of enterprises"。
Intelligent Device Innovation	Company C: "We adopt the unmanned technology in the fields of digitalized intelligent system and unmanned warehouse of the whole chain, and promote the construction of global intelligent supply chain infrastructure network based on the digital supply chain of big data". Company B: "At present, we are mainly promoting the implementation of some projects similar to unmanned warehouse, unmanned vehicle, unmanned robot handling, etc.

Table 4 Spindle coding analysis

Types	Category	Concept
Internal factors	Corporate Strategic Orientation	Corporate Strategic Orientation
	Supply Chain Network Relationships	Supply Chain Structure Supply Chain Networking
	Supply Chain Control System	Supply Chain Control
External factors	Peer competition	Peer competition
	National policy support	Policy Support
Moderating factors	The degree of application of intelligent technology	Information Technology Applications Intelligent device innovation
	Changes in market demand	Customer Needs differentiated services

Table 5 Description of the factors influencing the strategic orientation of the four companies

Name	Description
Company A	"The strategic orientation of the company will have an impact on the selection of the innovation model, for example, in terms of corporate policy, the relevant policies formulated according to the corporate strategy will have a significant propulsive effect on the selection process of the innovation model."
Company B	"Strategy is an action plan used to achieve future goals, and our company's strategy is biased towards technology orientation and will choose to focus on the technological part of the innovation process in the company, which also gives direction to the choice of the innovation model."
Company C	"Our product development needs to be adept at uncovering and satisfying the unseen needs of our customers, and this is part of our corporate strategy, so we will base our innovation activities on this as we innovate as a company."
Company D	"We will improve and innovate our service model according to the general direction of the market, which in turn will influence our choice of innovative models."

Table 6 Description of the factors influencing the differences in supply chain structure by the four companies

Name	Description
Company A	"Strong relationships in the supply chain can bring a constant and stable supply and demand, and companies should be able to choose the right innovation model based on the differences in supply chain network relationships."
Company B	"The supply chain network relationship in our industry is relatively complex, different enterprises have different relationship structures, is a relatively closed space, in the choice of innovation model is will need to consider the construction of the entire supply chain network relationship."
Company C	"There will be a direct impact, and supply chain network relationships are an important factor to consider in the process of innovation, which is the process of reinventing supply chain relationships."
Company D	"There will be a certain impact of, for example, the supply chain network relationship is not close, then the overall scheduling capacity of the organization is more demanding, which may increase the difficulty and complexity brought by innovation."

Table 7 Description of the factors influencing the supply chain control system by the four companies

Name	Description
Company A	"Different supply chain control system for the choice of the innovation model will vary, decentralized control system can be more efficient information communication, reorganization of resources and deployment of related technical capabilities."
Company B	"Every time we talk about innovation internally, we will consider the issue of upstream and downstream convergence, that is, we must take into account the innovation of partners, there may be times when you enter a certain segment of the industry, the degree of control inside the industry may not be the same as yours, some may be relatively monopolistic, some industries may be relatively open market may be some."
Company C	“Establishing a proper control system is also positive for us to explore the innovation model that suits us.”
Company D	“The control system will have an impact on the innovation model because there are times when a centralized control model may inhibit innovation, and companies should develop an appropriate control system to help the development of innovation.”

Table 8 Description of peer competition by the four companies

Name	Description
Company A	"When competition is more intense, we have to be aggressive in developing new products or services to capture more market share."
Company B	"Peer competition is also a mutual learning exchange, of course we always want to do better than our rivals, the more intense the competition the more we can promote our technological innovation."
Company C	"There will be an impact, we will innovate according to some different business points in the peer competition, for example, whether from the technology or from the service, we will find some differentiated service points in a certain business to be closer to the user, and our service recipients to go more to dig his needs, the main understanding of his demands, which will undoubtedly have an impact on the innovation model impact."
Company D	"Peer-to-peer competition will certainly produce the phenomenon of benchmarking, in terms of innovation, the competition between companies is actually built on the process of learning from each other, to do better than the opponent, in order to get more of the pie in the market."

Table 9 Description of national policy influencing factors by the four companies

Name	Description
Company A	"The policies introduced by the state will certainly have an impact on the industry, indicating the general direction of the industry, and we will adjust our model in a timely manner according to international policies or government support."
Company B	"National policies will have an impact, such as smart manufacturing or policies related to Industry 4.0, the promotion of smart manufacturing factories, so in fact the national policy to promote the whole chain of innovation."
Company C	"Yes, the national policy will go to guide the practice of enterprises, both technological innovation and service innovation model will have an impact."
Company D	"The impact of the national policy is more focused on our port service model. For example, the customs for the business of ore, which previously required a customs certificate, now the policy change can be chosen by the shipper, then our service model will also change accordingly."

Table 10 Description of the impact of the four companies on the application of smart technologies

Name	Description
Company A	"Companies can use technological innovation capabilities to better respond to changes in the environment, there are many modern information technology, but companies are not every good at and use, so that still according to their own situation to technological innovation, and the application of intelligent technology will also have an impact on the efficiency of the supply chain, promote the supply chain network relationships, and affect the business innovation model. "
Company B	"For us, technology upgrade is actually a direction of innovation, which is equivalent to one of our corporate strategy orientation, but the supply chain structure or operating model of enterprises is still different, which is also different for technology requirements, such as some focus on information technology, some focus on equipment updates, so that there is actually still an impact. "
Company C	"The advanced technology can also measure whether the smart supply chain innovation model is successful, for example, in the past, unloading and loading must be manual, mechanized operation is mainly to take forklift operation, but now with the maturity of robot technology and vision 3D technology, now you can achieve automated loading, this is a very direct example, but also our service in the This is a very direct example and an innovative model of our service."
Company D	"The application of smart technology aims to facilitate the development of dynamic technological capabilities that determine the mechanisms for transferring and sharing

	information within the organization, the ways and means of allocating resources within the organization, and smart technology also strengthens our control over suppliers, for example by requiring further data sharing among suppliers."

Table 11 Description of the factors influencing market demand by the four companies

Name	Description
Company A	"Market demand can be considered our guide, and we offer both products and services that are constantly innovating as market demand changes, and we definitely aim for customer satisfaction."
Company B	"That's for sure, innovation requires a lot of money and energy to invest, and if the market is particularly low on demand, then we will invest less in the corresponding technology, or equipment."
Company C	"Just like our current service innovation model, we provide the ultimate logistics experience for consumers while making them perceive and stick to our experience, attracting delivery users to our platform and becoming lifelong users, and continuously optimizing our service capabilities based on customer demand, which is based on decisions made by market demand. "
Company D	"There is an impact, for us, we continue to adapt to the needs of the market, according to the market to always adjust, but from the adjustment to maturity of this process, it requires us a great transformation, it takes a lot of time to adjust the innovation model or operating model to keep up with the market demand."

Table 12 Impact of manufacturer-supplier distance differences on innovation model choice

Name	Description
Company A	"The closer the better, of course, so that we can not only enable mutual sharing of resources among supplier network members through rights, but also increase supplier loyalty to keep the supplier network stable, which has an impact on the innovation model."
Company B	"The smaller the distance differences, the better conditions are created for new technologies or models to emerge from the network, thus allowing manufacturing companies to leverage network capabilities to access more of the resources they need for their own product innovation."

Table 13 Impact of supplier integration differences in distribution firms on the choice of innovation model

Name	Description
Company C	"Now the distribution industry is no longer just price and product competition, but the competition of the supply chain in, for us the most critical information flow integration, the supply chain integration focus is different, the innovation model will also be different."
Company D	"We are now mainly strengthening the integration of the development of information technology support, our integration is not only the development of a particular link, but must be the whole integration of the whole supply chain development."

Figures

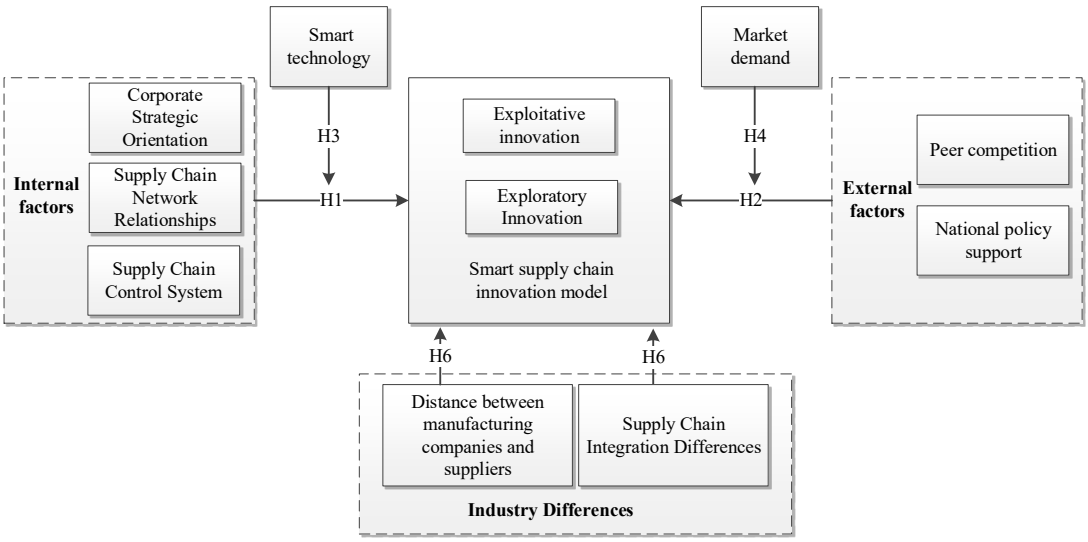

Figure 1 Model of factors influencing the choice of smart supply chain innovation model

Note 1: The H number corresponds to the proposition in the text.

Note 2: + indicates a positive relationship between factors