A framework for sustainable management of the platform service supply chain: an empirical study of the logistics sector in China

A Framework for Sustainable Management of the Platform Service Supply Chain: An Empirical Study of the Logistics Sector in China

ABSTRACT

Platforms have become an effective means of innovation in the logistics sector. However, not all platform-based business models become a success. This research investigates how a platform strategy can lead to a sustainable managed platform service supply chain. Based on analysis of data collected within the logistics sectors in China, the research results propose a structural mapping of a platform service supply chain, which differs from the traditional service supply chain structure. This research develops a sustainable management framework for the platform service supply chain, including three key elements: mutual facilitation between platform and business ecosystem; strategic alignment among the structural elements; and a sustainable element including value co-creation, co-opetition and dynamic configuration. The paper also provides a summary of practical implications to guide practitioners in building a successful platform service supply chain and enacting effective management strategies.

Keywords: Platform, service, supply chain, business ecosystem, sustainable management

1. Introduction

A platform strategy has been widely implemented in many areas, particularly new product development, and it is believed that a platform approach has radical impacts on the product development process or the entire innovation process (Clark and Fujimoto, 1991; Muffatto, 1999). Lately, the strategy has also been extended into the service design and development areas (Pekkarinen and Ulkuniemi, 2008; Simpson et al., 2006), while its implementation in the logistics sector has been increasing. With the support of rapidly developing Internet technologies and digital transformation, different types of logistics platform have increasingly been created (Cambra-Fierro and Ruiz-Benitez, 2009; Lapadusi and Caruntu, 2011; Rai et al., 2018; Robu et al., 2011; Váncza et al., 2010; Yang et al., 2009).

These logistics platforms have significantly transformed the operations and collaborations of the traditional logistics service supply chain (Geng and He, 2016; Tang, 2014; Wang et al., 2018). One of their expected advantages is the better matching of supply and demand for logistics services like transportation and warehousing (Li et al., 2014). However, more platforms are offering not only logistics services but also complementary services such as banking, accounting, and taxation. This means that more service providers rather than just logistics service providers are involved in the

logistics platforms. For one thing, this is in line with the network effects of a platform that attracts more players from both the supply and the demand sides (Boudreau and Jeppesen, 2015; Xiao et al., 2020). For another, with more stakeholders involved, a business ecosystem is formed. This aligns with the argument that a platform strategy always leads to the creation of a business ecosystem (Rong et al., 2013; Rong and Shi, 2014), which is defined as a business community consisting of all stakeholders interacting with each other to achieve a shared common fate (Moore, 1993, 1996). It is believed that one condition of a successful platform strategy is that a healthy business ecosystem has been built (Rong et al., 2018). It has been proven that in the enterprise software sector, joining a business ecosystem helps to improve business performance for both software vendors and platform owners (Ceccagnoli et al., 2012). In the mobile payment area, ecosystems are formed along with platform-based innovative service development activities, which helps to achieve competitive advantages (Junying, 2015; Kendall et al., 2011).

In the current literature on the logistics sector, however, there is a lack of research on the impacts of a platform strategy on the development of a business ecosystem. Much of the literature has focused on logistics platforms, with particular emphasis on service design (Lin and Pekkarinen, 2011; Pekkarinen and Ulkuniemi, 2008), integrating a logistics service with an e-commerce platform (Barenji et al., 2019), or distributed logistics platforms adopting advanced technologies such as blockchain and Internet of Things (Rožman et al., 2019). Those services besides logistics are ignored in the current research. Furthermore, not all the new platform-based business models in the logistics sector have been a sustainable success. Those logistics platforms may also face many issues, such as high external costs and environmental concerns (Rai et al., 2018). Along with the wider application of a platform strategy in the logistics sector, more managerial guidelines are needed for their development and management.

We conducted this research to address those research gaps. In order to differentiate this context from that of the traditional logistics service supply chain and logistics platform, we define it as a *platform service supply chain*, which is a service supply chain with a platform providing not only logistics services as core offerings but also other complementary services that support the logistics services. This research aims to explore the nature and structure of the platform service supply chain, and to investigate its sustainable management mechanisms by integrating the two concepts of platforms and business ecosystems. Hence, the research question for this paper is:

RQ 1: How can a platform service supply chain be developed and sustainably managed in the logistics sector?

We conducted the research within the logistics sector in China. One of the reasons for this choice was that, from 2014 until the end of 2018, over 1,000 platform-based logistics companies had entered the market (Cui, 2020). Meanwhile, the fast growth of platform-based businesses has also been

encouraged by the "Internet Plus" strategy proposed by the Chinese government to promote innovation (Fu et al., 2018a). Many logistics companies tend to use technologies like cloud computing and radio-frequency identification to build their logistics service platforms (Sun et al., 2012; Wang et al., 2012), or logistics information sharing platforms (Li et al., 2014). However, many of them have struggled to meet their expectations of success after adopting a platform strategy (CFLP, 2020). This demands urgent research on the above-defined research question and fits our research purposes perfectly.

The research results contribute to the area of service supply chain management and platform strategy by proposing a structural mapping of the platform service supply chain and developing a sustainable management framework. The research also contributes to the area of platform strategies by bringing platforms and ecosystems together and revealing their mutually influencing mechanisms. It also provides practitioners with managerial and practical insights to guide them in building successful platform service supply chains and management strategies.

This paper is organized as follows. The next section reviews the current literature on platform strategy and business ecosystems. After that, the methodology section explains why the case studies were chosen and how they were conducted, particularly the data collection process and data analysis strategy. We then present and discuss the research results. Finally, we present a conclusion, which will cover the research contributions, research limitations, and future research directions.

2. Literature Review

2.1 Platforms for Product and Service Design and Development

The concept of a platform originated in the area of product development (Clark and Fujimoto, 1991; Muffatto, 1999). It can be broadly defined as a relatively large set of product components that are physically connected as a stable sub-assembly and are common to different final models (Meyer and Lehnerd, 1997). The implementation of a product platform helps in increasing product variety, reducing complexity, shortening design lead time, reducing cost, and increasing the level of customization (Halman et al., 2003; Simpson, 2004; Simpson et al., 2014). When adopting a platform approach, an appropriate strategy is needed to reconsider the product itself (architecture), the product development process, and the organizational structure (Muffatto, 1999).

The benefits of the platform approach have led to its rapid application in the service design area (Fu et al., 2018b; Meyera and DeToreb, 2001; Simpson et al., 2006; Voss and Hsuan, 2009), such as for patient care services (de Blok et al., 2010; Meyer et al., 2007), e-commerce services (Lin and Daim, 2009; Mahadevan, 2000), Internet-based services (Daim et al., 2011), mobile Internet services (Ballon et al., 2008; Tee and Gawer, 2009), government public services (Brown et al., 2017), and human resources management services (Hofman and Meijerink, 2015). With services' inherently close interaction with customers, a platform approach helps a firm to increase its flexibility and

responsiveness to customers' needs (Sawhney, 1998) and to improve service quality (Pil and Cohen, 2006). It is also claimed that the platform approach can facilitate the implementation of servitization in a manufacturing firm to pursue both customization and operational efficiency (Cenamor et al., 2017).

At the industry level, a platform not only enables the development and innovation of new products and services, but can also influence strategies, shape business models, and transform entire industries (Basole and Karla, 2011; Fehrer et al., 2018).

2.2 Platforms for Logistics Services and Their Development

Beyond the service areas summarized above, the platform concept has also been implemented in the logistics service sector, and a platform is regarded as a way of achieving strategic flexibility, particularly in a dynamic business environment (Abrahamsson et al., 2003; Aldin and Stahre, 2003).

A key theme in the research on logistics platforms is that they are regarded as an organizational structure promoting coordination and connection along the whole supply chain to ensure fluid transportation connections and coordination with different transport modes (Varella and Buss Gonçalves, 2013). Hence, in some research they are termed *intermodal logistics platforms* that aim to enable different agents of a supply chain to be integrated in the same physical place (Cambra-Fierro and Ruiz-Benitez, 2009). Normally, they become *regional logistics platforms*, capable of fostering and facilitating logistics activities, business exchanges, and city development in a specific geographical region (Boudoin et al., 2014; Gajšek et al., 2012; Sainz et al., 2013; Silva and Leite, 2019).

Another theme focuses on the design and development of the logistics platform. For example, multi-agent platforms have been proposed for optimizing the allocation of loads in distributed transportation logistics (Robu et al., 2011). Under the umbrella of the smart city, logistics platforms have been proposed for optimizing transportation in order to improve the efficiency of transportation while simultaneously decreasing carbon emissions (Jiang, 2015). Borrowing the idea of modularization from manufacturing products and processes, the modular platform approach has been proposed as enabling an efficient and flexible design and delivery of logistics services (Cabigiosu et al., 2015; Pekkarinen and Ulkuniemi, 2008). Based on this, further research has proposed a modular service platform by integrating modular logic and quality function deployment techniques to improve logistics service design quality and variety (Lin and Pekkarinen, 2011). With the rapid expansion of e-commerce, the design of e-commerce logistics platforms is also attracting increasing attention (Barenji et al., 2019; Xu and Huang, 2017; Zhang et al., 2017).

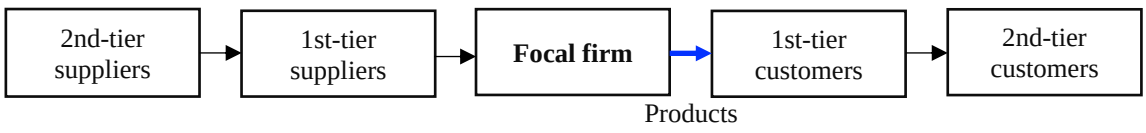
Despite the broad adoption of a platform strategy in the logistics sector attracting widespread attention from academia and practitioners, the development of knowledge about logistics platforms is still at an early stage (Jiang, 2015). The strategy's concepts are often varied and depend on the context in which the strategy is implemented (Gajšek et al., 2012; Grzybowska and Gajšek, 2016). A common

feature in most of the research is a focus either on a specific logistics service, such as transportation (Choi, 2020; Robu et al., 2011; Zhang et al., 2017), or on a combination of various logistics services (Daniluk and Holtkamp, 2015). However, interdependence is an essential feature of a platform-based business (Cenamor et al., 2013), with the success of such businesses depending not only on their core products/services but also on complementary ones. To some extent, the adoption of certain platforms depends on the complementary products/services (Basole and Karla, 2011). This inspired us to consider why some logistics platforms become a success whereas others do not. To reflect this contemporary development, this research proposes the concept of a *platform service supply chain*.

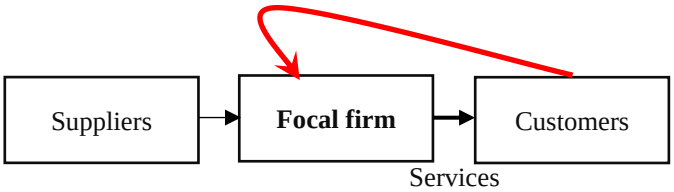
2.3 Platform Service Supply Chain

As mentioned above, we can define the service supply chain that uses a platform strategy as a *platform service supply chain*. Such a supply chain provides both logistics services and other complementary services. Since the concept is proposed in this research for the first time, we aim to develop a better knowledge of it by clarifying how it differs from the traditional service supply chain concept and by exploring its structure and management mechanism.

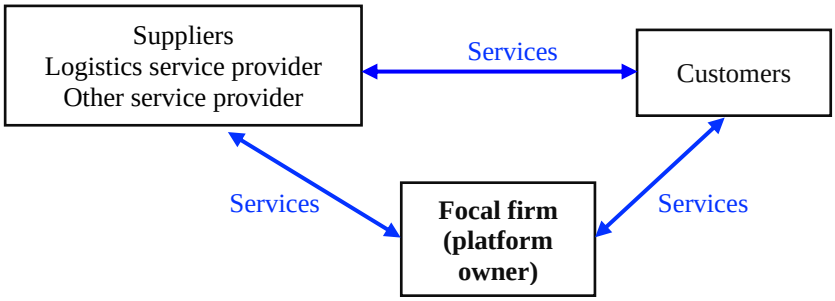
With the service sector playing an increasingly important role in national economies, service supply chain management is already receiving huge attention in relation to classic product supply chain management (Cho et al., 2012; Ellram et al., 2004; Wang et al., 2015). A service supply chain differs from the classic product supply chain and can be defined as "a network of suppliers, service providers, customers and other service partners that transfer resources into services or servitised products delivered to and received by the customers" (Lin et al., 2010, p.1191). In order to understand and compare the differences among these three concepts, Figure 1 presents a summary of them.



(a) Product supply chain (adapted from Harrison et al., 2019)



(b) Service supply chain (adapted from Lin et al., 2010)



(c) Platform service supply chain

Figure 1. Structure of a product/service supply chain and a proposed conceptual structure of a platform service supply chain

A key difference between service and product supply chains (Figure 1a) is that there is no transfer of goods or physical products per se in the service supply chain (Ellram et al., 2004). Within a service supply chain, it is the service that is being transferred to customers by utilizing the focal firm's service assets and staff (see Figure 1b). A service supply chain aims to provide specified, specialized services to customers (Liu et al., 2013), such as transportation, warehousing, freight, and distribution management in the logistics sector. These services are expected to be provided by the focal firm directly to customers in the service supply chain.

Another key feature of a service supply chain is the customer as an input into the service system (Lin et al., 2010). As presented in Figure 1b, customers not only provide themselves as an input, but also offer tangible belongings and specified demand information to the focal firm that provides the services to customers (Maull et al., 2012; Sampson and Spring, 2012). This can be called a dual-directional supply chain, whose essential nature is different from that of the product supply chain (Lin et al., 2010; Sampson, 2000). Hence, value co-creation is an essential feature of the service supply chain (Ren et al., 2015).

Within a platform service supply chain, the focal firm (the platform owner) does not have the products or services that it directly provides to its customers, but mainly exchanges information. However, the focal firm intends to attract as many customers as possible, as well as suppliers, via the network effects (Fu et al., 2017), and to make a feasible resource allocation between the demand and supply sides to provide or deliver bundles of products and/or services (Zha et al., 2015). Based on this review, we propose a conceptual structure of a platform service supply chain as presented in Figure 1c, which highlights a triadic relationship among suppliers, customers, and the focal firm, rather than a single- or dual-directional relationship within the product or service supply chain, respectively. As discussed above, the suppliers in this structure could be logistics service providers or other service providers, which this research aims to investigate.

However, the structure and nature of a platform service supply chain are still unclear. In particular, from a business ecosystem perspective, the sustainable success of a platform service supply chain relies not only on the three key types of players indicated in Figure 1c, but also on other types of stakeholder interacting with each other. This research aims to fill this gap by understanding the platform service supply chain and proposing a detailed structural mapping of it.

2.4 Platform and Business Ecosystem

The proposed definition and conceptual structure make clear that more stakeholders are involved in platform-based businesses. The structure is not a traditional supply chain with clear upstream and downstream players; rather, it is a more complex network structure that can be considered a business ecosystem. It is argued that a platform strategy is always linked with the establishment of a business ecosystem (Rong et al., 2013; Rong and Shi, 2014). In this research, we apply the business ecosystem perspective to observe the platform service supply chain, with the aim of understanding its complex structure and the interactions among the various service providers and services involved in it.

A business ecosystem can be defined as a loosely connected business community consisting of different levels of organizations, such as industrial players, associations, governments, and other relevant stakeholders, who share a common goal and co-evolve with each other (Moore, 1993). Some scholars have already emphasized the importance of platform management within a business ecosystem (Tsujimoto et al., 2018). However, within the current literature, research is scarce on the interactions between a platform and a business ecosystem (Rong et al., 2018). In fact, some concerns have been raised about the difficulties of distinguishing between the two concepts of business ecosystems and platforms (Adner, 2006; Adner and Kapoor, 2010). Hence, in this research we clearly follow the thinking that defines an ecosystem as a structure with four basic elements of activities, actors, positions, and links, whose foundation is the value proposition (Adner, 2006, 2017; Adner and Kapoor, 2010). Adner (2017) provided definitions of the four elements of the ecosystem and viewed the ecosystem as a structure in which the elements align with one another. Among the four elements, activities are defined as actions taken for the value proposition; actors refer to entities undertaking the activities; positions are the actors' locations in the flow of activities; and links are the various transfers happening across actors.

On the one hand, the co-evolutionary nature of a business ecosystem leads to a platform being considered a set of *access points* that ecosystem partners can use as functional components to build their own products and/or services (Iansiti and Levien, 2004). Hence, a platform is regarded as an interface that facilitates the interactions of the business ecosystem (Li, 2009; Rong et al., 2013) and the co-evolution of the whole business ecosystem (Rong et al., 2015). This understanding of a platform is similar to the concept of an industry platform, which is identified as a foundation to facilitate external companies' creation of innovative products/services and the formation of an innovation ecosystem (Gawer and Cusumano, 2014). There is no doubt that joining a platform helps

in encouraging complementary invention and exploiting indirect network effects to achieve better value co-creation (Ceccagnoli et al., 2012).

On the other hand, a platform and a business ecosystem can be treated as different levels of organization in an interconnected world (Gawer, 2014). In that respect, a platform is an organization of things (including technologies and complementary assets), while a business ecosystem is an organization of economic actors (Muegge, 2013). This makes it easier to understand why some researchers argue that a business ecosystem is built around a platform, which interlinks suppliers, complementors, distributors, developers, and so on (Mäkinen et al., 2014), and hence why such an ecosystem is also defined as a platform ecosystem (Ceccagnoli et al., 2012; Cennamo and Santalo, 2013; McIntyre and Srinivasan, 2017).

As discussed above, researchers have found it challenging to understand the mechanisms that explain the interactions between the platform and the business ecosystem in different contexts (Rong et al., 2013); for example, how the platform owner's decisions impact complementors' choices and their subsequent success (McIntyre and Srinivasan, 2017), or how they influence the development of the business ecosystem, or how other factors – such as digital empowerment (Sun et al., 2018) – will facilitate the development of a business ecosystem. Moreover, the bulk of current research is heavily focused on the high-tech sector, such as information technology industries (Thomas et al., 2014), health care (Kapoor and Lee, 2013), enterprise software (Ceccagnoli et al., 2012), and semiconductor lithography equipment (Adner and Kapoor, 2016). Research on the logistics sector has only just begun to explore this proposed concept of a platform service supply chain.

3. Methodology

To address these contemporary phenomena and the research gaps, the present research adopted a case study methodology to answer the research question (Yin, 2013).

3.1 Case Study Design

Multiple case studies were designed for this research in order to comprehensively reflect the current developments and scenarios of a platform service supply chain in the logistics sector. Table 1 summarizes the three chosen cases in light of the selection criteria, such as history, size, award, logistics service types, platform types, and ecosystem structure. The selection aimed to choose appropriate cases that represent the different types of platform currently existing in the logistics sector. For example, when we decided on the selection of Case B, we had similar case companies focusing on other specific logistics activities, like warehousing and materials handling. We noticed that they all achieved sustainable success and shared similar strategies and practices, so we selected only the largest one (Case B) as being representative of specific logistics activity (transportation) for this research. Cases B and C were selected to represent successful cases that focus on a logistics facility (a logistics park in Case B) and logistics information technology (Case C).

Table 1. Brief details of the case companies

Case / Features	A	B	C
History	Founded in 2006	Founded in 2013	Founded in 2001
Size (revenue and number of members attached to the platform)	2018 total revenue of all platform member companies (30,000+): 1.6bn USD	2018 total revenue of all platform member companies (60+ logistics parks and 21,000+ registered logistics companies): 15.3bn USD	2018 total revenue of all platform member companies (3,000+ large-scale logistics companies, and 800,000+ registered truck drivers): 6.5bn USD
Award (reputation at national or global level)	2018, "Excellent Logistics Company in Shanghai, China" according to the Shanghai government	2018, "The top 50 Most Valuable Investment Company", awarded by the Ministry of Industry and Information Technology，China 2019, "Top 10 Industrial Internet Logistics Company"	2019, only Asian supplier included in the Gartner Major Quadrant Report as a WMS* software leader 2019, "Top 25 Logistics Technology Companies in Asia" according to the APAC CIO Outlook
Logistics service type (s)	Transportation	Logistics park	Logistics information system including WMS and TMS**
Platform features	Platform for small to medium-sized logistics companies; provides logistics activity-based services (transportation)	Platform for logistics parks; links logistics parks in different regions to match supply/demand and allocate resources	Platform for large companies; integrates online and offline services, providing cloud services and software/platform development services
Key players in the business ecosystem	Case A (platform owner) Logistics service suppliers: transportation companies Service suppliers: business office, banks, insurance companies	Case B (platform owner) Logistics parks Logistics service suppliers: logistics companies providing warehousing and transportation services Other suppliers: vehicle, fuel, tire suppliers	Case C (platform owner) Software suppliers Logistics companies providing integrated logistics services

* WMS: Warehouse Management System ** TMS: Transportation Management System

3.2 Data Collection

We used semi-structured in-depth interviews to collect the data. The interviews were conducted during 2018–2020, with a two-stage strategy to ensure that comprehensive data were collected. An interview protocol and interview question structure were predefined to ensure the quality of data collection for this research. See Appendix 1 for the protocol and the interview questions. The positions of the interviewees varied from CEO to project manager, and our aim was to extract in-depth insights from their practices and experiences (see brief details in Table 2).

Two stages of data collection were designed for this research. The first stage was organized from early 2018 to mid-2019, with the second stage then lasting until early 2020. The first stage served as the main part of data collection, while the second stage was planned to cross-verify some confusing

points that arose from the interviews, and to collect further insights from the interviewees due to this sector now experiencing fast growth facilitated by the government.

Table 2. Brief details of interviews and length

Case	Company Category	Interviewees' Position in the Company	Length of Interview
A	Platform owner	CEO Sales manager	1 hour 2 hours
	Logistics company x 3	Operations manager x 3	1 hour x 3
B	Platform owner	CEO Project manager x 2	1 hour 1.5 hours x 2
	Logistics parks x 3	Operations manager x 5	1 hour x 2 1.5 hours x 3
	Logistics company x 3	Operations manager x 3	1 hour x 3
C	Platform owner	CEO Sales manager x 2 Project manager x 3	1.5 hours 2 hours x 2 2 hours x 3
	Logistics company x 2	Operations manager x 2	1 hour x 2
		Total:	33 hours

The questionnaire was designed in English and then translated into Chinese. The interviews were conducted in Chinese, and at the end of data collection all the transcripts were translated into English for data analysis.

Meanwhile, secondary data were also used to better understand industry developments and the companies' histories and profiles, and this also served the purpose of verifying the data collected from the interviews. The main sources of secondary data used in this research included industry reports (mainly officially released reports, such as that published by the China Federation of Logistics and Purchasing [CFLP]), company websites, and company annual reports.

3.3 Data Analysis

The design of the interview questions, the coding, and the analysis were based on the ecosystem-as-structure framework in Adner (2017). The collected data reflected the theoretical constructs and were analyzed within the empirical context. The process of data analysis highlighted the theoretical framework, and we used deductive reasoning based on exploratory observations.

Mapping, coding, and theme-building approaches were adopted in the analysis. The codebook involved concepts from the literature as well as ideas emerging from the evidence. Themes were built on the connections and relationships were sketched out based on the observations. The within-case analysis mapped investigations for systematic understanding. Cross-case comparison was then conducted to analyze the similarities and differences in the three case settings (Dey, 2016).

The data analysis in this research was an evolving process, with continuous refinement through chaining observed evidence with research questions (Yin, 2013). Careful steps were taken to avoid omission of important information, to ensure consistency and validity, to reduce bias, and to enhance

the accuracy of the analysis. Coding was cross-checked by collaborating researchers for the replication of understanding and interpretation of evidence. Primary data were triangulated with secondary data from various sources (administrative reports, service records, and websites of case companies) to improve the reliability of the results.

Based on the data analysis, the platform service supply chain for each case was mapped, covering the structural elements with the ecosystem perspective (*activities*, *actors*, *positions*, *and links*). These maps are presented in Figures 2, 3, and 4, which correspond to Cases A, B, and C, respectively.

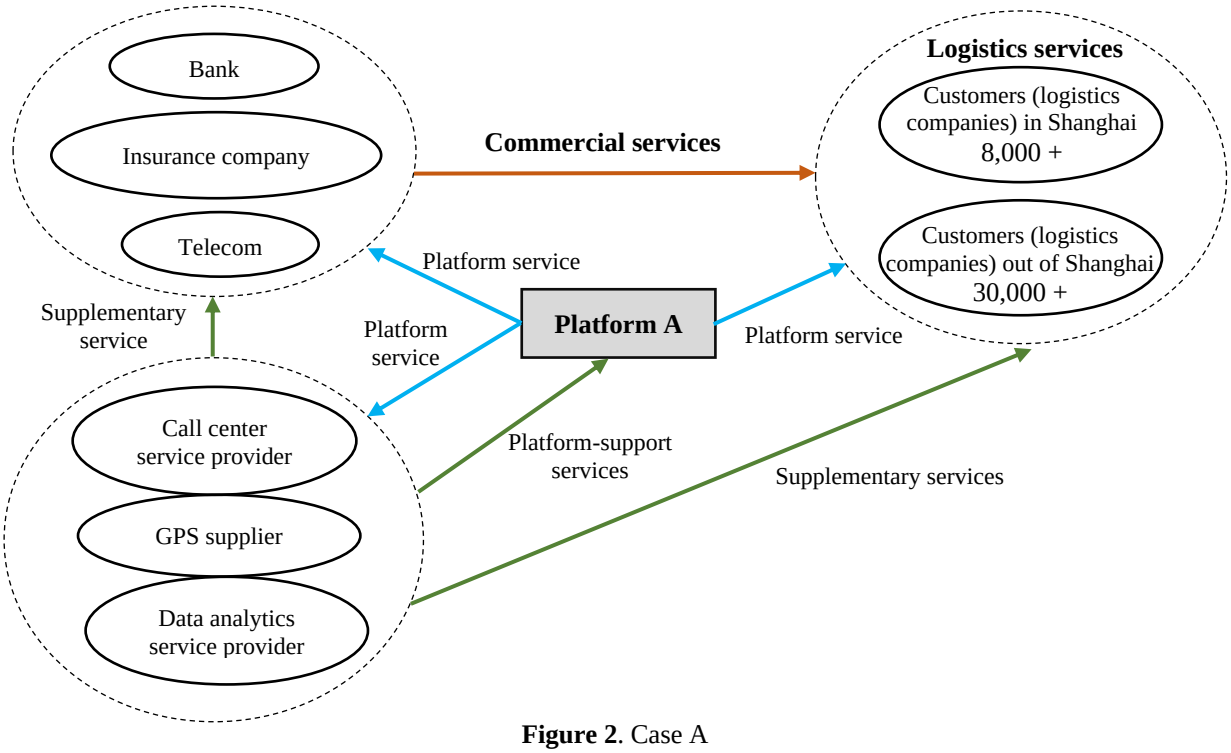


Figure 2. Case A

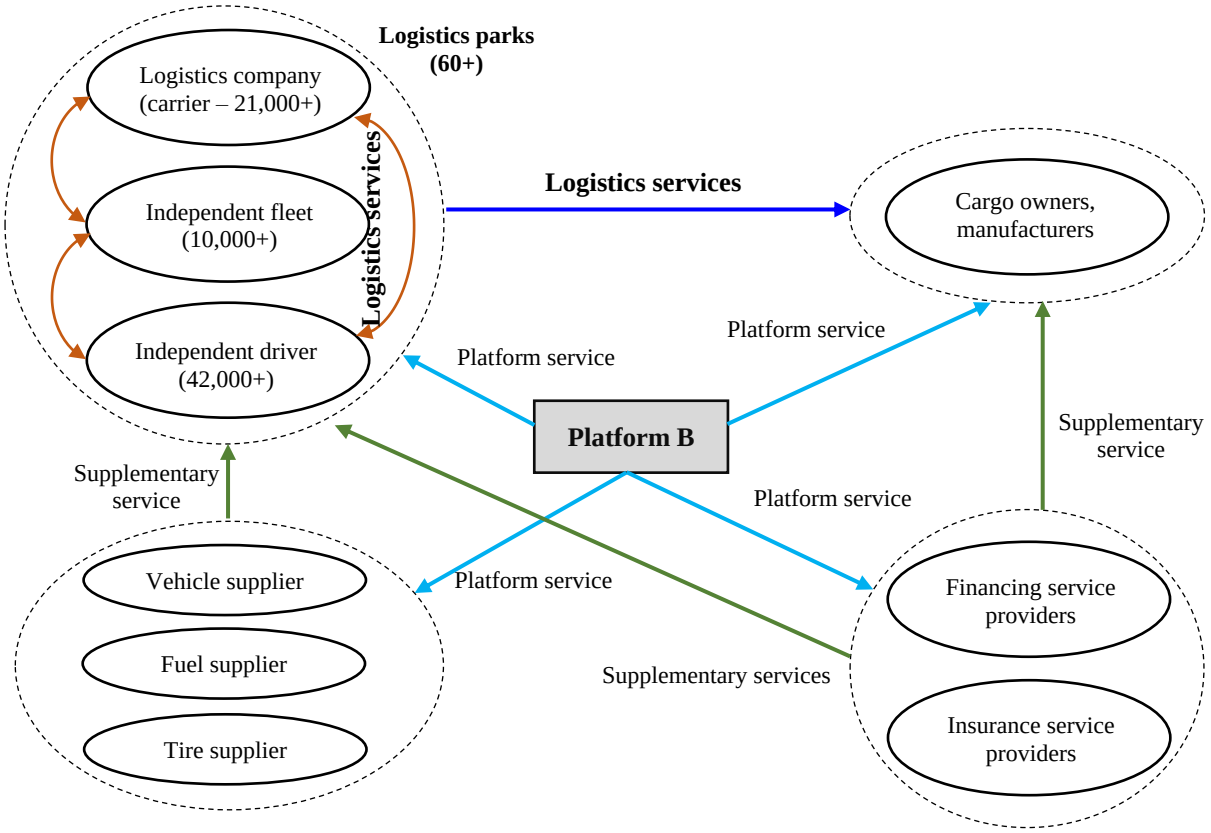


Figure 3. Case B

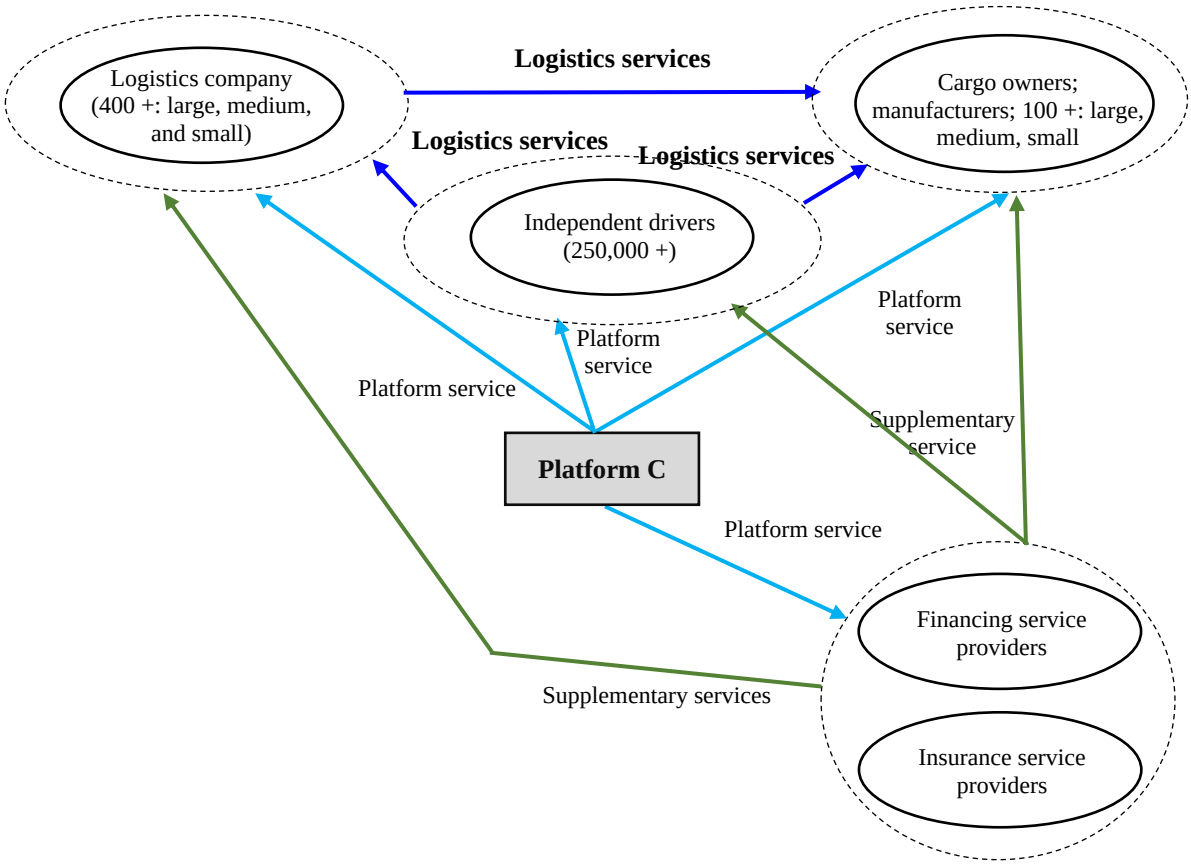


Figure 4. Case C

3.4 Case Study Summary

A summary of the three case studies, with the four structural elements from the perspective of ecosystem, is presented in Table 3. There were three different platforms, but all were related to logistics.

In Case A, the platform is devoted to providing integrated *commercial services* to small medium-sized logistics companies. These commercial services are provided by service providers, such as banks, insurance, and telecom companies, via the platform to customers (logistics companies). The initiative of this platform is to provide commercial services to logistics service providers with the aim of helping logistics companies focus their resources on what they are good at, such as transportation and warehousing. We observed that these commercial services also need support from other service providers, such as call centers, GPS, and data analytics services. Originally, the platform served logistics companies only within the Shanghai area, but it has quickly extended to a national level that covers more than 30 cities.

In Case B, the platform owner is a leading company in the logistics sector. The platform serves as a bridge linking various logistics parks in different regions with the aim of matching supply and demand sides to ensure effective and transparent transport services. The linked logistics parks now number more than 60 across 50 cities. The transport and warehousing services are provided by logistics companies, fleets, or independent drivers who are registered within the logistics parks. These services are provided to customers who are cargo owners or manufacturers. The platform owner emphasizes the importance of transport transparency, so it has invested heavily in developing various but integrated information systems and in cloud computing technologies to ensure visibility across the entire supply chain. Whereas Case A promotes commercial services to logistics companies, the platform in Case B aims to facilitate logistics services. However, just as in Case A, the platform in Case B also integrates other companies to support the logistics services. These companies include service providers of financing and insurance, as well as product suppliers of vehicle, fuel, and tires.

In Case C, the focal firm has evolved from a logistics software provider to become a cloud-based software-as-a-service (SaaS) platform. The platform we investigated in Case C provides software services and information management services to customers with the aim of helping them better integrate their online and offline logistics business. Since 2015, the focal firm has moved the software service to the cloud and achieved a highly successful annual growth rate of 30%. The software they provide covers not only specific logistics services like transportation and warehousing, but also supply chain collaboration and optimization. Their customers include logistics companies, cargo owners, manufacturers, and independent drivers, who can rent software from the cloud or let the platform manage their business data. The platform now focuses on industries like retail, healthcare, e-commerce, telecommunications, mobility, manufacturing, third-party logistics, and tobacco. As in Case B, there are supplementary financing and insurance services to support those operating the logistics services.

Table 3. Summary of the case studies

Ecosystem Elements		Case A	Case B	Case C
Structural components	**Activities**	• **Commercial services** - Business administration - Tax administration - Social security - Commercial factoring - Bank financing - Logistics insurance • **Platform services** (platform designed to provide various services [provided by third-party service suppliers] to logistics companies as customers) - Matchmaking supplier and customer for commercial services - Coordinating commercial services between service provider and customers - Invoicing and bookkeeping - Joint innovation with service providers and customers • **Supplementary services** - Call center service - GPS service - Data analytics services	• **Logistics services** - Freight transport - Warehousing service • **Platform services** (platform developed to provide services to logistics parks in different regions) - Matchmaking supplier and customer for logistics services - Coordinating logistics services between service provider and customers - Quality control and assurance of logistics services - Transportation management (e.g., route optimization and cargo tracking) - Warehousing management - Joint innovation with service providers and customers • **Supplementary services** - Financing service - Insurance service - Product supply (tires, fuel, vehicles)	• **Logistics services** - Freight transport - Warehousing service • **Platform services** (platform designed to link with software providers/developers and logistics companies as customers) - Cloud software services (TMS, WMS) - Software development - Integration and optimization of information systems for transportation and warehousing - Joint innovation with service providers and customers • **Supplementary services** - Financing service - Insurance service
	Actors	• **Company A** • **Commercial service providers** - Banks - Insurance companies - Telecom companies • **Supplementary service providers** - Call center service providers - GPS suppliers - Data analytics service providers • **Customers** - Logistics companies	• **Company B** • **Logistics service providers** - Logistics companies - Independent fleet - Independent drivers • **Supplementary service providers** - Vehicle suppliers - Fuel suppliers - Tire suppliers - Financial service providers - Insurance service providers • **Customers** - Cargo owners - Manufacturers	• **Company C** • **Logistics service providers** - Logistics companies - Independent drivers • **Supplementary service providers** - Financial service providers - Insurance service providers • **Customers** - Product suppliers - Cargo owners - Manufacturers

	Position	• **Platform owner** • **Commercial service provider** • **Supplementary service provider** • **Customer**	• **Platform owner** • **Logistics service provider** • **Supplementary service provider** • **Customer**	• **Platform owner** • **Logistics service provider** • **Supplementary service provider** • **Customer**
	Links	• **Transfer of resources (products, funds, services):** - Platform owner → Customer - Platform owner → Commercial service provider - Platform owner → Supplementary service provider - Commercial service provider → Customer - Supplementary service provider → Commercial service provider - Supplementary service provider → Customer - Supplementary service provider → Platform owner • **Transfer of information:** - Platform owner ↔Customer - Platform owner ↔Commercial service provider - Platform owner ↔Supplementary service provider - Commercial service provider ↔Customer - Supplementary service provider ↔Commercial service provider - Supplementary service provider ↔Customer	• **Transfer of resources (products, funds, services):** - Platform owner → Customer - Platform owner → Logistics service provider - Platform owner → Supplementary service provider - Logistics service provider → Customer - Supplementary service provider → Logistics service provider • **Transfer of information:** - Platform owner ↔Customer - Platform owner ↔Logistics service provider - Platform owner ↔Supplementary service provider - Logistics service provider ↔Customer - Supplementary service provider ↔Logistics service provider - Supplementary service provider ↔Customer	• **Transfer of resources (products, funds, services):** - Platform owner → Customer - Platform owner → Logistics service provider - Logistics service provider → Customer - Supplementary service provider → Logistics service provider - Supplementary service provide → Customer • **Transfer of information:** - Platform owner ↔Customer - Platform owner ↔Logistics service provider - Platform owner ↔Supplementary service provider - Logistics service provider ↔Customer - Supplementary service provider ↔ Logistics service provider - Supplementary service provider ↔ Customer
Strategic vision		• To co-develop a business community of logistics companies; to co-build an advanced reputation with high-level customer satisfaction.	• We are devoted to building a big-data-driven logistics ecosystem to help logistics companies achieve logistics business transformation.	• Transforming logistics through implementing information technologies. We are happy to co-evolve with our customers by using our software expertise.

4. Findings and Discussion

Based on the data analysis, this research derived several findings in relation to the research question. These include the structure of the platform service supply chain, the features of platform services, the facilitation mechanism between the platform and the business ecosystem, the digitalization and competition in the service platform and its ecosystem, and the sustainable management framework of the platform service supply chain. The rest of this section will discuss these findings in detail.

4.1 Structure of the Platform Service Supply Chain

From the mappings of the three cases (see Figures 2, 3, and 4), a generic structure of a platform service supply chain is formulated and proposed in Figure 5.

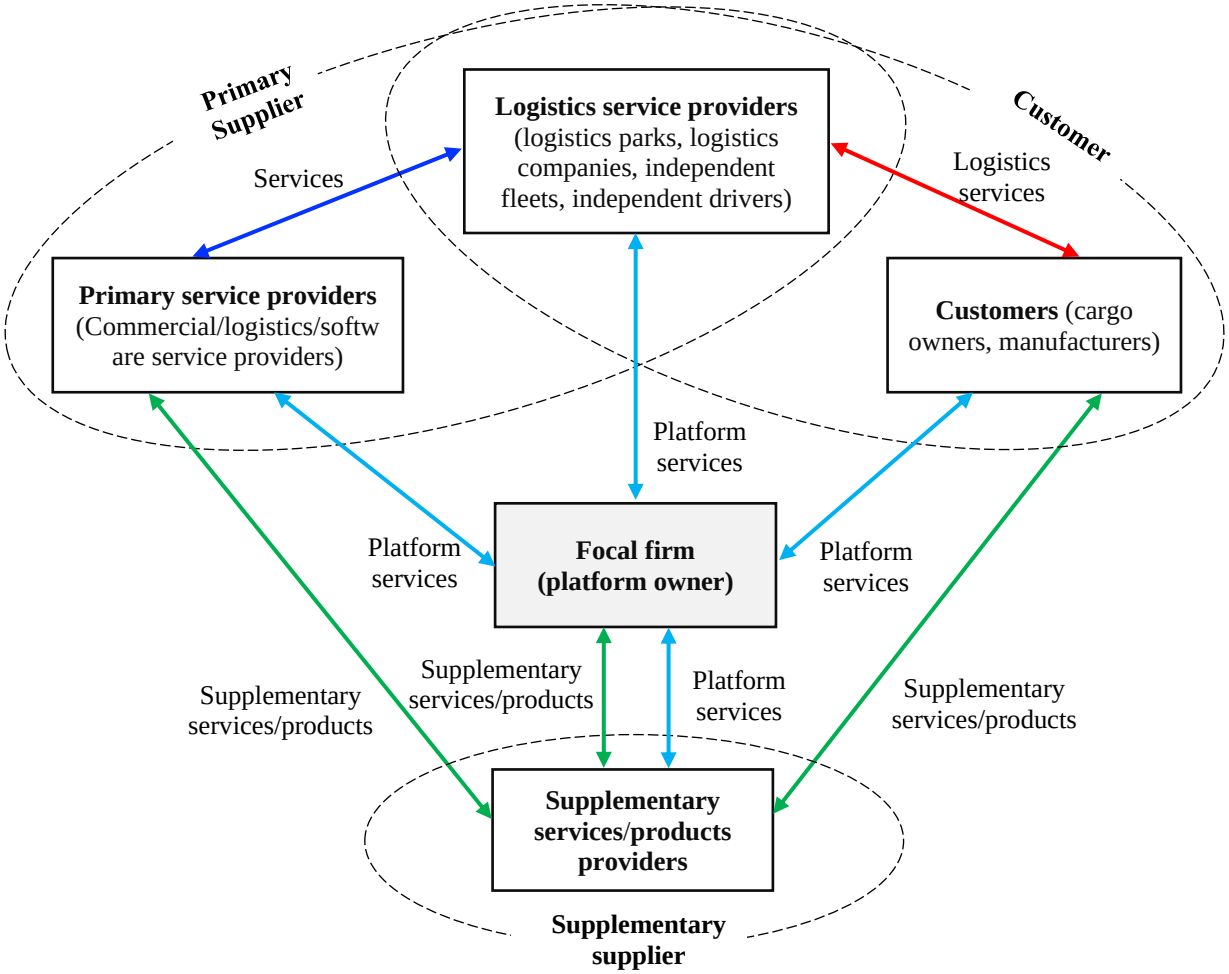


Figure 5. Structure of the platform service supply chain

The key *actors* in the proposed structure include the focal firm, primary suppliers, supplementary suppliers, and customers. The focal firm is *positioned* as the platform owner, who serves the same

roles as the focal manufacturer in the product supply chain, or the major service provider in the service supply chain. The platform owner uses its platform to attract and collaborate with actors from both the supply and demand sides to accomplish the fundamental logistics services. There are two types of suppliers on the supply side. Primary suppliers are those service providers offering logistics-related commercial services (Case A), professional logistics services (Case B), or software-related services (Case C) to customers. In supporting the accomplishment of the primary services, supplementary suppliers provide necessary parts, components, or products (such as tires and fuel in Case B) or supportive services (such as call center services and data analytics services in Case A, and financing services in Cases B and C) to those primary suppliers, including the platform owners, so that the primary suppliers can better deliver their services to customers. Within the structure, customers could be logistics companies who need commercial services (e.g., in Case A), or cargo owners or manufacturers (e.g., in Cases B and C) who need professional logistics services, such as warehousing and transportation.

What is interesting here is that, from the viewpoint of the platform owners, all the other actors (service providers and customers) become the platform's customers, receiving platform services from the focal firm. The platform *links* all the other actors within the platform service supply chain. On the one hand, this enables the integration of services from various providers; on the other, it offers service providers access to customer information (Gawer, 2014). As a result, the platform enables triadic interactions among service providers, the platform owner, and the customers. Such triadic interactions or triadic links are the essential foundation for the concept of the platform service supply chain proposed in this research. This triadic structure-based supply chain is different from the traditional, linear supply chain of activity flows in product or service supply chains, as the latter is based on a dyadic structure with a clear focus on upstream suppliers and downstream customers (Ki-Hyun and Jae-Young, 2020; Wilhelm, 2011).

In the traditional product supply chain, the upstream and downstream activities of a focal firm mainly focus on transferring goods and information along the supply chain, while the service supply chain is more about service provision along the supply chain, but with the essential feature of customer involvement (Maull et al., 2012; Sampson and Spring, 2012). There are similar activities involved in the three cases: logistics services, financing and insurance services, and software services. Hence, similar actors can be observed across the cases: logistics companies, banks, and insurance companies. It can be observed that the same type of actor may possess different positions in different platform service supply chains. For example, logistics companies are customers of the commercial services in Case A, whereas their positions in Cases B and C are as suppliers of logistics services. Financial services are considered supplementary to the logistics services in Cases B and C, but they form part of the primary services in Case A. Across the three cases, *activities* are closely associated with the value proposition of the service platform. The above-mentioned actors and activities are linked through the transfer of resources and information. The transfer of resources takes the form of

products, funds, and services and is realized in the activities of service provision. The transfer of information is bidirectional and embedded in the coordination and cooperation in the value-creation process. The transfer of resources and information also takes the form of joint innovation activities in developing new services.

From the perspective of the business ecosystem, a product-centric supply chain has distinctive upstream and downstream activities. Elements bundled by the focal firm in upstream activities are considered *components*, and these are provided to the focal firm by manufacturers of the final product. Offers that are bundled in downstream activities by customers are considered *complement*s (Adner and Kapoor, 2010). Providers of these offers are complementors, and they are regarded as a critical factor in the success of the product. The situation is different in the platform service supply chain, which does not have distinctive downstream complements.

4.2 Features of the Platform Service Supply Chain

Unlike the traditional service supply chain, the platform service supply chain has unique features, which are discussed below.

4.2.1 Triadic interactions

Within the platform service supply chain, the platform acts as a bridge between the supply side and the demand side, leading to triadic interactions among actors and enabling multilateral transfer of resources and information. This triadic interaction, which is the essential feature of the platform service supply chain that we propose in this research, happens among service suppliers, customers, and the platform owner.

As a result, the activities realized through these links feature co-creation of value, co-development of knowledge, and co-evolution of all actors. Hence, service delivery *activities* consist of two critical steps: demand–supply matching via the platform, and service provision between supplier and customer. We define the first step as platform services, and the three cases reveal that these services include information sharing and management matchmaking of suppliers and customers, software services, service standardization, and quality assurance. The second step is defined as primary services in this research, including logistics-related commercial services in Case A and logistics services in Case B.

This triadic interaction also happens in other platform-based business environments, such as within the e-commerce environment where the interactions occur among platform owner, suppliers, and customers (Lin et al., 2016). The triadic interactions identified in this research are summarized in Figure 6.

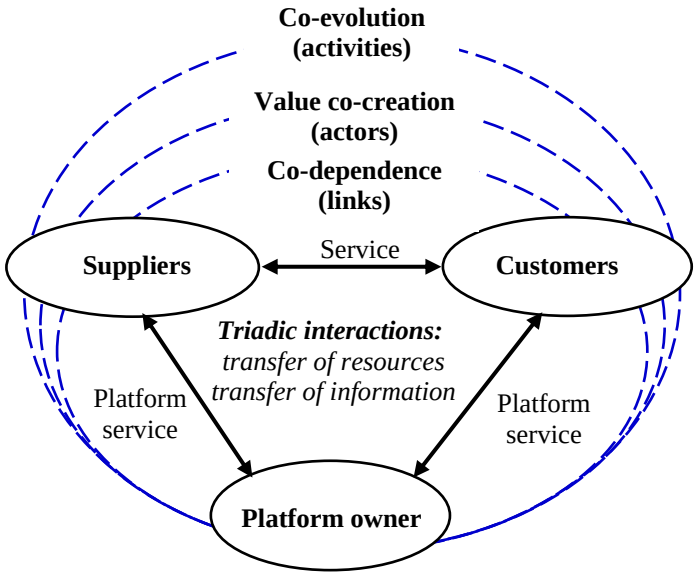


Figure 6. Triadic interactions within a platform service supply chain

These triadic interactions are a distinctive feature of a platform service supply chain, and they differ from the *dyadic interactions* between suppliers (or manufacturers) and customers in the traditional product or service supply chain. Interactions are considered critical if a successful contract between two parties depends on a third party (Chen et al., 2017; Song et al., 2016). In the platform service supply chain, the platform owner plays an essential role in enabling transactions between service providers and customers. This forms a base for the triadic interaction. As shown in Figure 5, the platform services provided by the platform owner create a bridge that links multiple suppliers (including primary and supplementary services providers) and customers with each other on the platform. This is considered the supply side and demand side of a platform, or the so-called two-sided market (Rochet and Tirole, 2003). Hence, there is *supply–demand matchmaking* via the platform before the services are delivered by the providers to the customers. These two parts form the triadic interactions within the platform service supply chain. The dependence on the platform to enable such triadic interactions is one of the key differences between the platform service supply chain and the traditional service supply chain, with the latter being more reliant on the mutual dyadic interactions between suppliers and customers (Chen et al., 2017).

A common feature in Cases A, B, and C is that the platform owner played a key role in matching supply and demand sides to facilitate transactions between the two. The platform owner also used various activities to encourage and promote cooperation among actors in sharing information and developing knowledge and capabilities, which leads to *value co-creation* among actors, where *co-dependence* forms through the links and *co-evolution* is achieved via activities (as seen in Figure 6). This can be regarded as a strategic alignment among those four structural elements of the platform service supply chain.

We started with specific logistics software (for example, TMS and WMS) and gradually turned to build our platform to offer software as a service… our platform aims at sharing resources among members. These include transportation capacity, supply of goods as well as information of customers. (Interviewee, Case C)

Through such matchmaking, the platform connects and coordinates a variety of services, and this enables multilateral sharing of resources and information to achieve *value co-creation* (Clarysse et al., 2014). As a result, the utilization of resources along the supply chain is optimized to achieve higher efficiency. This allows cost-cutting and brings more options to benefit both suppliers and customers. Case B provides an example of such benefits in its solution to the issue of returning empty vehicles: the matchmaking and coordination of the platform enable return loads for empty vehicles, and this reduces the costs of the transport service provider while simultaneously satisfying customer needs.

Many enterprises [in the sector] serve as third-party service providers, but our company is a platform. Building a platform is challenging as it requires proper values to be proposed to partners; providing third-party services is more straightforward. (Interviewee, Case B)

Co-dependence and *co-evolution* mean that actors within the platform service supply chain share each other's fate while maintaining an independent value proposition that differentiates them from competitors (Adner, 2017; Lu et al., 2014; Rong et al., 2020). The cases in this research demonstrate that co-dependence and co-evolution are achieved through collaboration among the actors involved.

For example, Case A features logistics-related commercial services provided to individual industrial customers. Actors like commercial service providers, logistics companies, and supplementary suppliers (including call centers, GPS, and data analytic service providers) are interdependent with each other. One actor that provides data analytics services joined the platform only five years ago as a response to a request from some customers. Now the data analytics service has become an essential service on the platform and is integrated with other commercial services and platform services, with the result that actor has grown to become one of the top 10 service providers on the platform. Meanwhile, more customers have started to use this service with its word-of-mouth benefits, with the aim of taking their logistics businesses to a new level. Obviously, there is a co-evolution among all actors.

Another example is the focal firm in Case C. The firm was originally a software company that focused on selling TMS and WMS. Along with the development of IT technologies (especially cloud computing) and a growing number of customers within the logistics sector, they started to adopt a SaaS platform strategy. This changed not only their own business, but also how its customers used software, paid for the software, or paid for the use of software. Since it moved to cloud service, the focal firm also recruited many third-party software companies and independent developers to the platform, which enriched the software that the platform could provide to its customers. Meanwhile, it

led to those newcomers not selling software directly to customers but via the platform. Clearly, they co-evolved with others from their old business models to the new ones.

Overall, the critical, triadic interactions in the platform service supply chain enable a circular flow of resources and information among all actors. This circular flow can be distinguished from the linear flow of resources and information in the traditional product and service supply chains. The bilateral partnership in traditional product and service supply chains is transformed into multilateral interdependence in a business ecosystem, which features co-evolution of member actors and co-creation of value through critical and multilateral interactions.

4.2.2 Supply chain-oriented platform services

In the traditional service supply chain, services normally focus on professional services, such as specific logistics activities (e.g., transportation, inventory, and warehousing), and are developed at the company level (Juho et al., 2012). By contrast, the platform services are developed at the level of the whole supply chain and focus on the facilitation and optimization of transactions and cooperation among multiple parties, or the optimization of the integrated operations in the supply chain. To be supply chain-oriented means that the platform services are designed either for all actors within the platform service supply chain, or for logistics companies to better manage their supply chains. This has been proven as an industrial trend in the logistics sector, as shown in the three cases we studied.

> *Our company aims to provide comprehensive services to serve any partners in the logistics industry, to help them better support their supply chain management. We also aim to be a supply chain hub to link all logistics companies to develop a friendly business community.* (Interviewee, Case A)

> *The vision of our business is to help different industries to manage and optimize their supply chains. Using our platform, we can link all supply chain players via logistics parks in different regions, and this will facilitate better matching and deploying of supply chain resources.* (Interviewee, Case B)

> *The cloud-based platform we developed is not just about selling software as a service to our clients; we are more eager to support companies in better managing information across the entire supply chain. The software we provide on the platform covers all areas within a supply chain, and we ourselves have also developed cloud-based "for supply chain" data management as our core capability.* (Interviewee, Case C)

Across the three cases in this research, those objectives are accomplished via platform activities such as the establishment and continuous optimization of the platform system, collecting and sharing market information, coordinating communication among platform members (players from both supply and demand sides), and conducting quality control and assurance.

Our company is responsible for the quality control on the side of [primary and supplementary] service providers, and meanwhile we are in charge of optimizing order management on the side of customers. (Interviewee, Case B)

This integrative feature of platform services requires a holistic view of the operations of the entire supply chain. The value creation of the platform service supply chain depends on its systematic efficiency in resource utilization and information sharing among actors on both supply and demand sides, or across the entire supply chain. This leads to the strategic priority of network effects in the platform service supply chain. The direct network effects relate to the size of the system; that is, the number of members, including suppliers and customers, registered on the platform. The indirect network effects are reflected through complementary invention and value co-creation among members at various positions in the activity flow (Ceccagnoli et al., 2012). In those cases, integration and joint innovation help to improve the services across the whole supply chain.

We developed 24-hour access to transport insurance for our customers. The integration of customer orders through our platform leads to the need and possibility of having 24-hour access for all partners within the supply chain. (Interviewee, Case A)

A few innovative services were created based on our platform, e.g., drop-and-pull transport and non-truck-operating common carriers. The connection that we built among logistics parks serves as the foundation for continuous innovation and whole supply chain linkage and optimization. (Interviewee, Case B)

We help any partners within the entire supply chain to design and develop new software products. Through joint effort with partners, we provide technology and professional expertise, and partners contribute demand information and product ideas. (Interviewee, Case C)

Traditionally, supply chain logistics optimization is limited to a focus on local specific areas due to technical difficulties. For example, supply chain visibility has been a critical challenge for many years, but there has been limited progress in the sector. However, with the platform strategy and the fast development and implementation of information technologies, a supply chain-oriented service becomes possible. Case C shows that much cloud-based software targets the optimization of operations for the entire supply chain rather than, as was previously the case, for individual companies only.

4.2.3 Role of the platform owner

The three cases in this research highlight the platform owner's role in connecting and matching service providers and customers. The platform owner serves, therefore, as the key to the

transformation of operations from the traditional service supply chain to the platform service supply chain.

> *Our platform aims to improve the industry level of application and management of information technology, increase supply chain efficiency, and reduce costs.* (Interviewee, Case C)

> *Our objective is to build a united community of groups in this sector, like an association… These people [logistics companies] have limited capabilities for and do not excel in coordination with administrative authorities and service providers. They need our platform to help them so that they can focus on their specialized businesses.* (Interviewee, Case A)

The platform owner's essential function in bridging the supply and demand sides places the platform owner at the center of the operation of the platform service supply chain. As a result, the platform owner undertakes the role of leading and managing the optimization of resource use and promotion of transfers among multiple actors. This requires the platform owner to strategically sustain and expand the networks of actors connected via the platform interface for the purpose of enhancing the network effects in value creation.

Furthermore, the platform owner plays a critical role as a visionary leader in the platform service supply chain. Especially at the early stage of the establishment of the platform service supply chain, the platform owner needs to promote the platform and its services, and attempt to attract as many suppliers and customers as possible to use the platform. Above all, it is important ensure that these suppliers and customers will continue to use the platform. From the cases we studied, the focal firms explored many ways to attract and retain suppliers and customers. For example, a *Logistics Open Day* and *Community Day* in Case A, and a *Value Sharing Scheme* in Case B helped to develop a friendly business community and long-term strategic relationships.

> *We like the comprehensive services provided on the platform; it saves us lots of time in doing boring admin paperwork, which helps us to concentrate on the transportation services we provide to our largest customer in the automobile industry.* (Interviewee, logistics company, Case A)

> *[The focal firm] brings a bright future to us with a big picture of an integrated online and offline logistics business. After joining the platform, we have extended our business from the local area to a broader national level, which we never thought would be possible. But we are now in a big ecosystem, and we are creating value together with other partners. The most important thing is that we are also benefiting from the ecosystem value as promised by the platform owner.* (Interviewee, logistics company, Case B)

4.3 Facilitation Mechanism Between Platform and Business Ecosystem

The research results indicate that in the process of developing an ecosystem, the platform plays a critical role. Building, promoting, and sustaining the platform facilitates the pace of the establishment of a business ecosystem. Meanwhile, the success of a business ecosystem could further enhance the development of the platform. This mutual facilitation mechanism, which is summarized in Figure 7, answers the research question of how to develop and manage the platform service supply chain. We argue that without the establishment of a successful business ecosystem based on the platform, it is difficult to say that a successful platform service supply chain has been built. The mutual facilitation mechanism between the platform and the business ecosystem brings some practical and managerial implications, which are discussed below.

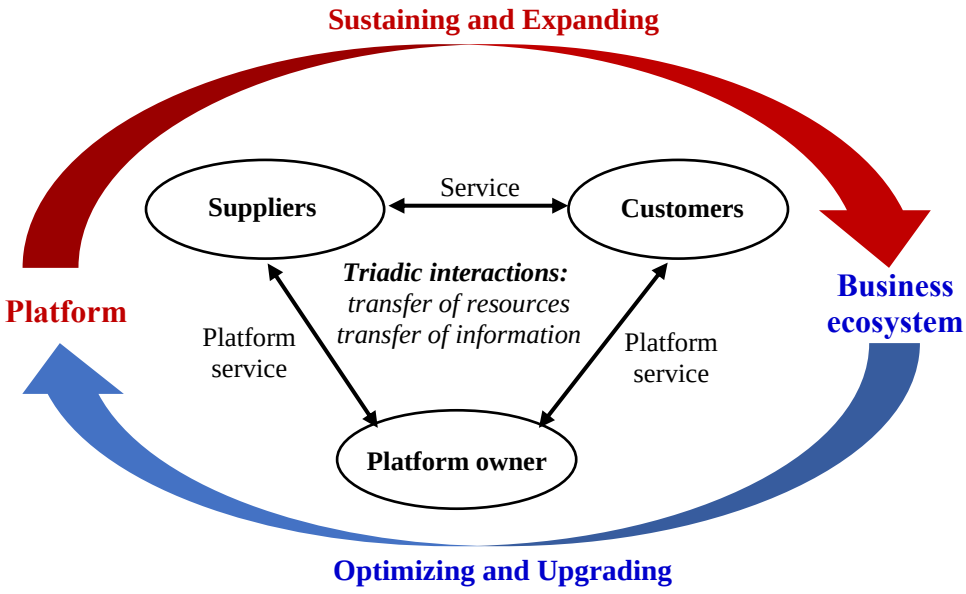


Figure 7. Facilitation mechanism of the platform service supply chain

4.3.1 Role of the platform: Sustaining and expanding

As indicated in Figure 7, the platform enables triadic interactions that achieve a circular flow of resources and information among the actors within the platform service supply chain. These triadic interactions are regarded as the essential facilitation mechanism through which value co-creation among the actors is realized and a business ecosystem is established. The research results highlight that *sustaining* existing users as well as *expanding* the services are the two major pathways to establishing a successful business ecosystem.

4.3.1.1 Sustaining. Besides promoting the platform to attract suppliers and customers to the platform, another key responsibility of the platform owner is to sustain the current users of the platform. Taking Case A in this research as an example, the platform owner retains existing members by setting up local offices to facilitate communication and by conducting on-site visits for customers

so that they can provide regular feedback. In Case B, the platform owner organizes teambuilding events to create a sense of community and group identity among existing members.

4.3.1.2 Expanding. With a stable number of users, the platform owner can then move to expand. This involves expanding the scope of the platform services by providing further variety to satisfy platform users. For example, the focal firms in Cases A and B strive to design and integrate new services on the platform to enhance the experience of using it. This also serves the purpose of attracting new users to join the platform. Expansion also involves expanding the scope of the community of suppliers and customers, which forms the foundation of a business ecosystem. In Case C, in order to broaden the community, the focal firm invited independent software developers and companies to join the platform. This extended the service offerings beyond the original software provided only by the platform owner.

4.3.2 Role of the ecosystem: Optimizing and upgrading

The platform plays an essential role in developing the business ecosystem, and the success and growth of the business ecosystem equally feed back into the sustainable development of the platform. The research results indicate two critical influences from the ecosystem on the platform: *optimizing* and *upgrading*.

4.3.2.1 Optimizing. A well-built business ecosystem embraces a variety of actors that complement each other, which facilitates the healthy development both of the ecosystem itself and of the platform. In Case A, the platform established a close relationship with local authorities to ensure the efficient operations of their own business, which acted as a supporting role to the platform owner within the ecosystem. Eventually, the platform owner included those local authority actors in the platform to provide coordinated tax and business administration services to platform users. Furthermore, the platform and the ecosystem have received huge support from governmental bureaus in facilitating their operations, as well as in facilitating their expansion into new regions. Case B provides an example where the good reputation of the platform brings new members into the ecosystem, and the expansion of the ecosystem leads to increasing demand for the platform's services. With more logistics parks joining the ecosystem, there was increased demand for diversified services from the platform. Therefore, the platform owner worked closely with the logistics parks and companies to optimize the current service offerings or to jointly design innovative services to enhance and optimize the platform services.

4.3.2.2 Upgrading. Beyond optimizing the platform and its services, it is also important that the development of the business ecosystem facilitates the upgrade of the platform. The growth of the business ecosystem requires that the platform's infrastructure and technology are upgraded in order to fulfill higher-level service requests, enhance quality and variety, and ensure supply chain integration. For example, in Case B, as well as optimizing the current platform services, the platform upgraded the strategic vision to be a supply chain hub rather than a logistics park hub. By building a comprehensive

business ecosystem, the resource pool was enhanced to create the opportunity and possibility for the platform owner to integrate more partners and processes within the platform service supply chain. As a result, the platform started to offer supply chain-oriented services, as discussed above. Compared to optimization, upgrading reflects more the co-evolutionary nature of a business ecosystem. By upgrading, the platform owner transfers its business model, and the other actors within the platform service supply chain co-evolve with the upgraded platform services.

4.3.3 Mutual facilitation mechanism

On the one hand, the platform enables critical, triadic interactions among actors within the platform service supply chain, promotes the establishment of the business ecosystem, sustains its development, and expands its scope. On the other hand, the success of the business ecosystem feeds into the platform by providing a good service reputation, expanding demand for services, and increasing external support. This pushes the platform not only to optimize its operations and management, but also to upgrade them to a next level, which sometimes amounts to an industrial transformation.

The mutual facilitation between the platform and the business ecosystem highlights a dynamic development mode that facilitates and promotes continuous innovation and improvement opportunities in services and businesses, leading to the emergence of new business models and industry sectors. This dynamic development also indicates that the platform owner within the platform service supply chain can quickly sense and capture the opportunities of the technological development and adopt it either to expand the service scope or to upgrade the platform services to a new level. For example, in Case C, the platform owner took advantage of rapid growth in big data and cloud computing technologies to move to offering cloud-based platform services.

4.4 Sustainable Management of the Platform Service Supply Chain

Drawing on the evidence of the successful development and management experience of the three cases, this research develops a sustainable management framework (see Figure 8) to provide implications for managing platform service supply chains.

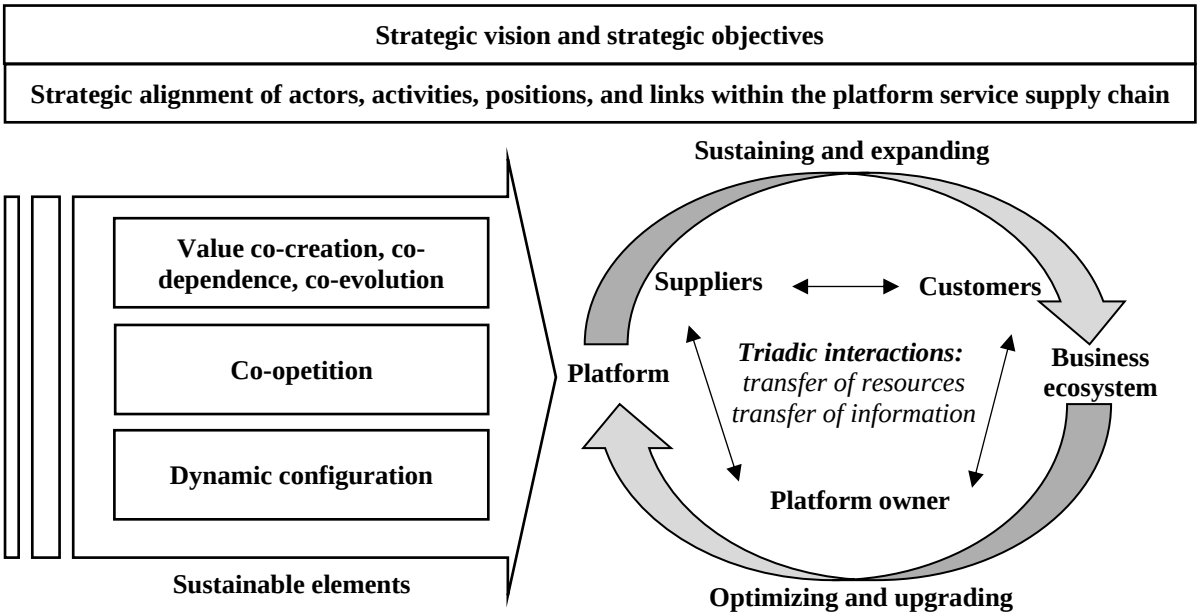


Figure 8. Sustainable management framework for the platform service supply chain

As indicated in Figure 8, the platform and its business ecosystem mutually facilitate their development and success. The sustainable management of the platform service supply chain therefore requires setting a strategic vision to enhance the mutual facilitating mechanisms and elements, to balance cooperation and competition, and to dynamically manage the configuration of actors and activities for value co-creation.

4.4.1 Strategic vision and strategic objective

The discussion in Section 4.2 indicated that once the business ecosystem forms, the platform leads to the strategic alignment of actors and their interactions in *value co-creation*, *co-dependence*, and *co-evolution*. The strategic alignment can also be treated as approaches to achieving the *strategic objective* of managing a platform service supply chain. The platform owner plays a key role in sustaining and expanding network connections, promoting the transfer of resources and information among actors, and balancing competition and cooperation. This requires the platform owner to develop a clear strategic vision for the value proposition of the holistic supply chain.

The research results indicate that *strategic vision* plays a critical role in developing and managing the platform service supply chain. The three cases in this research show that to sustain growth, all the platform owners established clear visions of value co-creation with all the actors within the platform service supply chain. For instance, in Case A, the platform aimed to extend the geographical scope of services to countries attached to the Belt and Road Initiative, with the objective of contributing not only to logistics optimization but also to environmental sustainability by promoting resource sharing, increasing resource efficiency, and reducing waste. In Case B, the platform owner had the objective of

building a mainline transportation network that connects over 60 cities in China. The platform in Case C aimed to serve as the access to the biggest business-to-business logistics ecosystem in China and to improve the industry level of data management.

The strategic vision and the proposed value guide the platforms' operations and decision-making. For example, in Case A, the platform owner once faced a situation of entering a new service area for business development but decided not to, instead remaining focused on the platform's core activity of bridging and coordinating suppliers and customers. Platform A's choice avoided direct competition with its suppliers in their specialized service areas and led to stable cooperation among actors in the ecosystem. Such a balance between cooperation and competition also demonstrated the platform owner's strategic vision of the proposed value co-creation of the holistic platform service supply chain.

4.4.2 Co-opetition

The cases in this research demonstrate that competition and cooperation coexist in the development of the platform and the business ecosystem. First, all actors cooperate within the platform service supply chain to achieve value co-creation. However, once the business model and its know-how has been understood, any actor can copy it and become a rival to compete with the original platform owner. For example, in Case A, one of the service providers, through close cooperation with the platform owner, gradually developed a similar platform and formed its own business ecosystem to compete with the platform that it had previously served. An even worse situation occurred in Case C: one of the software providers copied the entire business model and even took away a technical team from the platform owner, before launching a rebranded platform to compete in the market. The research results illustrate that cooperation among actors can *stimulate* competition.

> *The business expansion of some of our service providers enables them to extend their service scope and to gradually evolve into a platform themselves. They then run their own system and become a competitor of ours.* (Interviewee, Case A)

However, the research also highlights that cooperation among actors can *moderate* competition. As mentioned above, considering the existing cooperation, the platform owner in Case A decided to give up a business opportunity to avoid direct competition with the existing commercial service provider on its platform.

The third context is one in which cooperation *coexists* with competition. For instance, the platform owner in Case C serves as a software service provider to the platform in Case B. These two ecosystems share overlapping customers; hence, they sometimes have to compete with each other. However, the two platforms support each other very well with their own specialized services. Both of them intend to establish the healthy development of their own platforms and ecosystems.

Such examples indicate that platform owners should have a strategy of balancing cooperation and competition in order to ensure the stability and success of the platform service supply chain (Charleton et al., 2018; Hannah and Eisenhardt, 2018). In this research, we term the coexistence and balance of competition and cooperation in the platform service supply chain as ecosystem-oriented co-opetition, which covers how cooperation stimulates, moderates, and coexists with competition during the development and management of the platform service supply chain.

4.4.3 Dynamic configuration

The research results indicate that the development of the platform service supply chain goes through various stages, which requires a *dynamic configuration* of actors and interactions.

We followed the four-stage model proposed by Moore (1993) to investigate the development and management of a platform service supply chain, which includes birth, expansion, leadership, and self-renewal. The cases in this research reveal that all the platform owners undertook a dynamic configuration of actors and interactions at different stages.

Taking Case B as an example, at its initial *birth* stage, the focal firm adopted a "light asset model", according to which it quickly built connections with existing logistics parks rather than building logistics parks itself. This helped not only to save resources but also to facilitate the development of platform services and the establishment of close relationships with various actors. Entering the *expansion* stage, the platform faced increasing complexity in its interactions as well as a growing number of actors. The platform owner made a very clear decision to set the priority actor and interaction on which to focus, which helped the platform sustain the current users through profit-sharing activities while simultaneously attracting new users. At the *leadership* stage, the focal firm extended its platform services to a national level. The recruitment of a new actor, a supplementary service provider who offered data analytics services on the platform, enhanced the firm's leadership in the market. The platform is currently at the *self-renewal* stage. With other similar platforms entering and competing in the market, the focal firm has figured out how to renew itself to a new level, which has involved transforming itself from being a logistics park hub to becoming a supply chain hub focusing on supply chain-oriented services and relying on its existing actors and interactions.

The research results demonstrate that the strategic alignment among actors in different positions, through the configuration of activities and interactions via the corresponding links, plays a critical role in the success and healthy development and management of a platform service supply chain.

5. Conclusions

This research has investigated the nature, development, and management of the platform service supply chain. Building on the extant literature and in-depth studies of three cases in the Chinese logistics sector, it has defined the concept and developed both a generic structure of the platform

service supply and a sustainable management framework for it. Based on the results of the data analysis and discussion, this section summarizes the theoretical contribution of this research as well as its managerial implications for practitioners. The limitations of this research are then discussed, along with directions for future studies.

5.1 Theoretical Contributions

The proposed definition and generic structure of a platform service supply chain contribute to the current literature on logistics service supply chain management. Unlike the existing literature on service supply chain that focuses on customer involvement (Maull et al., 2012; Sampson and Spring, 2012) or dual direction (Lin et al., 2010; Sampson, 2000), this research has emphasized the adoption of a platform strategy by logistics service supply chains, and it has applied an ecosystem perspective to observe the operations and management of platform service supply chains.

First, the proposed definition and structure contribute to the research on platform service supply chains, and they enhance the understanding of platform service supply chains by extending the traditional firm-level view to a broader ecosystem view. In particular, by identifying the triadic nature of supply chain interactions, this research contributes to developing the theory of platform service supply chains. This triadic nature is different from the supplier–customer dyads in service supply chains highlighted by the main body of literature (Chen et al., 2017; Tseng et al., 2018). Investigating the triadic interactions helps to better understand the relationships of actors within the platform service supply chain. This research reveals that the platform-enabled triadic interactions transform the linear flows in the traditional supply chains into circular flows of resources and information. Therefore, this research has distinguished the nature of platform service supply chains from that of the traditional product and service supply chains.

Secondly, this research has investigated the relationship between the platform and the business ecosystem, and it has identified a mutual facilitating mechanism between them. This finding further develops our understanding of the relationship between platforms and business ecosystems (Rong et al., 2018). The research results demonstrate that the platform plays the essential role in sustaining and expanding the network connections and effects, which in turn promotes the growth of the business ecosystem; and the healthy development of the business ecosystem brings opportunities to upgrade and optimize the platform's operations and management. In light of this, we have been able to develop a sustainable management framework for platform service supply chains, which contributes to the understanding of platform strategies and business ecosystems. The experiences of the three successful cases of platform service supply chains illustrates the impact of a platform strategy on the development of the business ecosystem, and the focus on the Chinese logistics sector sheds light on logistics platform development in emerging markets.

5.2 Managerial Implications

This research has drawn on three case studies of platform service supply chains, in each of which a platform strategy successfully led to the healthy development of a business ecosystem. Based on the experiences in the three cases, the research results also provide managerial implications for practitioners in the sustainable management of platform service supply chains.

This study demonstrates that the strategic vision of the platform owner is a key factor when making decisions about sustaining and expanding the business ecosystem. The strategic vision of the platform owner calls for comprehensive consideration of the proposed value of the holistic supply chain, its integrative platform services, and its systematic efficiency. This includes not only the supply chain activities in service provision, but also the dimensions of the business ecosystem, such as the geographical scope of the networks, the openness of the system, and the environmental and social engagement of the platform.

The results of this research indicate that the platform owner plays the leading role in promoting value co-creation and balancing co-opetition within the platform service supply chain. Hence, it is recommended that platform owners align actors and interactions in order to sustain and expand network connections and effects within the business ecosystem. Along with the development cycle of the platform, the alignment of actors and interactions is a process of dynamic configuration.

The research results also show that, at the operational level, a systematic structure of membership management is important for the platform owner. Therefore, this research suggests that platform owners should provide compatible incentives to existing actors while also attracting new members to join the business ecosystem.

5.3 Research Limitations and Future Research Directions

This research has focused on the logistics service industry, so the research results should be further tested in other industry contexts/sectors to ensure their validity, to compare different industry sectors in order to obtain generic results, and to enhance the comprehensiveness of the understanding of the sustainable management of platform service supply chains.

A qualitative case study focuses on depth of analysis rather than on obtaining a large sample. This research selected three case studies. More cases of successful platform service supply chains could serve as meaningful examples to yield insights into the transformation from firm-based competition to ecosystem-based co-opetition, and to enhance understanding of how platform service supply chains develop. Moreover, based on the complicated relationships we noticed within a platform service supply chain, it is worth exploring the weak or strong links among different actors by using structure hole and network theory. Furthermore, local authorities play important roles in the three cases, such as by supporting the expansion to other regions. Therefore, it is worth further investigating how local authorities and industrial institutions facilitate the success of platform service supply chains. In addition, we noticed the importance of digitalization in supporting the three platform

service supply chains, so future research should investigate the role of digitalization in the development and success of platform service supply chains.

This research was conducted among logistics-relevant companies in China, which is an emerging economy. There could be further testing of whether the research results are valid in other emerging or developing country contexts. Furthermore, the results could be compared with the results from developed country contexts, which will ensure a comprehensive understanding of platform service supply chains.

Appendix 1 List of Interview Questions

Questions
Part 1 – Company profile information
Could you please introduce your company's background and history? (Different stages)
Could you introduce the platform/product/services your company is offering?
Could you explain the structure of your business ecosystem, including what partners are included (suppliers, customers, and other partners), and what kind of relationship you have with your partners at different stages? If possible, can you introduce your partners to us? (with contact info)
Part 2 – Strategic plan
What is the strategic plan and key actions of your company at different stages?
What is the strategy for your future (5–10 years, or more)?
Part 3 – Collaboration with partners (interview at focal firms)
How does your company nurture the business ecosystem? Or has the ecosystem recently originated by itself?
How do you design your business ecosystem? How did you design the configuration structure of the business ecosystem in the early stage? What does your business ecosystem look like?
How do you promote your vision to partners, convincing them to join and stay with your platform at different stages?
How do you encourage partners to work with you to design and develop new platforms/products/services?
How do you cope with ideas or visions that are initiated by your ecosystem partners? Do you have experience with your partners in co-designing visions?
Do you have other methods to promote your business ecosystem visions and ensure they are well accepted by partners, such as by investing in your partners?
How do you collaborate with your partners in the business ecosystem?

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