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Enhancing the Effects of Service Innovation in Supply Chains: Insights from contingency theory and boundary spanning perspectives

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Abstract
This paper considers contingency theory and boundary spanning perspectives to examine how supply chain flatness affects service innovation via demand response, inter-organizational systems, and information sharing when firms adopt IoT technology. The model is tested on data collected from 295 top manufacturing firms in Taiwan, using structural equation modeling. The results of this empirical study suggest that supply chain flatness is critical for ensuring service innovation, as it reinforces demand response and information sharing between supply chain members. The study findings provide useful insights into how parties should reinforce their supply management orientation to improve supply chain flatness, demand response, and information sharing, and in turn enhance service innovation in adopting IoT technology for the entire supply chain.
Keywords: supply chain flatness, inter-organizational systems, demand response, service innovation, contingency theory, boundary spanning

1. Introduction

Service innovation has become an important issue for Internet of Things (IoT) technology use in supply chains. Service innovation is the use of new solutions to meet new or existing customer and market requirements. Its importance in supply chains is well recognized (Grubbstrom & Hinterhuber, 2006; Katrina, 2019; Wang, Yeung, & Zhang, 2011). Service innovation has the potential to improve operational processes, reduce costs, and achieve competitive advantages due to the IoT's transparency, traceability, adaptability, scalability, and flexibility. The IoT provides new ways of connecting objects and systems through Internet protocols (IPs). In the IoT, things such as vehicles or refrigerators can be smart objects. Many innovative practices have been developed through connections in supply chains (Sambamurthy, Bharadwaj, & Grover, 2003; Dong, Xu, & Zhu, 2009; Rai & Tang, 2010). One striking example is that Google has used the IoT to deliver service innovation since it acquired Nest. In order to deliver service innovation, the world of IoT demonstrates a need to consider recasting the concept of product to reflect the frequent inextricable mixture of hardware, software, data and service (Noto,2016). Beyond dealing with the technical challenges of service system development, this study investigates the issues related to structural contingency and boundary spanning that can arise when firms adopt the IoT in their supply chains.

To achieve the advantages of service innovation, it is important for manufacturing firms to understand the factors that affect service innovation in supply chains. Research has focused on the effects of co-production, absorptive capacity, service relational characteristics, dialogic co-creation, and knowledge-based issues on service innovation (Zhang, Xue, & Dhaliwal, 2016). We studies have examined how supply chain flatness affects service innovation through other factors such as inter-organizational systems (IOS), information sharing, and demand response. Given increasing global competition and shorter product lifecycles, there is a growing need for new developments and quick responses. There have been few studies on the antecedents to inter-organizational service innovation, such as supply chain flatness, Inter-organizational Systems, information sharing, and demand response—the former one in relation to the contingency theory and the latter three of which to the boundary spanning perspective.

Supply management orientation is a major perspective that promotes bonding and

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reciprocation between supply chain partners to achieve synergy. It focuses primarily on creating an operating environment where the supply chain members interact in a coordinated fashion. Supply management orientation is determined by such factors as reduced number of suppliers, buyer–seller links, supplier involvement, and quality focus (Shin, Collier, & Wilson, 2000). These factors have been shown to help with addressing service issues early and enhancing performance (Chen, Paulraj, & Lado, 2004; Wagner et al., 2005).

Several prevailing theories have suggested that supply management orientation enhances service innovation. In this study, we used supply management orientation to apply the contingency theory and boundary spanning perspectives, as a result of the contingent perspective on the structural changes (L.Donaldson,2001), and bridge the gap between supply chain partners can be measured based on the boundary spanning behaviors for generating value to service customer needs (Koh, 2011, Fang, Palmatier, & Grewal, 2011; Zhang & Huo, 2013).Supply chain partners need to quickly respond to changes in demand through flat structure and boundary spanning, and must be able to adjust their service design for changing markets, to create incentives for better performance. As such, this study considers contingency theory and boundary spanning perspectives to enhance service innovation in supply chains.

To address the important issue of service innovation improvement in the context of supply chains, a research model is developed in this study to investigate the factors influencing service innovation. First, this study examines how supply chain flatness affects IOS and information sharing through demand response. Next, this study investigates how information sharing and demand response affect service innovation. It is an empirical study of manufacturing firms and their partners in Taiwan's supply chains.

The rest of this paper is organized as follows. Section 2 discusses supply chain flatness, IOS, and demand response information sharing. Section 3 provides the research model and hypotheses. Section 4 and Section 5 present the research method and results, respectively. Section 6 provides the discussion, and Section 7 concludes the paper.

2. The Effect of Supply Management Orientation on Service Innovation

To improve supply chain competition, service innovation is a significant factor for maintaining a firm's competitive advantage in an increasingly service-centered economy. Service innovation is concerned with service offerings and interdependent processes between new process and customer needs. The IoT is the fundamental technological element for smart and connected products, that using global Internet-based infrastructure to support their intelligent identification, location tracking, monitoring, and management (Karakostas, 2013; Fleisch, Weinberger, & Wortmann, 2014). IoT demands additional or enhanced capabilities from product delivery service providers and how industries operate and "service innovation". (Yu, Subramanian, Ning, & Edwards, 2015; Hervé,L, et al,2020). This new technology allows manufacturing firms to be flexible and offer smart services for their market success (Yu et al., 2015). Flexibility refers to product delivery service providers' hard and soft infrastructure enhancements offered to e-retailers to meet customer requirements (Yu et al., 2015). Service innovation also involves improving efficiency and effectiveness and responding to customers' changing needs quickly (Li & Lin, 2006; Marco ,2020)

With a supply management orientation, a manufacturing firm can reduce its number of suppliers and manage deeper exchange relationships to counteract its deficiencies in supply chain innovation (Chen et al., 2004). In other words, parties can make adaptive decisions to enhance service innovation. To achieve highly adaptive service innovation, manufacturing firms often demand that their partners maximize their total contributions with a limited number of suppliers and improve their understanding of what buyers need. In supply chains, a supply management orientation has become common and is one of the most important orientations in product development or service innovation (Shin et al., 2000; Swafford et al. 2008, Mostaghel,2019). As such, the value of a manufacturing firm's service innovation often depends on the supply management orientation that is developed and implemented with its partners (Jer,2017).

In this study, we used supply management orientation to apply the contingency theory and boundary spanning perspectives are key determinants of service innovation in adopting IoT technology. Changing organizational structure is a key determinant of competitive advantage, which concerns reducing layers with supply chain partners to improve organization flexibility (Vickery, 1999 & Lydia, 2018). A flat structure could reduce the costs and distortions associated with information dissemination (Galbraith, 1977). Without long approval processes, members could easily participate in information sharing and interact with each other, which would improve the effectiveness and efficiency of decision-making (Zhang & Huo, 2013). Inter-organizational structure flatness describes a manufacturer's relative number of partners in the supply chain (Shin et al., 2000). This has been given different labels in the literature. For instance, some have named this construct the "number of suppliers," while Damanpour (1991) calls it "vertical differentiation." Vickery et al. (1999) capture organizational structure flatness using "layers" and "spans of control."

Applying contingency theory improves the understanding of how and when organizations can create service innovation. Contingency theory argues that diversified firms should differentiate their structures and processes proportionally (Lawrence & Lorsch, 1967). With the creation of separate subunits and differentiated structures, however, comes the need to integrate organization-wide activities that can be standardized for greater efficiency and consistency (Michel & Hambrick, 1992; Markides & Williamson, 1996), thus increasing the importance of leadership in the formulation of a corporate operations strategy (Hayes & Wheelwright, 1984). Flatness within or between organizations is consistent with contingency theory (Urs ,1988; Huang, Kristal, & Schroeder, 2008). In a flat supply chain, authority is decentralized and employees are encouraged to build lateral channels through which they interact and coordinate business decisions (Flynn & Flynn, 1999; Galbraith, 1977). Flatness influences how authority and responsibilities are allocated and how employees interact with others across organizations (Newman, 1988). Supply chain flatness is important for a sustained competitive advantage.

Manufacturing firms have increasingly used boundary spanning information technologies to support transactions with their trading partners, such as suppliers and subcontractors (Stank, Crum, & Arango, 1999). Such boundary spanning behaviors bridge the gap between supply chain partners to service customer needs. These mechanisms are valuable for managing innovations arising from environmental changes (Callahan & Salipante, 1979). IOS-enabled business processes and models provide firms with various benefits, including operational improvement, enhanced competitive advantage, information sharing, and improved business relationships with supply chain partners (Mukhopadhyay & Kekre, 2002; DeLone & McLean, 2003; Melville, Kraemer, & Gurbaxani, 2004; Subramani, 2004). The more willing a firm is to improve its operations and business processes by leveraging inter-firm electronic links, the more likely it is to succeed in adapting to and competing in the fast-changing information environment (Zhang & Huo, 2013). Manufacturing firms with in-depth IOS usage often collaborate with their partners strongly, whereas firms with broad IOS usage often cultivate more inter-firm relationships (Zhang & Huo, 2013).

According to Michael (2003) demand response is one of the scale items for the supply chain agility construct. Supply chain agility refers to a supply chain's capability to respond in a timely manner to a changing marketplace environment (Michael, 2003). In many industries today, the prerequisites for successful manufacturing are organizations, processes, and products that can sense, and change or be changed in response to, customers' varying demands (McCarthy & Tsinopoulos, 2003). As organizations continue to seek competitive advantages, the focal source of such advantages has expanded from the realm of the single organization to the various supply chains that it acts within. The concept of agility has also moved from within an organization to the field of supply chain management (Whitea, Daniel, & Mohdzain, 2005). Supply chain agility is one approach to managing supply chains in volatile markets (Naylor, Mohamed, & Berry, 1999). Supply chain agility has been characterized differently, as follows: utilizing virtual teams (Bal, Wilding, & Gundry, 1999); having fast business processes (Mason-Jones & Towill, 1999); communicating real-time market data via information systems to all parties in a supply chain (Christopher, 2001; Towill, 2002b); making use of contract manufacturers (Mason, Cole, Ulrey, & Yan, 2002); being responsive to changes in throughput, destinations, and volumes (Huang, Uppal, & Shi, 2002; Prater, Biehl, & Smith, 2001); and using de-coupling and postponement points (Mason-Jones & Towill, 1999; Van Hoek, 2000).

Information sharing channels between suppliers and manufacturers allow information to be shared across a whole supply chain, based on which partners attempt to estimate market demands. Collaboration between partners enables better information sharing, which results in greater competitive advantages for all partners. The primary objectives of information sharing are to speed up information flow (Chow, Choy, & Lee 2007; Xu, Dong, & Evers, 2001), improve supply chain efficiency and effectiveness, and respond to changing customer needs more quickly (Li & Lin, 2006).To address this important issue for service innovation in supply chains and to investigate the factors influencing service innovation, this research develops a novel research model to examine how factors such as supply chain flatness affect service innovation. The model constructs and hypotheses are discussed in the next section.

3. Theoretical Framework and Hypothesis Development

Figure 1 shows the entire research model and the factor relationships. Five hypotheses were tested; each hypothesis is indicated in the figure by the letter H and a number. The arrows indicate the hypothesized relationships.

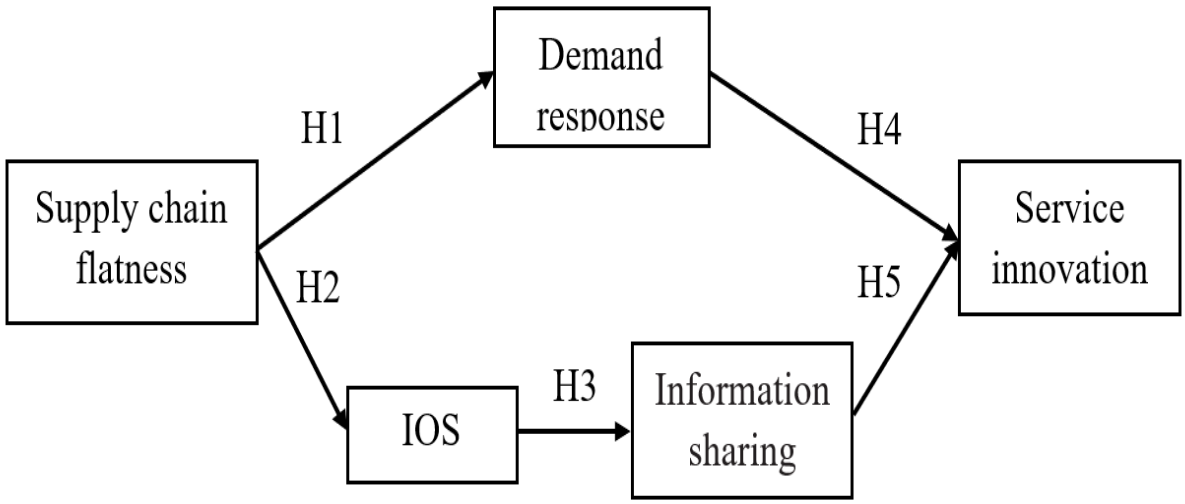


Figure 1. **The research model**

3.1 Supply Chain Flatness

Supply chain flatness can be defined as a state in which there are few levels in the inter-organizational hierarchy or few suppliers in the supply chain (Shin et al., 2000; Huang, Kristal, & Schroeder, 2010). This provides a way to link different functions between organizations. A flat structure shortens the length between decisions and reduces the costs and barriers associated with cross-functional communication, which facilitates joint decision-making, information sharing, and IOS deployment (Galbraith, 1977). It also enables different departments to combine their opinions and suggestions, which leads to shared interpretations and activities (Nahm, Vonderembse, & Koufteros, 2003). Hence, employees with different backgrounds and experiences can develop a common understanding, which prevents potential misunderstandings and encourages joint problem solving (Zhang, Qi, & Zhao, 2011). Therefore, this research expects that supply chain flatness can speed up the demand response and enhance IOS deployment, which enables different functional departments to work well together (Flynn & Flynn, 1999). As such, we present the following hypotheses:

H1: Supply chain flatness is positively related to demand response.

H2: Supply chain flatness is positively related to IOS.

3.2 Inter-organizational Systems

IOS are firms' valuable resources and assets that can positively affect their performance. IOS are forged through relationships between information technology (IT) assets and organizational resources (Bharadwaj, 2000; Wade & Hulland, 2004). This study considers that the depth and breadth of IOS deployment can influence various aspects of a firm's operational processes, including quick response time, speed of information sharing, and better customer service. When a firm increases its depth of IOS deployment with a specific partner, it digitizes its supply chain interaction with this supplier to a greater extent (Zhang & Huo, 2013). This higher level of digitization enables the firm to improve its business operations by lowering its transaction and production costs and automating and rationalizing its business processes (Subramani, 2004). In addition, the higher level of digitization allows the firm to develop better inter-firm capabilities to exchange information, cooperate, and collaborate with its supply chain partners (Ray, Muhanna, & Barney, 2005). Such capabilities benefit the firm in working with its partners to better serve customers. When the firm increases the breadth of its IOS deployment, it extends its supply chain digitization and can benefit from its resulting interactions with more suppliers (Zhang & Huo, 2013). Therefore, IOS depth and breadth are both expected to lead to information sharing between firms. Accordingly, we present the following hypothesis:

H3: IOS is positively related to information sharing.

3.3 Demand Response

Demand response is at the core of supply chain agility. As a business concept, agility was introduced as a means for firms to meet rapidly changing marketplace needs. As Gligor and Holcomb point out in their comprehensive literature review, "enriching the customer" is one of the most common outcomes associated with supply chain agility (Gligor, Esmark, & Holcomb, 2015). For example, Van Hoek, Harrison, and Christopher (2001) describe agility as a management concept centered on responsiveness to dynamic markets and customer demand. Ismail and Sharifi refer to agility as rapid responses to changes in supply and demand, while Lee describes it as the ability to quickly react to unexpected shifts in supply and demand (Holcombc, 2015). Meeting customer expectations in the context of shortened delivery lead times is a key feature of agile entities (Gligor et al., 2015). The better a firm's demand response, the greater its ability to react effectively to changing markets and create service innovation. As such, we present the following hypothesis:

H4: Demand response is positively related to service innovation.

3.4 Information Sharing

The nature of information sharing can vary from strategic to tactical, and its content can range from information about logistics activities to general market and customer information (Mentzer, Min, & Zacharia, 2000) Information sharing has two aspects: quantity and quality. The level (quantity) of information sharing refers to the extent to which critical and proprietary information is communicated to supply chain partners (Monczka, Petersen, Handfield, & Ragatz, 1998). The quality of information sharing includes such aspects as the accuracy, timeliness, adequacy, and credibility of information exchanged (Monczka et al., 1998; Moberg, Cutler, Gross, & Speh, 2002). While information sharing is important, its impact on supply chain management depends on what information is shared, when and how it is shared, and with whom (Chizzo, 1998; Holmberg, 2000).

To improve inter-organizational coordination and product quality, manufacturing firms often require their supply chain partners to share valuable information (Mentzas, 2002; Li & Lin, 2006; Pereira, 2009). The more and better the information shared with a firm, the greater the competitive advantage it acquires. Thus, if high quality information sharing characterizes an inter-organizational relationship, the competitive advantage of the whole supply chain will be enhanced (Holland, 1995). Service innovation can be regarded as the objective of improving existing services, creating new value propositions, or creating new service systems (IfM & IBM, 2008). A firm's service innovation capability is vital to its survival because innovative services drive the transformation of new services, products, processes, and technologies into outcomes that meet market needs (Zhang et al., 2016). Based on Penrose's (1959) seminal work, distinctive service activities may constitute a specific capability that can be developed in different ways to accelerate a firm's adaptation to environmental changes. The level and quality of information sharing influence the accuracy, timeliness, and distribution of critical proprietary information to supply chain partners. Hence, information sharing can lead service innovation during environmental changes. We thus present the following hypothesis:

H5: Information sharing is positively related to service innovation

4.Research Method

To develop the survey instrument, a pool of items was identified from the literature to measure the constructs of the research model. Data from a survey sample were used to assess the instrument's validity and reliability, and to test the hypothesized relationships of the research model.

4.1 Content Validity

All of the measures of the survey instrument were developed from the literature. Where appropriate, the manner in which the items were expressed was adjusted for the supply chain context, as shown in Table 1. The English version was developed first, then translated into Chinese and back-translated into English. When the back-translated English version was checked against the original English version, some questions were reworded to improve the accuracy of the translation. The expressions of the items were adjusted where appropriate to the supply chain context. The items were measured on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Table 1. **Constructs and Measures of the Research Items**

	Construct	Source
	Supply Chain Flatness	
SCF1	Our supply chain structure is relatively flat.	Shin et al. (2000); Zhang, Zhao, & Qi (2014)
SCF2	There are few levels in our supply chain hierarchy.	
SCF3	Our supply chain is in favor of a drastic reduction in sources of supply.	
	Inter-organizational Systems	
IOSD1	Extent to which such applications (e.g., web-based business-to-business [B2B] operations) are used in supplier selection (getting quotes, bids, etc.).	Zhang et al. (2016)
IOSD2	Extent to which such applications (e.g., web-based B2B operations) are used in invoicing and payment processing	
IOSD3	Extent to which such applications (e.g., web-based B2B operations) are used in demand management (procurement analysis)	
IOSB1	Proportion of total suppliers that interact with the firm through B2B supply chain applications	
IOSB2	Proportion of total supplier transactions done using B2B supply chain applications	
IOSB3	Proportion of overall interactions with suppliers carried out using B2B supply chain applications	
	Demand Response	
DR1	Our supply chain is able to respond to changes in demand without overstocking or lost sales.	Braunscheidel et al. (2009)
DR2	Our supply chain is able to leverage the competencies of our partners to respond to market demands.	
DR3	Our supply chain is capable of forecasting market demand.	
	Information Sharing	
IS1	We inform trading partners in advance of IoT adoption needs.	Li & Lin (2006)
IS2	Our trading partners keep us informed about issues with IoT adoption that affect our business.	
IS3	Our trading partners and us exchange IoT adoption information that helps business planning.	
IS4	Information exchange about IoT adoption between our trading partners and us is complete.	
IS5	Information exchange about IoT adoption between our trading partners and us is adequate.	
IS6	Information exchange about IoT adoption between our trading partners and us is reliable.	
	Service Innovation	
SI1	The technology (e.g., tracking system, radio-frequency identification [RFID], website) of our product delivery service provider gives prompt service.	Yu et al. (2015); Chen, Wang, Huang, & Shen (2016)
SI2	The technology (e.g., tracking system, RFID, website) of our product delivery service provider has convenient operating hours.	
SI3	Our company has introduced new services (e.g., tracking system, RFID, website) that our market competitors do not offer.	

4.2 Pre-test and Pilot Test

To improve the content and appearance of the 21-item questionnaire, a pre-test was performed on a sample comprising four academic researchers and four Ph.D. students. Several managers in the supply chain industry were then contacted to help with pre-testing the instrument. The respondents were requested to complete the questionnaire and provide comments on the wording, understandability, and clarity of the items, as well as the overall appearance and content of the instrument. The responses suggested that all of the statements should be retained and only minor cosmetic changes were needed. After further review by two other academic researchers, the instrument was deemed ready to be sent to a large sample to gather data for testing the research model.

4.3 Data Collection and Respondent Profiles

This empirical study aimed to collect data from manufacturing enterprises selected from the Chinese Credit Information Service's (Taiwan's leading credit company) top 2500 firms using IoT technology in 2014 in Taiwan. This study sought respondents who were expected to have experience with the operation and management of inter-organizational relationships between their manufacturing firm and its suppliers or subcontractors. Based on the literature and recommendations from practitioners, we selected function managers in senior management, who were involved in maintaining and developing inter-organizational relationships with suppliers or subcontractors, as respondents. In an effort to maximize the response rate, a modified version of Dillman's (2000) total design method was followed. A survey package, including (1) a cover letter explaining the research objectives, (2) the questionnaire, and (3) a stamped self-addressed envelope, was distributed to managers at each manufacturing firm in the supply chain industry. To make responding as convenient as possible, participants were offered two options for returning the questionnaire (via mail or fax).

Table 2. **Demographic and Characteristic Profiles of Participating Firms**

Demographic Profile	Number of firms	Percentage
Industry Type	**N = 295**	
Food/beverage	16	5.4
Textiles/fiber	23	7.8
Printing and related support activities	14	4.7
Chemical/plastics	50	16.9
Non-metallic mineral products	3	1.0
Basic metal industries	22	7.5
Electrical machinery/machinery and equipment	31	10.5
Electronics/communication	68	23.1
Transport equipment	20	6.8
Electronic parts and components	31	10.5
Leatherwear/fur products	4	1.4
Other	13	4.4
Total Sales Revenue (New Taiwan $)	**N = 295**	
Less than $1 billion	112	38.0
$1.1 billion to $2 billion	61	20.7
$2.1 billion to $3 billion	33	11.2
$3.1 billion to $4 billion	8	2.7
$4.1 billion to $5 billion	11	3.7
$5.1 billion to $10 billion	17	5.8
$10.1 billion to $20 billion	21	7.1
$20.1 billion to $50 billion	20	6.8
$50.1 billion and above	12	4.1
Years Established	**N = 295**	
6–10	24	8.1
11–15	22	7.5
16–20	36	12.2
21–25	20	6.8
26–30	30	10.2
More than 31	163	55.3
Position of Respondent	**N = 295**	
Top manager	150	50.9
Function manager	145	49.1

In the first two weeks, we invited corporations to enroll in the study. We recruited participants by making telephone calls. Corporate executives could choose whether to complete the questionnaire via e-mail or on paper. Next, 1413 paper forms were sent to the respondents. Two weeks after the initial mailing, personalized reminder letters, e-mails, or faxes were sent to all of the potential participants.

A total of 295 usable responses came from function managers or other senior managers, such as general managers, vice presidents, or CEOs. This resulted in a sample size of 295 with a response rate of 20.8%. A chi-square analysis of the respondents' industry distribution showed no difference from the industry distribution of all firms that participated in the survey.

5. Data Analysis and Results

Structural equation modeling (SEM) using AMOS 22 software was used to analyze the hypothesized relationships of the research model. SEM involves analyzing two models: a measurement (or factor analysis) model and a structural model.

5.1 Assessment of the Measurement Model

The 21 items in the survey instrument were first analyzed to assess their dimensionality and measurement properties. All of the items loaded significantly and substantially on their underlying constructs, providing evidence of convergent validity. The chi-square value of the measurement model was significant ($\chi2 = 283.201$, $df = 157$, $p < 0.001$); $\chi2/df$ was less than 2, indicating an ideal fit (Bentler, 1990). To assess the overall model fit without sample size bias, alternative stand-alone fit indices less sensitive to sample size were tested. For a good model fit, the goodness of fit index (GFI) should be more than 0.80, and the closer to 0.90, the better. The adjusted GFI (AGFI) should be more than 0.80, the comparative fit index (CFI) more than 0.9, and the root mean square error of approximation (RMSEA) close to 0.06 (Jöreskog & Sorbom, 1993; Hair, Anderson, Tatham, & Black, 1998). All of the assessments of the measurement model indicated acceptable model fit (GFI = 0.920; AGFI = 0.882; CFI = 0.978; NFI = 0.953; RMSEA = 0.052).

The composite reliability (CR), each variable's squared multiple correlation (SMC), and the average variance extracted (AVE) were used to assess the construct reliability. The results shown in Table 3 confirm the reliability of the six constructs, with CR > 0.6, SMC > 0.5, and AVE > 0.5 (Fornell & Larcker, 1981; Jöreskog & Sorbom, 1993; Hair et al., 1998). In addition, an assessment of the discriminant validity between the constructs supports the model fit. Table 3 summarizes the assessment results for the measurement model.

Table 3. **Assessment Results for the Measurement Model**

Construct	Item	Standardized loading	Standardized error	t-value	SMC	CR	AVE
Supply chain flatness	SCF1	0.70	0.780	10.408***	0.482	0.838	0.797
	SCF2	0.87	0.118	10.408***	0.748		
	SCF3	0.71	0.099	10.361***	0.507		
IOS	IOSD1	0.85	0.052	18.990***	0.719	0.948	0.867
	IOSD2	0.80	0.053	17.235***	0.647		
	IOSD3	0.86	0.053	18.990***	0.733		
	IOSB1	0.94	0.026	36.551***	0.892		
	IOSB2	0.96	0.028	36.551***	0.924		
	IOSB3	0.78	0.041	18.949***	0.601		
Demand response	DR1	0.87	0.087	14.343***	0.765	0.872	0.834
	DR2	0.90	0.050	18.273***	0.813		
	DR3	0.72	0.056	14.343***	0.522		
Information sharing	IS1	0.61	0.080	10.287***	0.369	0.910	0.796
	IS2	0.75	0.111	12.609***	0.564		
	IS3	0.68	0.119	10.287***	0.459		
	IQ1	0.92	0.045	22.636***	0.851		
	IQ2	0.88	0.044	22.636***	0.780		
	IQ3	0.88	0.044	22.416***	0.777		
Service innovation	SI1	0.97	0.023	43.641***	0.934	0.944	0.921
	SI2	0.96	0.031	34.467***	0.925		
	SI3	0.91	0.027	34.467***	0.842		

*** denotes significance at $\alpha = 0.001$.

5.2 Assessment of the Structural Model

Table 4 shows the inter-correlations between the five constructs of the structural model. The overall fit of the structural model is acceptable, as all of the measures of fit reach acceptable levels ($\chi2$ = 283.037; df = 157; α = 0.01; GFI = 0.919; AGFI = 0.880; CFI = 0.978; NFI = 0.953; RMSEA = 0.05).

Table 4. **Correlation Matrix of Constructs**

Construct	(1)	(2)	(3)	(4)	(5)
(1) Supply chain flatness	0.892				
(2) IOS	0.134	0.931			
(3) Demand response	0.124	0.464	0.913		
(4) Information sharing	0.680	0.505	0.234	0.892	
(5) Service innovation	0.580	0.521	0.422	0.377	0.959

5.3 Common Method Bias

Following Podsakoff and Organ's (1986) suggestion, a Harman's single factor test was run to ensure that common method variance did not account for our findings. Un-rotated principal component analysis revealed five factors with eigenvalues greater than 1, which accounted for 79.6% of the total variance. The first factor only accounted for 37.51% of the variance. This assessment provides evidence that no single factor accounted for most of the variance.

This paper assessed the data for empirical evidence of common method bias by conducting confirmatory factor analysis (CFA), which included a construct representing an unmeasured methods factor. It is assumed that common method variance is not a serious threat if a one-factor model has poor fit with its data (Handley & Benton, 2012). To develop the one-factor model, this study loaded all of the measurement items into a single factor. The CFA results indicated that the one-factor model did not fit the data ($\chi2$ = 598.066; df = 174; GFI = 0.85; AGFI = 0.801; CFI = 0.928; NFI = 0.902; RMSEA = 0.09). Thus, we concluded that common method bias does not appear to be a problem in this study.

5.4 Comparison with Alternative Models

This paper followed the procedure suggested by Anderson and Gerbing (1988) and evaluated two models, as shown in Table 5. The first was the proposed model in which two first-order factors (i.e., IOS and information sharing) accounted for all of the common variance among the six items. The second model hypothesizes that the six items converge into four first-order factors (i.e., IOS depth, IOS breadth, level of information sharing, and quality of information sharing).

To test whether the proposed model or alternative model should be accepted, sequential chi-square difference tests (SCDTs) were conducted by calculating the difference between the chi-square statistic values for the proposed and alternative models, with degrees of freedom equal to the difference in degrees of freedom for the two models. The results are presented in Table 5. The significant result satisfied the conditions suggested by Anderson and Gerbing (1988). The results suggested that the proposed model was better than the alternative model.

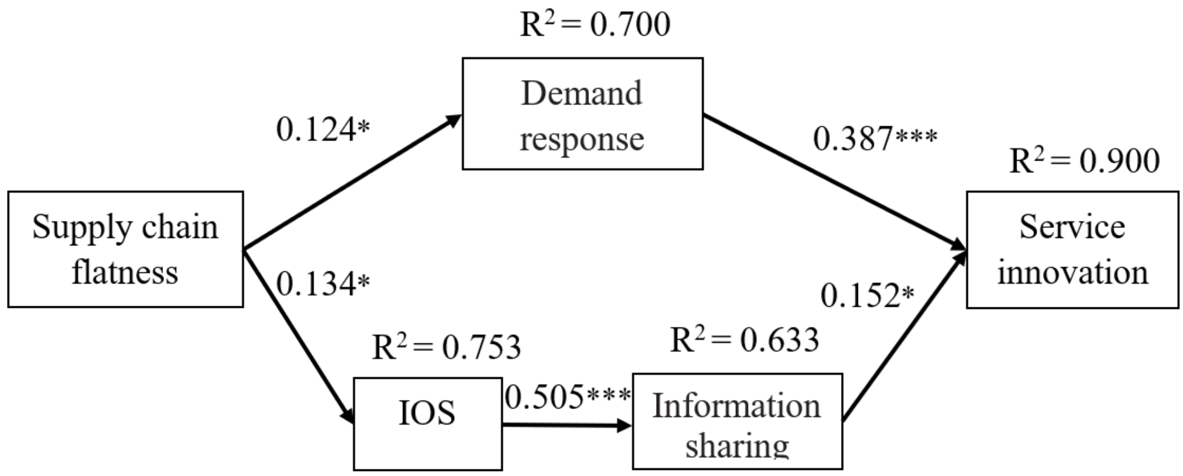
Table 5. **Comparison of Models**

Attribute	Model 1: Proposed Model	Model 2: Alternative Model
$\chi2$(df)	283.201(157)	336.599 (158)
$\chi2$ difference		53.398
df difference		1
SCDTs (α=0 .05)		Significant

5.5 Hypothesis Testing

SEM analysis and the relationships between the independent and dependent variables were assessed simultaneously via covariance analysis. Maximum likelihood (ML) estimation is used to estimate model parameters with the covariance matrix as data input. The ML estimation method has been described as being well suited to theory testing and development (Anderson & Gerbing, 1988; Jöreskog & Sorbom, 1993; Hair et al., 1998). Figure 2 shows the structural model with the coefficients for each path (hypothesized relationship), where solid and dashed lines indicate supported and unsupported relationships, respectively. Supply chain flatness has a significantly positive effect on IOS (H1: $\gamma = 0.134$, $t = 2.137$, $p < 0.05$) and a significantly positive effect on demand response (H2: $\gamma = 0.124$, $t = 2.108$, $p < 0.05$). IOS (H3: $\gamma = 0.505$, $t = 7.624$, $p < 0.001$) has a significantly positive effect on information sharing.

Demand response (H4: γ = 0.387, t = 6.460, p < 0.001) has a significantly positive effect on service innovation. Information sharing (H5: γ = 0.152, t = 2.407, p < 0.05) has a significantly positive effect on service innovation. Thus, all of the hypotheses are supported.



* and *** denote significance at α = 0.05 and α = 0.001, respectively.

Figure 2. **The structural model**

5.6 Multi-group Analysis

This study explored the formation of relationships from the perspectives of manufacturers and subcontractors using a survey questionnaire. A company's average total sales revenue and years since its establishment also have some impact, whether positive or negative. The 295 usable returned questionnaires were divided into two groups for the two models shown in Tables 6To examine the differences between the parameters of the two groups, statistical comparisons were made following the multi-group procedure suggested by Jöreskog and Sorbom (1993). The individual path procedure was separately examined for each group, and the estimated coefficients for each group were tested using a chi-square difference test. The path coefficients of the groups were analyzed separately using multiple group analysis, assuring that the model's goodness of fit was similar for both groups.

According to the returned questionnaires, most of the surveyed manufacturers and subcontractors averaged total sales revenue under NT$2 billion (58.7% of collaboration items), which indicates that more than half of the surveyed firms were small or medium. Thus, the Group 1 firms' average total sales revenue is less than NT$2 billion; however, the Group 2 firms' average total sales revenue is more than NT$2 billion. The fit indices were acceptable for Group 1 (χ2/df = 1.775; GFI = 0.885; AGFI = 0.821; CFI = 0.967; NFI = 0.930; RMSEA = 0.067) and Group 2 (χ2/df = 1.311; GFI = 0.876; AGFI = 0.811; CFI = 0.979; NFI = 0.917; RMSEA = 0.051). The estimation results show that the differences between the parameters of the two groups are significant. The findings reveal that supply chain flatness was more significantly associated with IOS in Group 2 (γ = 0.312, t = 2.552, p < 0.05) than in Group 1 (γ = 0.224, t = 2.240, p < 0.05). Supply chain flatness was more significantly associated with demand response in Group 1 (γ = 0.3.14, t = 2.465, p < 0.05) than in Group 2 (γ = 0.275, t = 1.975, p < 0.05). IOS had a more significant positive impact on information sharing in Group 1 (γ = 0.547, t = 6.362, p < 0.001) than in Group 2 (γ = 0.404, t = 3.863, p < 0.001). Demand response had a more significant positive impact on service innovation in Group 2 (γ = 0.507, t = 2.899, p < 0.01) than in Group 1 (γ = 0.291, t = 2.054, p < 0.05). Information sharing was more significantly associated with service innovation in Group 1 (γ = 0.446, t = 5.147, p < 0.001) than in Group 2 (γ = 0.197, t = 1.974, p < 0.05).

6. Discussion

In line with our hypotheses, supply chain flatness is positively associated with both IOS and demand response. In Taiwan, a flat supply chain can reduce the costs and distortions associated with information dissemination. Reducing layers can improve supply chain flexibility and IOS depth and breadth. Two dimensions of IOS deployment reflect the importance of technology deployment in enhancing firms' supply chain capability. Supply chain flatness can enhance IOS deployment because firms coordinate closely with their supply chain partners to manage their value-generation activities. Without long approval processes, different parties can easily participate in information sharing and interact with each other, which improves the effectiveness and efficiency of demand response (Zhang & Huo, 2013).

IOS is positively associated with information sharing. In Taiwan's supply chains, the depth and breadth of IOS deployment reflect the extent and scope of information and resource sharing between firms and their supply chain partners. These two dimensions of IOS deployment allow firms to form broad strategic networks of partnerships through effective information exchange and close coordination. Such networks provide firms with the ability to more efficiently integrate and streamline their supply chain processes, which serve as the basis for improving operational performance.

As hypothesized, demand response and information sharing have a positive impact on service innovation. This study provides practical insights into how supply chain members should reinforce the collaborative behaviors and activities that would improve their demand response and information sharing, to achieve a competitive advantage for the whole supply chain. In the IoT era, supply chain partners should adopt technologies that enable them to achieve higher flexibility in delivering service innovation. Deployment of IoT technology can speed up demand response and information sharing in service innovation. Thus, Taiwan's supply chain members need to focus on demand response and information sharing through IoT technology to deliver service innovation.

6.1 Theoretical Implications

With the development of the novel research model, the theoretical contributions of this paper to the literature are as follows. First, the results from our study contribute to the service innovation literature. Specifically, although contingency theory and boundary spanning are central notions in the literature, gaps remain in understanding their impact on service innovation (Monczka, Trent, & Callahan, 1983; Donaldson, 2001; Fang et al., 2011; Zhang & Huo, 2013; Mostaghel,2019). This study attempted to fill these gaps by identifying IOS and investigating their influences on service innovation when adopting IoT technology in a supply chain. This study contributes to linking supply chain flatness with IOS, information sharing, demand response, and service innovation for exploring the organizational structure between supply chain partners. The model's theoretical framework can be applied to other forms of IOS involving service innovation.

Second, the multi-group analyses of supply chain flatness, demand response, and service innovation are a direct extension of the literature. As shown in Table 6, the total effect of supply chain flatness on service innovation through demand response is more intense in the larger firms than in the smaller firms. In contrast, the total effect of supply chain flatness on service innovation through IOS and information sharing is more intense in the smaller firms. The results indicate that smaller firms tend to better maintain their IOS, and larger firms are more affected by their buyers. These findings are noteworthy.

Table 6. **Direct and indirect effects of supply chain flatness**

	Effect on service innovation					
	Group 1 (under NT$ 2 billion)			Group 2 (over NT$ 2 billion)		
	Direct Effect	Indirect Effect	Total Effect	Direct Effect	Indirect Effect	Total Effect
Effect of supply chain flatness						
through demand response		0.091	0.091		0.139	0.139
through IOS and information sharing		0.055	0.055		0.025	0.025

One possible explanation for the findings is that partners aim to reduce the time-to-market when introducing new services. Fast responses to customers in a dynamic environment create superior value, especially in larger firms. Larger firms own more resources in a supply chain, which may lead to them creating a smaller supplier base from their current network structure. Supply chain flatness helps enhance communication with suppliers or subcontractors, which is necessary for solving problems in buyers' service development processes. This implies that supply chain flatness may more easily help parties that have more interactions with others, and increase the speed of demand response activities that are positively related to the buyer–supplier service design. Moreover, supply chain flatness significantly affected service innovation in both groups in this study. It can eliminate mistrust between supply chain partners and help parties quickly respond to customer needs and, as a result, improve service innovation. Thus, partners should ensure that they maximize their total contributions in a reduced supplier base, to improve boundary spanning activities and enhance service innovation.

Another possible explanation for our findings is that IOS is one way to acquire important resources from other supply chain partners. This may reflect a practical phenomenon in supply chains, where smaller firms conventionally have reactive attitudes toward obtaining and applying up-to-date information (e.g., via IoT technology adoption) from supply chain partners. In smaller firms, parties perceive that, through supply chain flatness, IOS enhancement can be the net gain to be achieved in the future. When the number of suppliers decreases within a supply chain, its members are encouraged to integrate IOS and share resources, and the degree of service innovation will thus be elevated, especially in smaller firms.

6.2 Managerial and Practical Implications

This study provides multiple insights for manufacturing firms seeking to improve service innovation when adopting IoT technology. Improving service innovation is an increasingly popular activity, as a reduced supplier base and boundary spanning activities help achieve corporate goals and sustain competitive advantages (Koh et al., 2011; Fang et al., 2011; Zhang & Huo, 2013). The findings of this study are not only consistent with those of prior studies, but also suggest that supply chain flatness is critical for ensuring service innovation, as it reinforces demand response and information sharing between supply chain members. To enhance the benefits of service innovation, manufacturing firms that adopt IoT technology should focus on supply chain flatness that enhances boundary spanning activities (such as demand response, IOS, and information sharing). That is, if the reduction of the supplier base is reinforced with a view to improving demand response, IOS, and information sharing, service innovation can be enhanced. As such, greater supply chain flatness resulting in boundary spanning activities would help improve service innovation.

In particular, the multi-group analyses provide new insights into how supply chain flatness should be managed to enhance demand response, IOS, and information sharing to improve service innovation. Larger firms should consider reducing their number of suppliers; this is important for demand response, as it reduces development time for new service innovation processes. As indicated by the survey results, it is desirable to emphasize supply chain flatness, to enhance IOS and information sharing for improving service innovation in smaller firms. In other words, smaller firms rely more heavily on support from their supply chain partners to obtain up-to-date information (e.g., via IoT technology adoption). Whether IoT technology can fit into their existing operations to create new services is a significant concern.

7. Conclusions and Future Research

Service innovation enhances the competitive advantage of the IoT as a whole. This study has developed a new research model to understand the factors influencing service innovation developed and implemented by a firm and its partners when adopting IoT technology. A significant finding is that supply chain flatness is positively associated with service innovation, due to the influences of IOS, information sharing, and demand response. This study’s contributions to the literature are summarized as follows. First, the new research model explores the relationships between the important factors in relation to supply management orientation and service innovation when adopting IoT technology. Second, this study contributes to supply chain research by considering contingency theory and boundary spanning perspectives in the study of supply management orientation for enhancing service innovation, which has not been dealt with in previous studies. Third, when adopting IoT technology, relevant parties should reinforce supply chain flatness, demand response, and information sharing to facilitate the service innovation and its benefits. The findings provide useful insights into how IOS, information sharing, and demand response can be enhanced by supply chain flatness with a view to enhancing service innovation.

This study suffers from methodological limitations typical of most empirical surveys. The data for the study consisted of responses from single respondents, which may have caused response bias. The results must be interpreted taking this limitation into account. The use of single respondents may generate some measurement inaccuracy. In addition, the findings reflect the setting of Taiwan’s supply chains only, and the data were collected from firms that used IoT technology. To address these inherent limitations, future cross-industrial research on various forms of supply chains would valuable, to examine industrial differences in the development of supply chain flatness. Further research models may be developed over time, especially for rapidly developing economies, and it would be fruitful for future research to examine them longitudinally.

Moreover, this research only examined the effects of supply chain flatness. Studies of supply chain design should also address other related issues such as the centralization of power, the nature of formalization, and the locus of decision-making (Shin et al., 2000; Huang et al., 2010). In particular, future theoretical and empirical research could explore whether similar factors (such as supply chain flatness) are affected through IOS and information sharing or demand response and service innovation.

Finally, our research focuses on the impact of supply chain flatness on service innovation in supply chains. Further research may consider exploring the impacts of supply chain flatness and service innovation on some outcome variables, such as the degree of satisfaction or performance of supply chain partners.

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