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Exploring the Factors to Promote Circular Supply Chain Implementation in the Smart Logistics Ecological Chain

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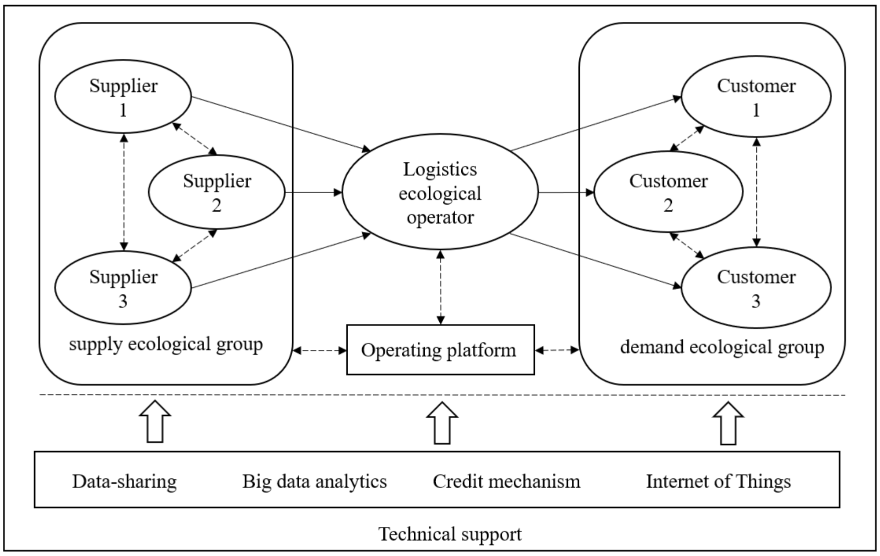
Abstract: Along with the fast development of smart logistics and B2B cooperation, smart logistics ecological chain (SLEC) has emerged as an important way in promoting circular supply chain implementation (CSCI). This research adopted case study methodology with four selected cases to explore the factors affecting CSCI in the SLEC. After data analysis following the resource-based view (RBV), five factors affecting CSCI were identified, including smart asset investment, multi-scenario service capability, and SLEC interaction. The research results indicated that those four factors have positive effects on supply-demand matching (SDM), which then positively promotes CSCI. Meanwhile, the results highlighted that the effect of personalized demand on SDM changes from negative to positive over time. However, personalized demand has a directly negative impact on CSCI. In addition to relying on the intermediary role of SDM, smart asset investment and SLEC interaction also have a directly positive impact on CSCI via enhancing consumers' interest in participating in CSCI and improving the operational efficiency of the SLEC.

Keywords: circular supply chain implementation (CSCI); smart logistics ecological chain (SLEC); multi-case study; supply-demand matching (SDM).

1. Introduction

The circular economy, which refers to an industrial economy that aims to achieve greater sustainability with restorative objects and design (Ghisellini et al., 2016), has attracted huge attentions from countries like China, the United States, and Japan (Suzanne et al., 2020). One of the essential purposes of the circular economy is to recover value from tangible commodities through a closed loop of recycling and energy recovery (Ashby, 2018). In general, the execution of a circular economy project involves not only the circularity of the manufacturing system, but also the collaboration with other members throughout the entire supply chain (Suzanne et al., 2020). Therefore, the importance of the circular supply chain for the development of the circular economy has been proven in recent years (Dubey et al., 2019).

With the fast development of smart logistics and business innovation, many stakeholders have begun to work together and achieve B2B cooperation, which forms a smart logistics ecological chain (SLEC). The SLEC is a new service supply chain structure composed of a supply ecological group, a logistics ecological operator and a demand ecological group (Liu et al., 2020; Liu et al., 2021b), as described in Figure 1. The supply ecological group involves members who provides products or services to customers, such as product sellers, logistics service providers, financial service providers. Within a SLEC, members in the supply ecological group can achieve resource sharing and mutual benefits. The demand ecological group is a community where customers can share information and communicate with each other. The logistics ecological operator is the core of a SLEC with the support of data sharing, big data analytics, credit mechanism and Internet of Things. The main goal of a logistics ecological operator is to achieve an efficient and effective matching between the supply and demand groups. Whether applied to a service enterprise or a service supply chain, SDM has proven to be an essential capability for the successful development of service operations (Liu et al., 2019b). Therefore, this capability is also valued in the SLEC, which is an important type of service supply chain.



Note. The dotted lines denote information flows, while the solid lines denote product/service flows.

Figure 1. The structure of smart logistics ecological chain

Through theoretical and practical analysis (see Section 2.4), we found that the SLEC is an important supply chain type for promoting circular supply chain implementation (CSCI). However, to make full benefits of building and managing the SLEC to promote CSCI is a challenging task. One of the critical difficulties is to identify and clarify the impact of various factors in the SLEC development process on CSCI (Liu et al., 2021a). Although many studies have qualitatively or quantitatively discussed various ways to promote CSCI (Gu et al., 2019; Elia et al., 2020; Wang et al., 2020), research on the impacting factors on connecting SLEC and CSCI is still scarce. This study aims to fill this research gap by answering the following research questions: ***How do factors in the SLEC development process affect CSCI? What role does SDM play in the relationship between factors affecting CSCI and CSCI?***

To address the research questions, we adopted the resource-based view (RBV) to identify and classify potential impacting factors and employed a multi-case study method. The RBV defines a firm as a bundle of resources and capabilities, which has been widely used in the strategic management literature and has been increasingly applied to the field of supply chain management in recent years (Wu et al., 2006; Yu et al., 2018; Zimmermann et al., 2020). Following the RBV, we aimed to identify valuable and unique resources/capabilities in the SLEC development process. After coding and analyzing the interview transcripts, five factors were identified in this paper. Through the multi-case analysis, the influence paths of these identified resources/capabilities on CSCI were derived.

This research makes the following contributions. First, different from current literature, this study explored factors affecting CSCI in the SLEC development process, which provides a new direction for the circular supply chain management research. While the existing research are more focused on effective ways to promote CSCI in the traditional supply chain structures (Gu et al., 2019; Elia et al., 2020; Wang et al., 2020). Second, many existing studies still focus on the impact of traditional factors on supply chain construction (Elia et al., 2020; Vegter et al., 2020). However, we identified factors including smart asset investment, multi-scenario service capability, SLEC interaction, and personalized demand, which enriches theoretical understanding of supply chain management and facilitates the knowledge development of SLEC. Third, this study applied the RBV to identify resources/capabilities factors involved in our framework and explore its influencing paths on CSCI, which furthers the RBV toward a theory of promoting the CSCI. Fourth, this research brought insights to managers supporting their decision-making when managing the CSCI. For instance, the manager of core company in the SLEC should know that leading or promoting the construction of SLEC will not only realize the smart and ecological transformation of the company but also lay the foundation for the development of circular supply chain.

The remainder of this paper is organized as follows. Section 2 provides a literature review. Section 3 introduces the case study design with multiple cases selected for this research and the data collection and analysis process. Section 4 presents a brief for the selected cases. Section 5 presents the key findings from this research. Section 6 discusses our theoretical contributions, managerial implications, and directions for future research.

2. Literature review

2.1 The SLEC

Many scholars have conducted useful explorations on smart logistics. In general, smart logistics is a logistics system that uses intelligent technologies and intelligent facilities to comprehensively perceive and identify all links of logistics and make optimized logistics service decisions (Uckelmann, 2008). Kirch et al. (2017) argued that smart logistics is a key means of developing cross-company or cross-industry transportation network logistics and information-efficient organizations, and it is an inevitable trend in the development of modern logistics. The existing research has covered many smart technologies applied in logistics, such as autonomous control (Windt and Hulsmann, 2007), cloud computing (Gregor et al., 2017), product intelligence in industrial control (Mcfarlane et al., 2013), intelligent transportation systems (Montreuil, 2011), self-organizing logistics (Bartholdi III et al., 2010), digital analysis (Govindan et al., 2018; Chen et al., 2021a) and the Internet of Things (Liu et al., 2019a; Ding et al., 2020). Most of these studies focused on how technological innovation can improve the efficiency of a logistics system. For example, Liu et al. (2019a) proposed a real-time information-driven dynamic optimization strategy for smart vehicles and logistics tasks. The results shown that this strategy helps decrease logistics costs, reduce fuel consumption, and improve vehicle utilization rates. Guo et al. (2020) proposed a self-adaptive collaborative control mode from which smart production logistics systems can enhance capabilities in terms of intelligence, flexibility, and resilience.

With the development of smart logistics in the industry, many stakeholders in the smart logistics network have begun to work together to jointly plan, set common goals and obtain mutual benefits, that helps to establish a new organizational network which has been defined as SLEC (Liu et al., 2020; Liu et al., 2021b). In biology, ‘ecological’ refers to the interaction and mutual restriction between organisms (Wang et al., 2016). From an industrial perspective, ‘ecological’ refers to a cooperative relationship of resource sharing, mutual benefit, and mutual dependence. The proposed concept of SLEC is a combination of a smart logistics network and an ecological network. Taking JD Logistics (the second largest e-commerce logistics company in China) as an example, the SLEC centered on JD Logistics is committed to building a smart logistics network, which heavily relies on the applications of intelligent logistics system, data-driven analysis, and intelligent technologies. In addition, JD Logistics realized the complementarity of resources such as smart logistics facilities, business operations, consumers’ data and information systems by connecting various supply chain members. It also empowers supply and demand ecological groups with intelligent technologies through a smart platform (Chan et al., 2018). Nowadays, an increasing number of companies have paid more attention to develop comprehensive understandings of SLEC (Liu et al., 2021a). Therefore, the application of ecosystem theory to the study on smart logistics will be a major trend in future research.

2.2 Circular supply chain management

The Ellen MacArthur Foundation (2013) defined the circular economy as an economy that is restorative and regenerative by design. In recent years, research on the circular economy has attracted increasing attention from academics and practitioners (Geissdoerfer et al., 2018; Prieto-Sandoval et al., 2018). In circular economy research, circular supply chain management plays a very important role (Dubey et al., 2019). When supply chain members work systematically to integrate the circular economy concept within the supply chain process, they can develop innovative business models and relevant supply chain functions to achieve recycling resources throughout the supply chain life cycle. This process is called circular supply chain management (Wang et al., 2020).

Numerous scholars have discussed different ways to promote circular supply chain management quantitatively or qualitatively. In quantitative research, operations research is widely used to solve decision-making problems in circular supply chain management (Gu et al., 2019; Zhi et al., 2019; Nasr et al., 2021). For example, Gu et al. (2019) studied cooperation between companies using different reverse logistics management strategies in natural resource and energy-intensive industries. Zhi et al. (2019) used evolutionary games to study the issue of cooperation in carbon emission reduction in the context of the circular economy. Nasr et al. (2021) presented a novel two-stage fuzzy supplier selection and order allocation model for a closed-loop supply chain.

In qualitative research, case study and literature review methods have been widely used (Elia et al., 2020; Lahane et al., 2020; Vegter et al., 2020). For example, Elia et al. (2020) conducted empirical analysis with a sample of 98 companies to analyze the relationship between the level of supply chain integration and the circular economy strategies. Lahane et al. (2020)

conducted a state-of-art review of circular supply chain management via content analysis. The review covered the available circular supply chain literature and highlighted research trends, gaps, and potential directions for future studies. Vegter et al. (2020) conducted a systematic literature review to conceptualize the processes and performance objectives of a supply chain in a circular business model. In addition, some scholars have proposed new frameworks for circular supply chain management (Garrido-Hidalgo et al., 2020; Wang et al., 2020). Garrido-Hidalgo et al. (2020) presented an end-to-end framework for the adoption of the Internet of Things in the management of electric vehicle battery packs following the principles of circular economy. Wang et al. (2020) developed a system architecture of blockchain-enabled circular supply chain management for the fast-fashion industry.

2.3. The RBV

The RBV defines a firm as a bundle of resources and capabilities (Wernerfelt, 1984; Peteraf, 1993), and this theory has proven to serve as an influential theoretical framework for understanding how competitive advantage and financial performance are achieved (Corbett and Claridge, 2002). The RBV indicates that enterprises have valuable, rare, inimitable and non-substitutable (VRIN) resources, which can be transformed into unique advantages in the marketplace (Varadarajan, 2020). In general, capabilities refer to the ability of a firm to use its resources ‘to affect a desired end’ (Yu et al., 2018). In contrast to resources, capabilities are embedded in the dynamic interactions of multiple knowledge sources and are more specific and less transferable; hence, they may lead to a competitive advantage (Peng et al., 2008). The RBV holds that firms will have different resources and varying levels of capabilities with regard to resource exploitation. Firm survival depends on the ability to create new resources, build on existing capabilities, and make capabilities more inimitable (Peteraf, 1993).

2.4 Summary

As discussed above, the concept of SLEC emphasizes the network layout and the construction of the supply and demand ecological groups (Liu et al., 2021a). With this ecological structure, collaboration required by the circular supply chain among supply chain members is much easier to be achieved. In addition, the logistics ecological operator can provide suppliers or consumers with technical supports required for the circular supply chain. Whilst from the perspective of industrial practice, there are also evidence that the SLEC promotes the circular economy. For example, the SLEC with RRS Logistics (a leading logistics company in China) acting as the logistics operator uses its supply and demand ecological groups, unique ecological information platform, and invests in unmanned intelligent recycling machines to achieve the rapid recycling of home appliances (Consumer Daily, 2019).

However, to make full benefits of the SLEC to promote CSCI, it is important to identify and clarify the impacting factors in the SLEC development process on CSCI. After a comprehensive literature review, we found that although many studies have qualitatively or quantitatively attempted to explore the ways of promoting CSCI (Gu et al., 2019; Elia et al., 2020; Wang et al., 2020), research on the impact of various factors involved in the SLEC development process on CSCI is still scarce. This paper aims to address this research gap through a multi-case study, and to contribute to effectively promote the development of circular supply chain.

The RBV provides an effective way to identify and classify factors for the research purposes of this paper. It has been widely used in the strategic management literature and has been increasingly applied to supply chain management in recent years (Wu et al., 2006; Yu et al., 2018; Zimmermann et al., 2020). Following the RBV, we first identified valuable and unique resources/capabilities involved in our study in the SLEC development process. Then, various pathways of achieving CSCI were being investigated through the multi-case analysis. Through analyzing the data collected via interviews, this research identified a tangible resource - smart asset investment, three intangible capabilities (namely SLEC interaction, multi-scenario service capability and SDM capability), and personalized demand, which is related to SDM capability.

3. Research methodology

Case study can be used to achieve different goals, including to provide descriptions, test theories, or construct theories (Eisenhardt, 1989). Regarding the different types of case study, inductive multi-case study is the main method used to construct theories. For example, Gersick (1988), Graebner and Eisenhardt (2004), Graebner et al. (2010) and Gong et al. (2018) are all studies that used an inductive multi-case study to construct theoretical frameworks. In order to address the research gaps and research questions discussed above, and to investigate the contemporary nature of the targeted phenomenon (Yin, 2013), this research adopted the inductive multi-case study to explore the framework of factors affecting CSCI in the SLEC.

3.1 Case selection

We conducted case study with the selected Chinese enterprises. One reason why choosing China as the research context is that China as a developing country but holds an important position in terms of global competition and has become the second largest economy in the world. With the fast development of the smart and circular economies in China, many scholars paid particular attention to Chinese practice (Dameri et al., 2019; Li et al., 2019). It is believed that the research results will also be valuable to other developing countries. Furthermore, increasing number of logistics companies in China have made rapid responses to circular economy in recent years, including actively building SLECs (Cui, 2018). Therefore, our multi-case study selected China as the research context to explore this contemporary phenomenon of SLEC.

In terms of case selection, we followed the logistics company ranking from the China Federation of Logistics and Purchasing (CFLP). From 2005 to 2020, the CFLP evaluated more than 6,000 logistics enterprises in China and divided them into five levels from 1A to 5A, of which 5A represents the highest level. In order to select the appropriate cases for this research, firstly we screened the ranking and consulted with industry experts. We noticed that the enterprises who have developed SLECs are mainly leading enterprises, hence we narrowed our selection scope down to 171 enterprises that achieved the 5A-level title after 2014. Secondly, our research team visited the official websites and collected news reports of these 171 enterprises. After sorting out the contents from the official websites and news reports, we excluded 159 enterprises that have not established an SLEC or a circular supply chain, which results in 12 enterprises were selected as candidate cases for this research[1]. Refer to existing inductive multi-case study (Gong et al., 2018), theoretical sampling was adopted to guide the selection of case companies from two extremes of CSCI type. So thirdly, we focused on two types of circular supply chains: products recycling and packaging recycling. For the 12 candidate enterprises, there are seven enterprises for packaging recycling and five enterprises for products recycling. We contacted these enterprises by telephone to check their willingness of participating in this research and 10 of them agreed. Finally, to further select appropriate representative samples from the 10 enterprises, we established following specific selection criteria:

(1) Selected enterprises have actively promoted CSCI over the past two years and have made actions and achievements in the construction of SLECs over the past two years.

(2) Selected enterprises reflect diversity in enterprise scale, service domain, service objects and circular supply chain type to make our conclusions universal.

(3) Complete and comprehensive survey information on the selected enterprises is available, and the authenticity of the survey information can be guaranteed.

Based on the above criteria, six of them were excluded, with four enterprises left as the final cases for this research: RRS Logistics, Cainiao Network, Sinotrans and JD Logistics. Table 1 provides basic information of these enterprises. We carried out semi-structured interviews with each enterprise to collect data (see Section 3.3).

Among the four selected enterprises, the circular supply chains of RRS Logistics and Sinotrans are focused on the products recycling, while Cainiao Network and JD Logistics on packaging recycling. By comparing the relative number of employees and the service domain of each enterprise, we could find these four enterprises are positioned differently into small, medium, and large scale. For example, the number of employees in RRS Logistics is 1200, which is small compared to other enterprises. In addition, the service domain of RRS Logistics

[1] These twelve enterprises include: Transfar Logistics, RRS Logistics, SF Express, Joyi Supply Chain, JD Logistics, Eternal Asia Supply Chain, STO Express, Best Logistics, YTO Logistics, Cainiao Network, Sinotrans and China Post.

is home bulk logistics, which is more constrained than the other three enterprises. Therefore, we set the size of RRS Logistics as small.

Table 1. Basic information of the four enterprises

Enterprise	Founded	Headquarters	Enterprise scale (Number of employees)	Service domain	Service objects
RRS Logistics	1999	Qingdao	Small (1,200)	Home bulk logistics	Brands of home appliances
Cainiao Network	2013	Hangzhou	Medium (117,893)	E-commerce logistics	Online retailers and individual end consumers
Sinotrans	2002	Beijing	Large (221,775)	Multimodal transportation, shipping agency, etc.	International trading or large manufacturing export enterprise
JD Logistics	2012	Beijing	Medium (105,936)	E-commerce logistics	Individual end consumers, enterprise users, and government

3.2 Data collection

Following a typical inductive study, we preliminarily constructed each case with semi-structured interview, telephone follow-up and file data. Our data collection process was designed with the following stages:

(1) We designed an interview protocol with eight open-ended questions, which is shown in the Appendix. For preparation, we contacted the senior management or CEO of the company by phone to facilitate subsequent face-to-face interviews.

(2) We carried out semi-structured interviews. Each interview lasted 90–120 minutes. Three interviewers attended all interviews to ensure consistency, recorded the answers independently, and communicated later to confirm the correctness of the transcripts. We obeyed the '24-hour principle' (Eisenhardt, 1989) that the interview details were recorded within 24 hours along with the interviewer's impressions of each enterprise.

(3) We documented the interview transcripts and followed up if needed. After each face-to-face interview, all the members of our team met to cross check the transcripts. For ambiguous answers or questions, we called the manager to verify.

(4) We also collected secondary data about the case companies from different sources including the official websites or news reports related with each company. Multiple sources of data can provide more accurate information and more robust theoretical results.

3.3 Data analysis

We followed the inductive multi-case study method to conduct within-case analysis and cross-case analysis to analyze the collected data (Gong et al., 2018). It is worth noting that Yin (2013) pointed out that inductive multi-case studies follow a grounded theory approach.

Data coding. Coding techniques were used to identify factors following the RBV. We used a combination of open coding and axial coding to process the interview transcripts. Open coding involves an initial 'tagging' of the original data, namely every word or fragment in the data. After open coding, axial coding focuses on the data tagged by open coding and recodes the important categories formed in the previous coding stage by cyclic comparison (Liu et al., 2021b). Through the data coding, five factors that affect CSCI in the SLEC development were identified and shown in Table 2. Regarding the results, we firstly tested the repeated consistency of the coding, which was re-coded by multiple researchers within the research team to ensure reliability. The interviewees were consulted again to ensure consistency with the semi-structured interviews.

Within-case analysis. There is no standard format for within-case analysis, but the purpose is clear that helping researchers process large amounts of data and become familiar with the unique patterns of each case before conducting the cross-case analysis (Eisenhardt, 1989). The within-case analysis of this study is presented in Section 4.

Cross-case analysis. After the within-case analysis, we obtained the theoretical framework through the cross-case analysis presented in Section 5. For a cross-case analysis, it is necessary to reference generated theories, case data, and literature to continuously refine the concept definitions, theoretical relationships, and propositions (Eisenhardt, 1989).

Table 2. Dara coding results

Main Category	Subcategory	Concept
SDM	Quantity SDM	Quantity forecast, quantity matching of goods
	Quality SDM	Service quality, customer satisfaction, product quality matching
CSCI	circular supply chain building	-
	circular supply chain operating	-
Smart asset investment	Intelligent facility equipment	Unmanned operation equipment, smart express vehicle, smart recycling machine
	Intelligent technology	Big data, Internet of Things, blockchain, AI
SLEC interaction	Information exchange	Real-time communication, industry meetings, close communication
	Ecological sharing	Information sharing, data sharing
	Ecological empowerment	Platform empowerment, technical support
Multi-scenario service capability	Scenario-based solutions	Consumption scenarios, scenario ecology, scenario requirements
	Multi-scenario service	Diversified service scenarios, diversified service products, diversified service locations and times
Personalized demand	Product personalization	Customized products, production customization, user development
	Service personalization	Customized service, diversified service demand

Develop propositions and framework. Based on the within- and cross-case analysis, propositions were developed and its theoretical logic reflects a combination of opinions based on case evidence, existing research, and independent logic. We then revisited all cases to verify whether the data and original transcripts could support these propositions. When theoretical saturation was reached, we stopped the iteration between data and theory and adopted the remaining propositions to form the theoretical framework.

3.4 Validity and reliability

Researchers who view cases as nothing more than anecdotes tend to dismiss case studies as a somehow less rigorous than quantitative studies. However, case study research can also be rigorous (Yin, 2013). We followed the classic criteria to ensure the validity and reliability of our case study design (Yin, 2013).

*Construct validit*y requires that researchers use multiple sources of evidence and establish a chain of evidence (Yin, 2013). This paper drawn from multiple sources of evidence, including official website information, news reports, interviews and direct observations. Moreover, we obtained a clear chain of evidence from the records of typical quotes so that the readers could move from the case summaries to the initial data and observe how the conclusions were derived.

Finally, we requested the providers of the evidence to check and verify the records and drafts before starting data analysis process.

External validity is ensured through repetition and replication logics to carry out a multiple case analysis to obtain robust conclusions. The selection of the four enterprises addressed this issue. From the 10 case candidates, we chose only the 4 most typical and representative enterprises, and we found another group of 4 enterprises with similar characteristics to carry out similar study by replication logic which came out same results as this research. In this way, external validity was ensured.

Reliability denotes that every step of a case study, such as the data collection process, is repeatable and that if a study were repeated, the same results would be obtained. Yin (2013) showed that we can achieve reliability by establishing a case study draft and case study database. A detailed database is recorded for each case which maintained extensive notes and documents for all stages to improve reliability.

4. Case description – Within-case analysis

4.1 RRS Logistics

RRS Logistics was established in 1999. It is positioned as a logistics company providing supply chain solutions for large household items. In terms of SLEC development, RRS Logistics has established an open ecological platform. Through cooperatiing with ecological partners in different fields, it provides users with so-called scenario-based solutions. In 2020, RRS Logistics managed 178 smart warehouses, more than 6,000 delivery and installation network nodes, and more than 200,000 on-site service personnel in China. In terms of CSCI, in 2019, RRS Logistics established a strategic cooperation with the Youdemai platform, which provides RRS customers access to recycling and the use of unmanned intelligent recycling machines. With the help of the ecological groups of RRS Logistics, they have achieved the effectively recycle of major appliances such as TVs, refrigerators, air conditioners and 3C products (Consumer Daily, 2019).

4.2 Cainiao Network

Cainiao Network was established in 2013 by the Alibaba Group. In terms of SLEC development, Cainiao Network ascribed great importance to the digital supply chain and hopes to directly connect consumers and production. In 2020, Cainiao Network stated that it would pursue comprehensive supply chain digital construction for more than 10 industrial clusters and more than 1,000 factories, and establish digital community life stations for consumers. In terms of CSCI, Cainiao Network was committed to promoting packaging recycling. In 2017, Cainiao Network released a box-back plan aiming to set up approximately 5,000 green recycling bins in 200 cities across China in 2018, and to advocate the importance of recycling resources. On May 28, 2019, Cainiao Network, together with the China Environmental Protection Foundation, Alibaba Charity Foundation, and large express companies, jointly proposed a Green Express Day and announced that it would install more than 50,000 green recycling bins in China.

4.3 Sinotrans

Sinotrans was established in 2002 and is a large-scale logistics enterprise focused on comprehensive logistics services. In terms of SLEC development, with the goal of becoming a world-class smart logistics platform company, Sinotrans has accelerated the construction of its digital supply chain service capabilities in recent years. At present, Sinotrans has widely used smart technology, smart equipment, and multiparty logistics resources to provide manufacturing companies with full-process visualization and full-lifecycle supply chain solutions. Regarding CSCI, Sinotrans has provided reverse logistics services to many manufacturing companies. For example, in cooperation with P&G, Sinotrans not only provides transportation, warehousing and packaging services for its products, but is also responsible for the management of its customer returned products.

4.4 JD Logistics

JD Logistics registered as a logistics company since 2012 and eventually became the JD Logistics Group in April 2017. In terms of SLEC development, JD Logistics realized the complementarity of resources such as logistics facilities, business operations, and information systems by connecting various supply chain members. JD Logistics empowered supply and demand ecological groups through a smart platform. Specifically, for supply ecological groups, the smart platform not only allocates orders for logistics providers according to different service levels but also provides accurate suggestions for their service improvements. For demand ecological groups, the smart platform provides value-added service functions (such as inventory management and dynamic pricing) to sellers and provides more accurate express services for individual customers. Regarding CSCI, in 2017, JD Logistics launched a plan to reduce packaging cost, mainly involving terminal recycling. For example, JD Logistics cooperates with P&G, Coca-Cola, and other companies in using its supply chain system to effectively recycle beverage bottles and other packaging materials.

5. Cross-case analysis

After our within-case analysis, we conducted a cross-case analysis, which we presented in this section. Based on the RBV, after analyzing the data coding results as illustrated in Section 3.3, this research identified the influencing factors. These include a tangible resource - smart asset investment, the intangible capabilities (namely SLEC interaction, multi-scenario service capability and SDM capability), and personalized demand, which is related to SDM capability. The research results also revealed several relationships among those factors as discussed below in this section.

5.1 Relationship between SDM and CSCI

The research results highlighted the importance of SDM in the SLEC. The RBV argues that firms have various levels of capabilities that lead to different level of profitability and operational efficiency. One of the ways increasing firm’s performance is to make the capabilities more inimitable to achieve competitive advantage (Nath et al., 2010). No matter being applied to a service enterprise or a service supply chain, SDM has become an important capability for the sustainable development of service operations (Liu et al., 2019b), and also an important determinant of success in many service-oriented businesses (Cheng et al., 2018). As stated above, the basic principle of SDM is to accurately identify demand and coordinate it with other related factors (Bitran and Mondschein, 1997), and to shift demand from peak to off-peak forms to achieve the SDM coordination. In the SLEC, SDM matches customer demand with the supply of the entire supply chain. Although the SLEC is derived from the traditional supply chain, customers in the SLEC have stricter requirements for service quality and accuracy than those from the traditional supply chain (Martin et al., 2016). For example, the manager of Cainiao Network said the following:

'The degree of supply-and-demand matching is reflected not only in the more accurate prediction and realization of quantity but also in better meeting the quality needs of customers.'

The research results (summarized in Table 3) indicated that SDM has a positive impact on CSCI. This is in line with the argument that SDM has a positive impact on market feedback and the continuous quality improvement of service products (Chen et al., 2016). When consumers are more satisfied with the services of the supply chain, they will also be more willing to actively respond to and support CSCI initiatives and practices. Especially in the SLEC, due to the existence of the demand ecological group, customers also affect each other, which results in that customer satisfaction plays a more important role. In addition, SDM is a systematic evaluation indicator that reflects SLEC's service integration capabilities. CSCI requires the SLEC to have the SDM capability to coordinate upstream and downstream members of the supply chain to meet consumer recycling needs. For example, the manager of RRS Logistics said the following:

'At RRS Logistics, when customers are willing to recycle, RRS Logistics needs to have the SDM ability to coordinate supply chain members such as consumers, manufacturers, and recyclers to implement CSCI.'

The managers of the Cainiao Network, Sinotrans and JD Logistics also believed that SDM will facilitate the successful construction of a circular supply chain, and then the operational efficiency of a circular supply chain will increase as the degree of SDM increases. In summary, we developed the Proposition 1 as below.

Proposition 1: SDM can directly promote CSCI.

Table 3. Relationship between SDM and CSCI

Enterprises	SDM	Relationship between SDM and CSCI
RRS Logistics	An ecological chain needs to identify the potential needs of customers and provide rich service content. The role of the platform is to better bond service providers and customer needs.	At RRS Logistics, when customers are willing to recycle, RRS Logistics needs to have the SDM ability to coordinate supply chain members such as consumers, manufacturers, and recyclers to implement CSCI.
Cainiao Network	The degree of supply-and-demand matching is reflected not only in the more accurate prediction and realization of quantity but also in better meeting the quality needs of customers.	In the supply chain, better matching the demand side and the supply side will help the successful construction of a circular supply chain.
Sinotrans	In Sinotrans, the matching of supply and demand is mainly reflected in the matching of quantities. The most feared thing is a mismatch between goods and suppliers, such as ships.	The CSCI requires the matching of demand and supply. The higher the degree of supply-and-demand matching, the higher the efficiency of the ecological chain. Therefore, the easier it is to implement circular supply chain.
JD Logistics	The degree of supply-and-demand matching is part of the operating efficiency. Improvement in the degree of supply-and-demand matching increases operating efficiency.	As the degree of supply-and-demand matching increases, the operating efficiency of the enterprise will increase and the positive effect will also increase.

5.2 Relationship between SDM and other influencing factors

The results from this research also revealed that SDM has close relationships with other influencing factors including smart asset management, SLEC interaction, multi-scenario service capability, and personalized demand. This will be discussed in detail in below sections.

5.2.1 Smart asset investment

Based on the data coding and analysis, we identified a tangible resource of SLEC - smart asset investment included into our framework. The RBV indicates that enterprises have valuable, rare, inimitable, and non-substitutable resources, which can be transformed into unique advantages in the marketplace (Varadarajan, 2020). Smart asset investment reflects a unique resource introduced by the SLEC. Smart asset refers to intelligent facilities and equipment, intelligent technologies, and intelligent information systems invested by enterprises for more efficient and accurate demand identification, supply-and-demand analysis, and demand realization during SLEC operation. Among these assets, intelligent facilities and equipment differ from automation facilities. Intelligent facilities and equipment emphasize sensitive and accurate perception functions, correct thinking and judgment functions, while automation facilities and equipment only focus on efficient and repeated execution (Ma and Xue, 2020). Smart asset investment provides the foundation and medium for enterprises to establish a SLEC (Abdel-Basset et al., 2018). Moreover, the SDM process of the SLEC shows a certain level of technological dependence. New technologies and intelligent algorithms can help the SLEC solve current supply-and-demand matching problems, such as those related to excessive information and inaccurate data. Furthermore, the improvement of intelligent algorithms and information systems can help smart logistics ecosystems better meet customer needs, such as needs for improved route optimization and more efficient information communication (Wu et al., 2016).

Table 4 summarized the results of our interviews on smart asset investment. Although each enterprise makes different types and amounts of investments in smart assets, all managers emphasized that the higher the smart asset investment, the higher the degree of SDM in the SLEC. This positive impact manifests in different ways in real-life practices. For example, the manager of RRS Logistics commented:

'Smart assets can empower providers through route navigation, guideline selection, and installation guidelines to address customer needs more efficiently and with high quality and improve the level of SDM.'

The manager of the Cainiao Network highlighted:

'Increasing investment in smart assets will have a positive impact on the degree of supply-and-demand matching because this investment can improve the efficiency and accuracy of services.'

The managers of JD Logistics and Sinotrans also noted that smart assets can indeed improve the efficiency of supply-and-demand matching. Hence, we summarized above points into the Proposition 2 as below.

Proposition 2: Smart asset investment has a positive impact on SDM.

Table 4. Relationship between smart asset investment and SDM (CSCI)

Enterprises	Smart asset investment	Relationship between smart asset investment and SDM	Relationship between smart asset investment and CSCI
RRS Logistics	RRS Logistics has invested a lot of research and development costs in software and hardware, including system development, application of big data, AI, intelligent development, etc. RRS Logistics also invested smart recycling machines for product recycling.	Smart assets can empower providers through route navigation, guideline selection, and installation guidelines to address customer needs more efficiently and with high quality and improve the level of SDM.	The investment of smart assets can promote the construction of a circular supply chain. For example, the investment of RRS Logistics in smart recycling machines has a positive effect on increasing the recycling ratio of consumers.
Cainiao Network	Cainiao Network had planned to invest 100 billion RMB in smart assets within two years. In terms of terminal network, Cainiao Network upgraded Cainiao Station to a digital community life service station, adding services of smart shipping and smart recycling.	Increasing investment in smart assets will have a positive impact on the degree of supply-and-demand matching because this investment can improve the efficiency and accuracy of services.	Investing in smart assets can not only stimulate consumers' interest in participating in recycling, but also improve the operational efficiency of the entire reverse supply chain.
Sinotrans	Sinotrans uses smart technology and smart equipment, integrates multi-party logistics resources to provide manufacturing companies with full-process visualization and full-lifecycle supply chain solutions.	Increasing investment in smart assets will definitely have a positive impact on the degree of supply-and-demand matching. The specific optimal investment amount needs further consideration.	The investment of smart assets in logistics services will improve the overall operational efficiency of logistics services, including the operational efficiency of reverse logistics.
JD Logistics	JD Logistics has invested a lot in unmanned technology and smart logistics system. For packaging recycling, JD Logistics launched a carton recycling system and set up a logistics packaging laboratory to develop recycled packaging.	The investment in smart assets will definitely improve operating efficiency, otherwise the company will not invest. The improvement in operating efficiency also includes the degree of supply-and-demand matching.	The investment in smart express vehicles and recycling system will increase the efficiency of product recycling. The packaging laboratory has a long-term positive impact on CSCI. Packaging recycling is simpler and less process compared with product recycling, which can better reflect the advantages of smart assets.

5.2.2 SLEC interaction

The research results found that the SLEC interaction, as an intangible capability reflecting coordination between members of the SLEC, plays an important role in the success of the SLEC. Interactions between SLEC members refer to interactive behaviors, including real-time communication, information sharing, and data sharing based on IoT technology and supported by the ecological community to achieve a win-win outcome. The RBV indicates that capabilities are embedded in the dynamic interactions of multiple knowledge sources and are more specific and less transferable; hence, they may lead to a competitive advantage (Peng et al., 2008). Cortada (2016) believed that the exchange and sharing of information is key to the success of the industrial ecological chain. Liu et al. (2021b) proposed that the interconnection and value sharing of main members in the SLEC are key to achieve a win-win situation in the ecological chain. Therefore, the interactions of SLEC members are not only a characteristic of the SLEC but also one of the most important factors affecting the operations of the SLEC. Our research results showed that in the SLEC, the higher the degree of interaction between SLEC members, the higher the degree of SDM. Moreover, the higher the degree of interaction between SLEC members, the greater the advantages of the SLEC in integrating different members and providing communication platforms for different members. Furthermore, the higher the degree of interaction between SLEC members, the more accurately and quickly customer needs of the SLEC can be transferred to core enterprises and service providers.

Table 5 summarized the results of our interviews on the interactions of SLEC members. Obviously, there are different forms of interaction between SLEC members. For example, RRS Logistics focuses on information sharing between members of the SLEC. The Cainiao Network focuses on data sharing between the platform and manufacturers. Sinotrans focuses on close, real-time communication with service providers and customers. JD Logistics focuses on the platform’s empowerment for brand owners. Although the companies’ interaction methods differ, the research results highlighted a positive correlation between SLEC interaction and SDM for all four companies. This can be explained that as communication between members becomes more frequent and open, the SLEC can cater to customer demand more accurately and efficiently. For example, the managers of RRS Logistics said the following:

'More open information has a positive impact on the preparation of upstream and downstream resources. If the warehouse can inform the dispatcher in advance of information about the rate of preparation and production time, the dispatcher will reduce wait times, improving the degree of supply-and-demand matching.'

In summary, we presented the Proposition 3 as below.

Proposition 3: SLEC interaction has a positive impact on SDM.

Table 5. Relationship between the SLEC interaction and SDM(CSCI)

Enterprises	The SLEC interaction	Relationship between the SLEC interaction and SDM	Relationship between the SLEC interaction and CSCI
RRS Logistics	The interaction between members of the ecological chain mainly involves information sharing, but also includes some other interactions.	More open information has a positive impact on the preparation of upstream and downstream resources. If the warehouse can inform the dispatcher in advance of information about the rate of preparation and production time, the dispatcher will reduce wait times, improving the degree of supply-and-demand matching.	If the various entities in the SLEC can fully share information and collaborate, the operational efficiency of the circular supply chain will be higher. RRS Logistics attaches great importance to the interaction between service providers and customers, manufacturers and customers, manufacturers and service providers. The home appliance recycling of RRS Logistics also benefits from the interaction between members of the SLEC.
Cainiao Network	Cainiao Network will share data with manufacturers, unify manufacturers' online and offline data, and provide dual-channel unified inventory services.	As the exchanges between members are more frequent and open, the increase in SLEC interaction will have a positive impact on supply-and-demand matching.	Cainiao Network has united many partners in the construction of circular supply chain, such as Shentong, Yunda, YTO and so on. Close interaction with partners can promote the construction of circular supply chains.
Sinotrans	Sinotrans has close, real-time communication with service providers and customers, and there are regular industry meetings.	The higher SLEC interaction, the higher the degree of supply-and-demand matching in the ecological chain.	Sinotrans has always maintained good interaction with manufacturers, service providers and raw material suppliers. This interaction can promote the implementation of reverse logistics.
JD Logistics	JD Logistics empowers manufacturers. Empowerment will increase customer awareness and improve communication efficiency.	The platform is an enterprise that emphasizes interaction. The higher the degree of interaction between various members of the ecological chain, the higher the operating efficiency must be.	The most important part of the ecological chain is the cooperation, empowerment, data sharing and other ecological chain interactions between the upstream and downstream of the supply chain. The higher the degree of this interaction, the easier it is to construct a circular supply chain.

5.2.3 Multi-scenario service capability

Our research result found that multi-scenario service capability is a special capability of the SLEC that contrasts with the capabilities of traditional supply chains. Making this capability more inimitable allows the SLEC to gain an advantage. This follows the RBV that one of the abilities determining the success of a firm is inimitable capability (Peteraf, 1993). In this research, multi-scenario service capability is defined as the ability of the SLEC to provide customers with multi-scenario solutions or to continuously develop new service scenarios. Based on the case study results, multi-scenario service capability is reflected in two ways. For one thing, the SLEC solves customer problems by providing multi-scenario solutions. Multi-scenario solutions can improve the degree of SDM. For another, the SLEC continues to develop new service scenarios, such as an instant delivery scenario and a door-to-door service scenario. As a result, the SLEC can identify the potential needs of customers and promote the innovation of service scenarios, which then improves the degree of SDM (da Mota Pedrosa, 2012).

Table 6 summarized the results of our interviews on multi-scenario service capability. It reflected in RRS Logistics as the personalized customization of the enterprise for end consumers. Both Cainiao Network and JD Logistics reflected in the richer scenarios of service products. Sinotrans has paid more attention to the increase of service scenarios. Regarding the relationship between multi-scenario service capability and SDM, the manager of RRS Logistics mentioned:

'Multi-scenario services of the ecological chain will increase consumer satisfaction and more accurately meet consumer demand, which will have a positive impact on the degree of supply-and-demand matching.'

The manager of JD Logistics also commented:

'With the increase of scenarios in the ecological chain, the ecological activity of the ecological chain will also increase, thereby stimulating the generation of other businesses and better meeting customer needs.'

The managers of Cainiao Network and Sinotrans concluded that multi-scenario services will better serve customers and help improve the degree of SDM in the SLEC. In summary, we propose the Proposition 4 as below.

Proposition 4: Multi-scenario service capability has a positive impact on SDM.

Table 6. Relationship between multi-scenario service capability and SDM

Enterprises	Multi-scenario service capability	Relationship between multi-scenario service capability and SDM
RRS Logistics	Our goal is to build a scenario-based ecological chain. The scenario is divided into client and consumer scenarios. The client works with brand and channel vendors, emphasizing the end-to-end whole process. The scenario-based transformation of the ecological chain places more emphasis on personalization based on end consumers.	Multi-scenario services of the ecological chain will increase consumer satisfaction and more accurately meet consumer demand, which will have a positive impact on the degree of supply-and-demand matching.
Cainiao Network	Cainiao Network has many service products, such as same-day delivery, next-day delivery, on-time delivery, and on-site services.	This multi-scenario service will improve the degree of supply-and-demand matching in the ecological chain because it can more accurately meet consumer needs.
Sinotrans	Taking Bao Gong Logistics as an example, Sinotrans's service scene has been extended from warehouse management to the management of import and export business.	This multi-scenario service will better serve customers and help improve the degree of supply-and-demand matching in the ecological chain.
JD Logistics	Scenarios serve customer needs. If customers have needs, we add corresponding scenarios.	With the increase of scenarios in the ecological chain, the ecological activity of the ecological chain will also increase, stimulating the generation of other businesses and better meeting customer needs.

5.2.4 Personalized demand

The results from this research (see Table 7) highlighted that personalized demand is a factor closely related to the SDM capability. Personalized demand refers to the personal preferences shown by consumers, including different preferences on product/service characteristics, purchase place, and delivery time. For example, customers who purchase washing machines of RRS logistics buy products with different functions or sizes, and have different preferences for the time of installation services. Driven by personalized demand, the personalized service method of on-demand production has become a new production mode. The

SLEC can accurately capture the personalized needs of customers through smart operations and then has greater personalized service capabilities than traditional supply chains. Therefore, meeting personalized demand has become one of the key factors in the SLEC to improve its competitiveness. Only when the results of the SLEC's services are consistent with customer expectations can customers be satisfied with the SLEC (Martin et al., 2016). However, personalized demand also increases the difficulty associated with identifying and meeting customer needs in the SLEC, which leads to a decrease in the degree of SDM (Hussain, 2016). Good news is that the decline of SDM only occurs over the short term. Regarding the long run, personalized demand requires the SLEC to be able to understand customer needs and customize related services for customers. As a result, personalized demand can stimulate the smart logistics ecosystem to continuously improve its customized service capacity, which will increase the degree of SDM. In addition, personalized services can influence other potential customers through word of mouth (Tontini et al., 2017). Therefore, over the long run, there is a positive correlation between personalized demand and SDM.

Table 7. Relationship between personalized demand and SDM (CSCI)

Enterprises	Personalized demand	Relationship between personalized demand and SDM	Relationship between personalized demand and CSCI
RRS Logistics	At present, there is increasing demand for personalization, and original large-scale manufacturing has gradually transformed into user-determined product development. Even users from different channels have different needs.	In the short term, an increase in personalized demand will complicate business processes, which will have a negative impact on the degree of supply-and-demand matching in the ecological chain. However, over the long run, the ecological chain will gradually be able to meet personalized needs, and the resulting premium and income changes will increase the value of the ecological chain.	Consumers' personalized needs will increase the diversity of products, increasing the construction cost of a circular supply chain. In addition, the different needs of consumers for recycling services will also make recycling more complex.
Cainiao Network	At present, there is increased personalized demand, and it is not difficult for the Cainiao Network to cater to this demand. The difficulty lies in meeting the individual needs of consumers within a certain cost bracket.	The increase in personalized demand poses a great challenge to the business, but it also presents an opportunity for the future. It is increasingly difficult for general-purpose products to support demand from customers.	Consumers' personalized demand for services will make recycling more complex, which has a negative impact on the CSCI.

Sinotrans	The personalized demand of Sinotrans mainly comes from cargo owners. For example, a stainless-steel production company requires full process monitoring during port-to-door service.	With increased personalized demand, the degree of supply-and-demand matching will decrease in the short term. However, as the service matures, personalized demand will become a new source of profit.	The individual needs of consumers will complicate the goods owner's handling of recycled or returned goods, exacerbating the difficulties of CSCI.
JD Logistics	Demand for personalization has increased in recent years from individual cases to large quantities.	The impact of personalized demand on the company's supply-and-demand matching is two sided. In the beginning, personalized needs only involved individual cases. Matching supply and demand can become difficult. As the volume of personalization needs increases, there will be similarities in these personalization needs. As a result, companies can optimize business processes to increase the degree of supply-and-demand matching.	At present, there are still obstacles to the implementation of packaging recycling. Consumers have different recycling habits and degrees of awareness of recycling, and it is difficult to establish a unified recycling system.

Regarding the impact of personalized demand on SDM, the manager of RRS Logistics said:

'At present, there is increasing demand for personalization, and original large-scale manufacturing has gradually been transformed into user-determined product development. Even users from different channels will have different needs.

In the short term, an increase in the degree of personalized demand will complicate business processes, which will have a negative impact on the degree of supply-and-demand matching in the ecological chain. However, over the long run, the ecological chain will gradually be able to meet personalized needs, and the resulting premium and income changes will increase the value of the ecological chain.'

The manager of JD Logistics said the following:

'The impact of personalized demand on the company's supply-and-demand matching is two sided. In the beginning, personalized needs were just individual cases. Matching supply and demand can become difficult. As the number of personalization needs increases, there will be similarities in these personalization needs. As a result, companies can optimize business processes to increase the degree of supply-and-demand matching.'

The managers of RRS Logistics and JD Logistics expressed perceptions of a negative correlation between personalized demand and SDM in the short term and a positive correlation over the long run. The managers of Cainiao Network and Sinotrans also commented that an increase in personalized demand in the short term poses a great challenge to the respective businesses, but with the continuous improvement of services, personalized demand presents as an opportunity for the future. In summary, Propositions 5a and 5b are obtained.

Proposition 5a: In the short term, personalized demand has a negative impact on SDM.

Proposition 5b: Over the long term, personalized demand has a positive impact on SDM.

5.3 Relationship between CSCI and other influencing factors

Besides the relationships between SDM and those influencing factors, the research results also investigated the relationships between CSCI and those factors, which will be explained in detail in the following sections.

5.3.1 Smart asset investment

The case study results indicated that smart asset investment can directly promote CSCI, and this directly positive impact involves two aspects. First, smart asset investment in the SLEC increases consumers' interest in participating in the construction of circular supply chains. For example, as the manager of RRS Logistics said:

'The investment of smart assets can promote the construction of a circular supply chain. For example, the investment of RRS Logistics in smart recycling machines has a positive effect on increasing the recycling ratio of consumers.'

The manager of Cainiao Network also said that investing in smart assets can stimulate consumers' interest in participating in recycling. Second, smart asset investment in the SLEC can improve the operational efficiency of the entire circular supply chain. For example, the manager of Sinotrans said the following:

'The investment of smart assets in logistics services will improve the overall operational efficiency of logistics services, including the operational efficiency of reverse logistics.'

The managers of JD Logistics also stated that its investment in smart express vehicles and smart systems has improved the efficiency of product recycling.

In general, smart asset investment in the circular economy involves electronics, software, sensors, and actuators that processing and exchanging data for improved results (Anagnostopoulos et al., 2017; Zhang et al., 2019). For example, Esmaeilian et al. (2018) recognized four categories of smart waste management system technology: the development of data acquisition and sensor-based technologies, communication and data transmission technologies, field experiment technologies, and technologies for setting and scheduling truck routes. Emerging technologies also play an important role in CSCI (Gupta et al., 2019; Garrido-Hidalgo et al., 2020). Gupta et al. (2019) emphasized the role of big data analytics in achieving a shared circular supply chain. Garrido-Hidalgo et al. (2020) demonstrated the potential for IoT technology and related systems to promote the CSCI of waste electrical and electronic equipment.

By cross comparing the cases, we also found that it is easier for packaging recycling to invest smart assets in CSCI. The managers of JD Logistics said that packaging recycling is simpler with less processes comparing with product recycling, which better reflects the advantages of smart assets. Both JD Logistics and Cainiao Network have invested special smart assets in packaging recycling. However, Sinotrans has invested smart assets for the building of an SLEC but has not yet invested in product recycling. In summary, we highlighted the Proposition 6 as below.

Proposition 6a: Smart asset investment can directly promote CSCI.

Proposition 6b: The positive impact of smart asset investment is more prominent in packaging recycling than in product recycling.

5.3.2 SLEC interaction

Our research results emphasized that in the SLEC, interaction can strengthen communication among consumers, manufacturers, retailers, logistics companies and other stakeholders. This aligns with the argument about circular-oriented innovation often requires collaboration (Brown et al., 2021). Veleva and Bodkin (2018) also argued that establishing long-term partnerships with key players in supply chains is critical for creating and capturing values in a circular supply chain. Geissdoerfer et al. (2018) found that organizations will adopt a proactive approach to not only shareholders but also to other internal and external stakeholders in promoting circular supply chain management. The core platform can use advanced technology and equipment to empower manufacturers or consumers to promote the SLEC to efficiently complete the process of product recycling and reuse (Liu et al., 2021a). The four case companies ascribed great importance to strengthening SLEC interactions and highlighted that such interactions can directly promote circular supply chain efficiency. For example, the manager of RRS Logistics said the following:

'If the various entities of the SLEC can fully share information and collaborate, the operational efficiency of the circular supply chain will increase. RRS Logistics attaches great importance to interactions among service providers and customers, manufacturers and customers, manufacturers and service providers. The home appliance recycling processes managed by RRS Logistics also benefit from interactions between members of the SLEC.'

The managers of the Cainiao Network also echoed that close interactions with partners can promote the construction of circular supply chains. The managers of Sinotrans noted that strong interactions among manufacturers, service providers and raw material suppliers can promote the development of reverse logistics. The managers of JD Logistics stated that SLEC interactions are crucial to the construction of a circular supply chain and that the more frequent such interaction happens, the easier it is to construct a circular supply chain. In summary, we developed the Proposition 7.

Proposition 7: SLEC interaction can directly promote CSCI.

5.3.3 Personalized demand

As presented in Table 7, this research found that personalized needs have a negative impact on CSCI, which is supported by the opinion that consumer demand is an important factor in circular economy (Veleva and Bodkin, 2018). Mishra et al. (2018) proposed that one of the capabilities required for the final return of materials to the biosphere or back into the industrial production system is excellent customer service. Furthermore, with the continuous development of the economy, the personalized needs of consumers have become a major challenge faced in the realm of CSCI. Farooque et al. (2019) also highlighted that researcher needs to investigate circular economy issues arising from the proliferation of product varieties and the consequent short lifecycle of customized products. For example, the manager of RRS Logistics said the following:

'Consumers' personalized needs will increase the diversity of products, thereby increasing the construction cost of a circular supply chain. In addition, the different needs of consumers for recycling services will also make recycling more complex.'

The managers of Sinotrans also stated that the personalized needs of consumers will exacerbate the difficulty experienced by goods owners in handling recycled or returned goods, which in turn makes CSCI more challenging to be realized. The managers of Cainiao Network said that consumers' personalized demands for services will increase the recycling difficulty, which has a negative impact on the CSCI. The managers of JD Logistics said that consumers have different recycling habits and levels of awareness, which makes it difficult to establish a unified recycling system. After comparing and analyzing the case results, we found that the negative impact is more prominent in the realm of product recycling. For product recycling by RRS Logistics and Sinotrans, personalized demand is reflected in personalized needs not only for products but also for recycling services. For packaging recycling by JD Logistics and the Cainiao Network, the difficulties of CSCI are reflected only in the different service required from consumers. We summarized these points into the Proposition 8.

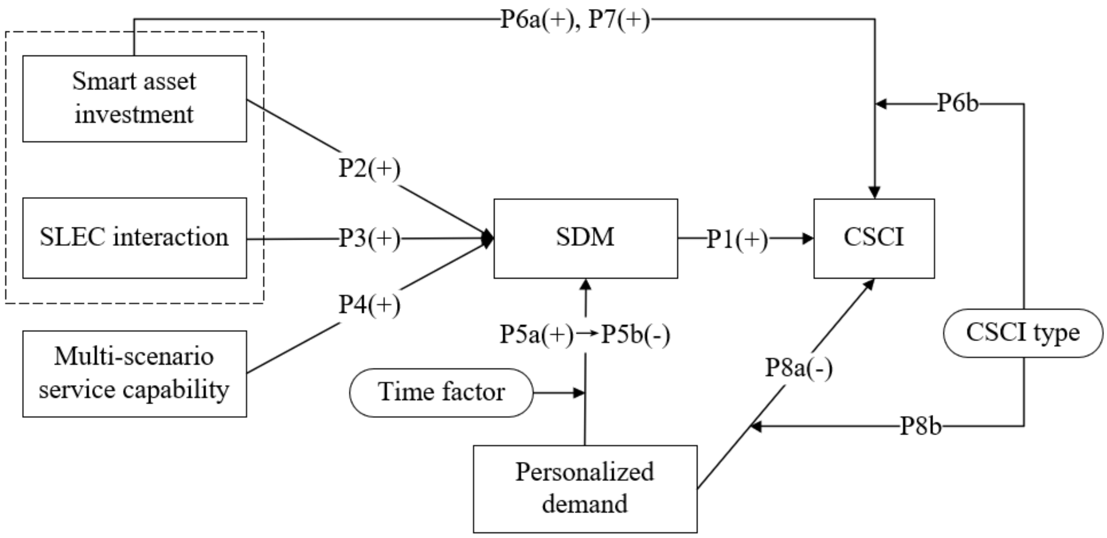
Proposition 8a: Personalized demand has a directly negative impact on CSCI.

Proposition 8b: The negative impact of personalized demand is more prominent in product recycling than in packaging recycling.

5.4 Theoretical framework of factors affecting CSCI

In this research we conducted case studies and adopted RBV to analyze the collected data.

Based on the research results, we developed a framework to include all the identified factors that affects the CSCI and their inter-relationships, which is shown in Figure 2.



Notes: '—' denotes a negative effect, '+' denotes a positive effect, and '→' denotes the role of time.

Figure 2. Theoretical framework of factors affecting CSCI in the SLEC

As shown in Figure 2, we concluded that SDM is an important intermediary variable that affects CSCI (P1). SDM can promote CSCI which means that the SLEC needs better coordinate supply chain members such as consumers, manufacturers, and recyclers, that will eventually contribute to CSCI. The higher the degree of SDM is, the higher the operational efficiency of the entire ecological chain. Moreover, we concluded that three important factors, smart asset investment, SLEC interaction and multi-scenario service capability, can promote CSCI via improving the degree of SDM (P2, P3, P4). This conclusion proves that the construction of SLEC and CSCI is complementary. The development of SLEC is an important way to promote the circular economy. In addition to the intermediary role of SDM, both smart asset investment and SLEC interaction can enhance consumers' interest in participating in the circular supply chain and improve its operational efficiency, thus both having a directly positive impact on CSCI. It worthy to highlight that the positive impact of smart asset investment is more prominent in packaging recycling (P6a, P6b, P7).

We also found that the direct and indirect effects of personalized demand on CSCI are different. Personalized demand affects SDM, and the effect of personalized demand on the degree of SDM will change from negative to positive over time (P5a, P5b). In the short term, an increase in the degree of personalized demand will complicate business processes, which will have a negative impact on the degree of SDM. However, over the long run, the SLEC will gradually be able to meet personalized needs, and the resulting premium and income changes will increase the value of the SLEC. In addition, personalized demand has a directly negative impact on CSCI, and this negative impact is more prominent in product recycling (P8a, P8b).

6. Conclusions

Under the influence of business innovation and smart technology, a new supply chain mode, the SLEC, has gradually emerged and plays an important role in promoting CSCI. Based on the case studies and with the RBV, this study developed a framework of factors that affect CSCI. We found that SDM is an important intermediary variable that affects CSCI. Factors including smart asset investment, multi-scenario service capability, and SLEC interaction have a positive effect on SDM, and SDM can promote CSCI. However, the effect of personalized demand on SDM changes from negative to positive over time. In addition to the intermediary role of SDM, smart asset investment and SLEC interaction can enhance consumers' interest in participating in the circular supply chain and improve the operational efficiency, thus having a directly positive impact on CSCI. Personalized demand exacerbates the difficulties of CSCI and thus has a directly negative impact on CSCI.

6.1 Theoretical contributions

First, this study made a first attempt to explore ways to promote the CSCI from the perspectives of ecological cooperation and smart supply chains. Although many studies have qualitatively or quantitatively discussed ways to promote circular supply chain management (Gu et al., 2019; Elia et al., 2020; Wang et al., 2020), they are limited to a focus on traditional supply chain structures. This study extended that and explored the CSCI in the context of the

SLEC, which provides a new direction for the circular supply chain management research.

Second, the framework developed in this paper promotes the construction of a theoretical SLEC system. The concept of SLEC has received extensive attention from industry (China daily, 2020; Liu et al., 2021a), but relatively few studies in particular empirical ones have been conducted in academia. This paper studied the impacts of the construction of an SLEC on the CSCI, which not only enriches theoretical knowledge of the SLEC but also clarifies the importance of the SLEC to the development of circular economy.

Third, this research made contribution to enrich the theoretical system of supply chain management in particular in the age of digitalization and sustainability. Many existing studies still focus on the impact of traditional factors on supply chain construction (Elia et al., 2020; Vegter et al., 2020; Chen et al., 2021b) but with limited consideration of the influencing factors related to smart logistics, ecological chain and the circular economy. Different from the existing studies, we analyzed new factors, including smart asset investment, multi-scenario service capability, SLEC interaction, and personalized demand, which helps to further enrich theoretical understanding of circular supply chain management.

Fourth, we have known that the RBV is a valuable theory for helping enterprises gain advantages in the marketplace (Yu et al., 2018; Zimmermann et al., 2020). This paper applied the RBV to identify factors that being included into the proposed framework and explore the influence paths of these identified resources/capabilities on CSCI through the multi-case study, which furthers the RBV toward a theory of promoting the CSCI.

6.2 Management implications

First, companies could try to promote CSCI through increasing the investment in intelligent facilities or intelligent technologies, and establishing specific partner resource sharing and communication mechanisms. In addition, providing customers with multi-scenario solutions or developing new service scenarios also helps to promote CSCI by improving the degree of SDM in SLECs.

Second, manager of the core company in the SLEC should know that the construction of SLECs and circular supply chains is complementary. Leading or promoting the construction of

SLEC can not only realize the smart and ecological transformation of the company but also lay the foundation for the development of circular supply chain.

Third, managers should understand that the trend of increasing personalized demand will promote CSCI in the future. In the short term, personalized demand will challenge the business processes and management modes of the SLEC. However, as long as the SLEC can improve itself intending to satisfy personalized demand over the long run, personalized demand will improve the degree of SDM and thereby promote CSCI.

6.3 Limitations and future research

With the limitations of only focusing on logistics companies and basing the research within the context of the industry sectors in China, few directions worthy to be further investigated and explored to enhance the knowledge building on this topic. First, the purpose of this paper is to propose a framework for factors that influence CSCI. Future research can further analyze the weight of these factors and develop scales to measure it. Second, this paper selects four logistics companies for a multi-case analysis. Future work may pay attention to manufacturing logistics and study SLECs with manufacturing companies. Finally, due to sample selection limitations, the conclusions may be more applicable to enterprises in developing countries than to those in developed countries. Future research could expand the research contexts to test the research results concluded from this study, and also usie other research methods such as quantitative and statistical analysis.

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Appendix

Interview questions

1. Basic information

   1) What is your company's service area, service object and service scope?

   2) How about the construction of smart logistics ecological chains in your company? What are the important factors involved in the process of building a smart logistics ecological chain?

   3) What activities has your company carried out in promoting the construction of a circular supply chain?

2. Factors affecting CSCI

   4) What kind of investment have you made in smart assets? How does investment in smart assets affect the SLEC and CSCI?

   5) What kind of personalized demand is your company facing? What is the impact of the increase in personalized demand on the SLEC and CSCI?

   6) What are the interactions among the members in your smart logistics ecological chain? How does the interaction between the main members of the ecological chain affect the SLEC and CSCI?

   7) What kind of multi scenario service capability does your company have? How does multi scenario service capability affect the SLEC and CSCI?

   8) What is the impact of the matching degree of supply and demand on the CSCI in your SLEC?