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Performance Implications of Logistics Information Technology Adoption for 3PL Firms

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Abstract

Purpose—The third-party logistics (3PL) firms increasingly rely on information technology (IT) to improve the supply chain process and firm performance in the context of the globalized and fiercely competitive market. The purpose of this study is to investigate how logistics IT adoption as a standardized resource affects firm performance. Moreover, we explore the mediating role of customer collaboration and the moderating role of government policy support between logistics IT adoption and firm performance from the resource-based view and socio-technical perspective.

Design/ methodology/ approach— Survey data acquired from a sample of 235 3PL firms in China were analyzed using partial least squares structural equation modeling (PLS-SEM).

Findings—The empirical results show that logistics IT adoption has a positive effect on both financial and operational performance by strengthening customer collaboration. Additionally, government policy support amplifies the positive effect of customer collaboration on operational performance, rather than on financial performance.

Originality/value—This study offers rich empirical insights to the growing body of SCM and 3PL literature. And the findings contribute to our understanding of the technological and developmental issues of 3PL firms both theoretically and

practically.

Keywords: information technology adoption, financial performance, operational performance, customer collaboration, government policy support

Introduction

With the fierce market competition and increasingly complex logistics service needs, a growing number of firms are relying on third-party logistics (3PL) to centralize main business, reduce inventory, and improve operational efficiency (Sum *et al.,*2001; Selnes and Sallis,2003; Hsiao *et al.*, 2010; Stank *et al.*, 2017). 3PL has been rapidly expanding and becomes the fundamental industry that supports economic and social development, with the development of China's manufacturing industries. According to China Federation of Logistics & Purchasing (2020), the total logistics revenue was 10.3 trillion RMB in 2019, with the growth rate of 9%, and the total logistics expenditures were 14.6 trillion RMB, accounting for 14.7% of GDP. In recent decades, with the development of Internet and mobile Internet, information technology (IT) has injected new vitality into service industries and becomes a new driving force to propel the development of the logistics firms (Choy *et al.*, 2014).

Drawing on previous literature, the use of IT has a significant influence on business performance (Karia, 2018; Evangelista *et al*., 2012, Li *et al*., 2009; Bharadwaj, 2000). Logistics information technologies, e.g. data acquisition technologies (e.g. RFID), information technologies (e.g. EDI), warehousing technologies and transportation technologies (e.g. GPS, GIS) help firms integrate information across the supply chain and thus speed the delivery time (Hazen and Byrd, 2012; Lin, 2007; Yang *et al*., 2009). There is a trend that logistics firms focusing on IT tend to better meet customer requirements (Tripathy *et al*., 2016) and lead to competitive advantage (Lai *et al*., 2006). However, there are many logistics firms failing to achieve better financial performance by investing in logistics IT (Lai *et al*., 2007). Due to the high cost of advanced technology, the difficulty of establishing complex information systems, and the lack of IT experts' guidance, it is easy for logistics firms to lose cost advantages when adopting IT (Jeffery and Leliveld, 2004). Besides, as a kind of standardized resource, specific technologies are easily duplicated by other competitors, which makes it difficult for firms adopting IT to maintain a sustained competitive advantage. As such, given the rapid development of 3PL industries based on logistics IT, an in-depth investigation of the underlying mechanism via which logistics IT adoption affects the financial and operational performance of 3PL firms, especially within the current dynamic social-economic environment, is called for.

To address this research gap, we develop a theoretical model of logistics IT adoption and empirically test it using data from a sample of 235 3PL firms in China. Although IT may fail to create competitive advantage when acting alone, its value can be realized when it is associated with organizational capability along the supply chain (Wong *et al*., 2015; Xu, *et al.*, 2014; Powell and Dent-Micallef, 1997). From the relational view of strategic management and prior studies, collaboration with customers along supply chains is a strategic resource or capability (Dyer and Singh, 1998; Stank *et al.*, 2001; Leuschner *et al*., 2013; Xu *et al*., 2014; Flynn *et al*., 2010;

Zhao *et al*., 2011; Sehgal and Gupta, 2020). Thus drawing on the resource-based view (RBV) and socio-technical perspective, we propose that customer collaboration as an organizational capability, can work as a catalyst in converting IT into higher value for firms. Moreover, this relationship needs to be re-examined in the context of 3PL with the changing environment dynamics, especially when it comes to government policies and regulations in emerging economies. In this study, we examine the influential contingency effect of government policy support in moderating the relationship between customer collaboration and firm performance. Integrating the socio-technical perspective and RBV as the theoretical underpinnings provide a strong foundation to understand how 3PL firms pursue better financial and operational performance when faced with changing technological and social dynamics. Practically, our findings shed light on how IT adoption helps 3PL providers, highlight the important role of customer collaboration when transforming logistics IT investments into firm performance, and encourage the government to provide supportive policies to strengthen the performance improvements from IT-enabled customer collaborations.

The remainder of this paper is structured as follows. In the next part, we review the literature about theoretical background and propose research hypotheses. And then research methodology is presented, followed by the analysis and result section. Finally, we close with conclusions and limitations.

Theoretical background and research hypotheses

RBV and socio-technical perspective

The resource-based view highlights the importance of unique resources and capacities and regards them as the most important source to achieve better corporate performance (Barney, 1991). The core of RBV suggests that only if the resources and capabilities are valuable, rare, inimitable and non-substitutable, they can constitute a source of sustainable competitive advantage (Wernerfelt, 2016). Thus, a firm should possess certain intangible resources that competitors cannot copy or buy easily to gain a competitive advantage in the market. Resources and capabilities are two important tools used by firms to develop and implement their strategies, and how to create and sustain competitive advantage by leveraging them has become the focus of researchers (Srivastava *et al.*, 1998; Hunt and Morgan, 1995; Srivastava *et al.*, 2001).

While in the field of information systems, physical IT as a standardized resource may not create sustainable competitive advantage when acting alone from the perspective of RBV (Mata *et al.*, 1995) because competitors can acquire the similar IT easily. Therefore, how IT can enhance firms' performance has become a hot topic in recent research. Bharadwaj (2000), Hazen and Byrd (2012), and Karia (2018) suggested synchronizing and associating sophisticated technologies with an integrated organizational capability through resource complementarity and co-specialization to achieve information advantage and synergistic benefits. According to strategic management perspective, the ability to manage inter-organizational relations should be regarded as a strategic resource, while partners in the supply chain should be regarded as capabilities (Dyer and Singh, 1998; Paulraj *et al.*, 2008; Rungtusanatham *et al.*, 2003). Huo (2012) and Xu *et al.* (2014) considered collaboration with customers as relational capability and competency. Sehgal and Gupta (2020) posited that firms who integrate customers into production activities have greater potential to stay innovative and inimitable. As such, in this paper, we aim to examine the adoption of logistics IT in 3PL firms and propose that logistics IT can benefit 3PL firms' financial performance and operational performance by being associated with customer collaboration in order to acquire complementary capabilities and expertise that are unique and inimitable.

The concept of socio-technical perspective originated in the British coal mining industry (Trist, 1981), and it argued that advanced technologies, whether accompanied or predicted by regulatory action, have become the driving force in addressing complex inter- and intra-organizational problems. However, it cannot function effectively to improve corporate performance and practices when acting alone (Fischer and Herrmann, 2011). In this regard, the main insight of socio-technical perspective is that the technical factors and social factors are interdependent within the whole social-economic environment (Trist and Murray, 1993), which indicates that technology could not be effectively exploited without fully understanding the social environment (Trist and Bamforth, 1951; Emery, 1959; Jaffe *et al.*, 2003). In general, technical factors include technology, machines, or equipment, and they are produced and continuously modified to provide a reliable experience for individual users and serve the needs of the organization. Social factors include social relationship that needs to coordinate, control, and continuously evolve to manage emerging risks in the organization (Carayon *et al.*, 2015; Mumford, 2006). Social-economic environment refers to the policy implemented by the government. It has been posited that social factors behave differently from technical factors due to the nature of people in social networks which are more unobservable and subtle (Walker *et al.*, 2008). The two factors are both affected by the changes in the whole social-economic environment no matter it is regulated or formal, as social-economic environment can create constraints or incentives that influence the process of technological change (Kerr and Newell, 2003).

In this paper, the socio-technical perspective is applied to the logistics industry as technical factors, social factors, and social-economic factors are all essential factors for 3PL firms' long-term success in rapidly developing supply chains (Chen and Paulraj, 2004). Logistics IT and customer collaboration are technical and social factors respectively to disentangle the mechanism that explains 3PL firms' performance. We propose that logistics IT can have a great effect on firm performance via customer collaboration, and the relationships between customer collaboration and firms' operational and financial performance are moderated by the government policies and regulations within a dynamic social-economic environment.

Conceptual model

Based on RBV and socio-technical perspective, we propose a conceptual model of the relationships among logistics IT adoption, customer collaboration, firm performance and government policy support grounded in (see *Figure 1*). In this model, logistics IT adoption affects firm performance through customer collaboration, and the relationships between customer collaboration and firm performance will be moderated by government policy support. In particular, firm performance includes financial performance and operational performance, which is consistent with supply chain management (SCM) literature (e.g., Wu *et al.*, 2006; Sanders, 2007, 2008).

--- *Insert Figure 1 about Here* ---

Research hypotheses

Logistics IT adoption and customer collaboration

IT adoption is the extent to which a firm embeds a certain set of information technologies in its operations and makes them fully functioned (Li *et al.*, 2009). In this paper, we mainly focus on three common logistics information technologies: Internet of Things technology, big data technology and logistics information management platforms, in which Internet of Things technology includes Radio Frequency Identification (RFID), Bar codes, Satellite positioning system or other tracking technology (GPS), Data logger, Machine learning, Cloud computing and so on; big data technology can manage to monitor business operation data, real –time data of business flow and logistics nodes; logistics information management platforms include Enterprise Resource Planning (ERP), Electronic Ordering System (EOS), Transportation Management System (TMS), Warehouse Management System (WMS), Freight Forwarding Management System (FMS), Order Management System (OMS) and so on. Nowadays, information technologies permeate many parts of the supply chain processes and convey information about related exchange activities. Increasing investments of logistics IT has become a trend in logistics firms to promote their competitive advantages (Lai *et al.*, 2010). On the one hand, managers use different information technologies to properly allocate and utilize existing resources to improve the efficiency and effectiveness of day-to-day logistics operations in the short term; on the other hand, the IT systems can help to analyze business information more accurately and intelligently to support decision making in the long term (Elbashir *et al.*, 2008).

Customer collaboration refers to the degree of provider-buyer collaboration through mutual sharing of resources, information, strategy, and knowledge in the synchronized process of operations (Stevens and Johnson, 2016). It includes collaboration of materials, human capital and equipment, from placing orders to follow-up orders (Sahin and Robinson, 2002). Successful customer collaboration requires accurate and timely information shared between 3PL firms and their customers (Stock *et al.*, 2000). Efficiently managing information flow is the key weapon to gain the leading edge for 3PL firms.

Logistics IT can improve 3PL providers' ability to manage the information flow and strengthen their collaborations with customers (Brandyberry *et al.*, 1999). Logistics IT adoption can coordinate and deliver information, materials, and organizational capacities more accurately and timely, which can reduce the operational redundancy and resource waste and create added value for 3PL firms. These make a 3PL provider different from its competitors and thus more reliable and attractive to customers. In return, customers would be more willing to collaborate with 3PL firms to share their planning and needs.

From the transaction cost economics (Coase, 1937; Stoeken, 2000), logistics IT adoption also helps to reduce the transaction costs in the relationship between 3PL firms and their customers. Logistics IT has great potential to improve the transparency, accuracy and reliability of the information sharing with customers, and 3PL managers can make more efficient decisions with lower costs and uncertainties. Therefore, we propose the following hypothesis:

H1: Logistics IT adoption has a positive effect on customer collaboration.

Logistics customer collaboration and firm performance

In logistics, point-of-sale data can be shared and operational consistency along the supply chain can be achieved by cooperating with customers (Turkulainen, 2017). It helps to reduce information uncertainty and lower costs (Chen *et al.*, 2000; Bayraktar *et al.*, 2009; Ryu *et al.*, 2009; Coppini *et al.*, 2010; Wangphanich *et al.*, 2010), which contributes to 3PL firms' competitive advantage. It has been pointed out that a close relationship with customers lowers costs by 12 to 23 percent (Lee *et al.*, 2000), and Lin *et al*. (2002) reported greater inventory cost savings through sharing demand information. Meanwhile, collaborating with customers also creates superior customer value by finding new and better ways to serve them (Ittner and Larcker, 1998; Reichheld, 2001). Information sharing and exchanging facilitate 3PL firms to better understand and meet customer needs in the dynamic markets (Lee *et al.*, 1997). This is an effective way to promote service delivery innovation for 3PL providers (Hammer, 2004; Srivastava *et al.*, 1999) and differentiate themselves from competitors. All of these may enhance customer satisfaction and loyalty, increase sales, and enlarge market shares (Fabbe-Costes and Jahre, 2008). As such, customer collaboration helps to reduce costs and increase sales, and financial performance of

3PL firms will thus be improved.

Additionally, information sharing and joint decision-making with customers enable 3PL firms to improve the operational efficiencies and make the supply chain more agile, adaptable and aligned (Lee, 2004). Resources would be fully utilized and allocated; operational processes would be optimized; duplicated routines and non-value-added activities would be eliminated through reasonable segmentation and better solving related operational (delivery, service and flexibility) issues together (Esper *et al.*, 2010). Walmart, for example, has managed to increase inventory turnover and improve operational efficiency by sharing point-of-sale information and sales and inventory data (Nguyen, 2017). Thus, customer collaboration positively impacts a firm's operational performance due to improved transactional efficiency throughout the supply chain, which helps 3PL firms to achieve superior operational performance (Davis and Spekman, 2004; Marn and Rosiello, 1992).

Based on the above, we propose the following hypotheses:

H2: Customer collaboration has a positive effect on (a) 3PL firms' financial performance and (b) operational performance.

The moderating role of government policy support

From the socio-technical perspective, government regulatory as the essential factor in the dynamic environment plays an important role in affecting technical and social factors through policy instruments (Carayon *et al.*, 2015). Due to the underdeveloped market mechanisms, government policy support, which is regarded as one of the key business priorities, often has a greater impact on corporate operations in emerging economies than in developed countries (Hong *et al.*, 2015). Government policy support refers to the extent to which local governments provide supportive policies to business entities in the market or a specific industry, and active support may include regulatory or financial assistance, as well as the provision of efficient services such as licensing and customs clearance, etc.

The value of customer collaboration may increase with the strong government policy support. Strong policy support provides 3PL firms with legitimacy in both social and environmental context (Sheng *et al.*, 2011). The Chinese government not only introduces favorable policies for logistics industries to build open communication platforms and create benign business trading environment but also matches related useful resources for their cooperation. With the social and environmental legitimacy (Bai *et al.*, 2016), the utility of customer collaboration would be amplified by the industry-university-research interactions encouraged by the government (Wang *et al.*, 2016a). This government-backed and customer-supported social capital can weave a safety net (Sheng *et al.*, 2011) to protect 3PL firms from financial and market fluctuations in a long term. As such, the positive effects of customer collaboration on financial and operational performance will be strengthened. In contrast, the lack of support or even more strict control from the government is a negative signal to market, and it will jeopardize the positive performance implications from existing partnerships between customers and 3PL providers.

Based on the above, we propose the following hypotheses:

H3: Government policy support strengthens the relationships between customer *collaboration and (a) financial performance and (b) operational performance.*

Research Methodology

Sampling and data collection

We conducted a nationwide survey across 23 cities in China to test our hypotheses, and a large professional survey company was employed to collect the data. The survey was conducted from 2017 to 2018. The stratified sampling method was used, 690 companies in 23 cities were randomly selected, and the sampling pool consisted of 6254 logistics companies in the A-level directory of China Federation of Logistics & Purchasing. During the data collection process, we first called every sampled company to inform them of our purpose before sending questionnaires. The questionnaires were then sent to the respondents via email or postal mail, with a postage-paid return envelope to the complete sample of 690 companies. Ten days later, follow-up telephone calls were used to remind them of answering the questionnaires. At last, the final sample contained 235 usable responses, yielding a usable response rate of 34.06%.

Measures

The measures were developed by adapting items from well-established constructs applied in previous studies and we consulted logistics professionals to make sure they are appropriate for the 3PL and Chinese context. Specifically, we invited four leading operations management professors in Chinese and Western universities to assist with the design of measurement items. The items were then sent to a group of logistics experts and practitioners for discussion and modification. Then we conducted a pilot study in 30 firms before running the final survey. The final scales are shown in Appendix A.

In this study, the scales of logistics IT adoption were adapted from previous research (Evangelista *et al*., 2012) which emphasizes the extent to which logistics IT is applied and well functioned. Customer collaboration was measured by a four-item scale developed from Danese and Romano (2011). Government policy support was measured by four items adapted from Sheng *et al*. (2011). Operational performance was adapted from Laumer *et al.* (2015) and Neely *et al*. (2005), including delivery, service quality and flexibility. The items were measured using a seven-point Likert scale with 1=strongly disagree and 7=strongly agree. Respondents were asked to indicate their degree of agreement regarding statements.

Financial performance was measured in terms of return on investment, return on sales, revenue growth, and market share suggested by Sum and Teo (1998). Respondents were asked to compare their company's financial performance with that of their major competitors on a 7-point scale, with 1 indicating that the firm was significantly worse than competitors and 7 indicating that it was significantly better.

Respondent profile

A wide range of 3PL firms in China were included, and respondents were mainly top management and logistics managers who are familiar with firms' logistics activities. The sample covered a variety of 3PL firms, as shown by the annual operating income in Table 1.

--- *Insert Table 1 about Here* ---

Results

Partial least squares-structural equation modeling (PLS-SEM) was used for data analysis in this study. PLS is a second-generation modeling technique that simultaneously evaluates the quality of research structures and the proposed relationship (Fornell and Bookstein, 1982). It has been widely used (Peng and Lai, 2012) and has a strong ability to handle complex models (Hair *et al.,* 2013). PLS-SEM technologies are well documented across disciplines (Ringle *et al.,* 2012; Hair *et al.,* 2012). We used SmartPLS (version 3.2.8) software to assess the measurement and structural models (Ringle *et al.,* 2015). A bootstrapping estimation procedure was used to test the hypotheses. The results of the measurement model and structural model are described as follows.

Non-response bias and common method bias

We compared the difference of early and late (after several rounds of calls) responses for logistics services, number of employees, annual sales, and variables used in this study (Armstrong and Overton, 1977; Stank *et al.,* 2001) and then conducted the t-test to address the non-response bias. The result showed no significant differences exist, indicating that non-response bias would not affect the empirical result in this study.

As to the potential issue of common method bias for one informant-reported questionnaire, we conducted both program control and statistical control to minimize its impact on the test results. First, we adopted the method suggested by Podsakoff *et al*. (2003) with fully considering the psychological feelings of the respondents in the process of item setting and dividing adjacent variables in the conceptual model into different parts. Second, to confirm the effectiveness of this strategy, we conducted a test, as recommended by Podsakoff *et al*. (2003). Accordingly, two measurement models were compared following the analytical procedure proposed by Liang *et al*. (2007), with one measurement model including all of the traits and the other model adding a method factor. The results showed that the path coefficients were insignificant and subtle. Third, the correlations, as shown in Table 3, between the latent variables involved in this study were all lower than 0.9, less than the threshold suggested by Pavlou *et al*. (2007). Therefore, the influence of common method bias does not appear to be a major concern in this study.

Reliability and validity

Rigorous procedures were used to develop and validate the survey instruments. We followed two commonly used methods to test construct reliability. First, we conducted exploratory factor analyses (EFA) using both orthogonal and oblique rotations to ensure high loadings on the hypothesized factors and low loadings on cross-loadings in the datasets. All of the items loaded onto the expected factors without significant cross-loadings. Then, the reliability of each construct was tested using Cronbach's alpha. The Cronbach's alpha values, shown in Table 2, were over 0.7 for all of the constructs, indicating that all of the constructs were reliable.

Next, convergent validity and discriminant validity were tested (O'Leary-Kelly and Vokurka, 1998). As shown in Table 2, the CRs of all the factors were greater than threshold 0.80, and the average variance extracted (AVE) for all of the latent variables were greater than the threshold 0.50 (Bagozzi and Yi, 1988). Thus, convergent validity was achieved. Further, the squared correlations between each pair of constructs (Table 3) were all lower than their AVEs, which provides strong evidence supporting discriminant validity.

--- *Insert Table 2 about Here* ---

--- *Insert Table 3 about Here* ---

Hypotheses testing results

Figure 2 shows the empirical results of the structural model. As indicated by path coefficients, logistics IT adoption has a significantly positive effect on customer collaboration. The path coefficient was 0.151 ($t = 2.711$, $p < 0.01$), providing support for H1. Customer collaboration has a positive and significant impact on financial performance and operational performance. The path coefficient was 0.385 ($t = 5.856$, $p < 0.001$) and 0.505 ($t = 7.762$, $p < 0.001$) respectively, hence H2 (a) and H2 (b) were both supported. Further, we also conducted post hoc analysis to examine the mediating effect of customer collaboration between logistics IT adoption and firm performance. The direct effects of IT adoption on financial and operational performance were significant in a simple model ($b = 0.197$, $p < 0.01$ and $b = 0.174$, $p < 0.01$ respectively) but not significant in the full model when customer collaboration is included ($b = 0.068$, $p = 0.356$ and $b = 0.014$, $p = 0.817$ respectively). The indirect effect from logistics IT adoption to financial performance through customer collaboration was 0.057 ($t = 2.400$, $p < 0.05$) and the percentile 95% confidence interval was from 0.016 to 0.108. The indirect effect from logistics IT adoption to operational performance through customer collaboration was 0.076 ($t = 2.455$, $p <$

0.05) and the percentile 95% confidence interval was from 0.022 to 0.143. Therefore, customer collaboration positively mediated the relationship between logistics IT adoption and financial and operational performance.

Regarding the moderating effects of government policy support, as shown in Figure 2, government policy support positively moderates customer collaboration's impact on operational performance. The path coefficient was 0.193 ($t = 3.357$, $p < 0.01$), providing support for H3 (b). However, it does not significantly moderate the effect of customer collaboration on financial performance as the path coefficient was 0.047 ($t = 0.780$, $p = 0.436$), which suggests that H3 (a) was not supported. The moderating effect was shown in Figure 3.

--- *Insert Figure 2 about Here* ---

--- *Insert Figure 3 about Here* ---

Discussion and conclusion

To understand the influence mechanism of how logistics IT adoption as a strategic priority affects 3PL firms' financial and operational performance, this study proposes a conceptual model from the resource-based view and socio-technical perspective. Some important findings and implications emerge as follows.

Major findings

The empirical results suggest that logistics IT adoption has a significantly positive effect on customer collaboration, which indicates that 3PL firms with advanced logistics IT such as big data, logistics information platform, and the Internet of things have the great potential to manage information flow more accurately and timely. This helps to reduce transaction barriers in the supply chain and build up the closer links between 3PL providers and customers that supports collaboration (Brandyberry *et al.*, 1999).

Additionally, our findings show that customer collaboration positively enhance both financial performance and operational performance, which can be explained by RBV. Collaboration with actors along the supply chain, especially customers, as an organizational capability helps firms to achieve better performance including financial performance and operational performance (Barney, 1991; Wang *et al.*, 2016b). In this sense, firms who adopt IT can only achieve better performance when the investments on IT are transformed into valuable, rare, inimitable and non-substitutable resources such as customer collaboration. For 3PL firms, logistics IT may not create sustainable competitive advantage when acting alone (Mata *et al.*, 1995) as it is easily imitated, and they have to use IT systems and platforms to better understand and meet customer requirements (Tripathy *et al.*, 2016) and build strategic assets such as inter-firm relationship (Johnson, 1999).

Finally, this study examines the moderating effect of government policy support on the relationship between customer collaboration and firm performance. Although government policy support significantly amplifies the positive effect of customer collaboration on operational performance, it does not significantly influence that on financial performance as predicted. A possible explanation might be the inherent nature of the 3PL business, whose main focus is the efficiency of operations, which is also emphasized by the government. The relevant supportive policies from the government are aimed to create a benign market environment for the whole logistics industry, which influence operational performance directly, such as better public logistics infrastructures and related training and services provided by the government. However, the market itself could still be competitive, and 3PL firms as players need to work harder to improve their financial performance.

Theoretical implications

The findings contribute to our understanding of the technological and developmental issues of 3PL firms theoretically. First, a significant contribution of this study is that the theoretical underpinning of combining socio-technical perspective and RBV provides a strong foundation for further understanding how 3PL firms pursue better financial and operational performance. Within the socio-technical perspective, IT adoption (technical factor) and customer collaboration (social factor) are interdependent to influence firm performance under the dynamic social-economic environment, as the relationship between customer collaboration and firm performance is affected by the government policy regulation. RBV suggests linking logistics IT with an integrated organizational capability through resource complementarity and co-specialization to achieve information advantage and synergistic performance. This study integrates the socio-technical perspective and RBV to build up solid linkage between logistics IT adoption and firm performance under the specific boundary condition.

Further, although previous research has studied the relationship between IT and supply chain performance (Devaraj and Kohli, 2003; Jin, 2006; Allenby and Rossi, 1991), this study aims to explore the role of customer collaboration and the moderating role of government policy support between IT adoption and firm performance in an integrated conceptual model. While more and more 3PL firms are looking for effective ways to improve financial and operational performance and often invest heavily in IT systems, it is unclear how IT adoption influences firm performance. This model verifies the important role of customer collaboration in converting logistics IT to firm performance (Devaraj *et al.*, 2007; Swink *et al.*, 2007) and examines the moderating role that government policy support strengthens the effect of customer collaboration on operational performance. With supportive government policies, customer collaboration can create more value to reduce information asymmetry, improve the service quality and supply chain flexibility and eventually contribute to better operational performance (Laumer *et al.*, 2015; Stank *et al.*, 2017).

This study offers rich empirical insights to the growing body of SCM and 3PL literature. Several studies have outlined the importance of collaboration along the supply chain (e.g., Chang, 2016; Li *et al.*, 2009), but there is limited understanding on how IT investments can be transformed into competitive advantage and how government should support the growing and prosperity of the whole industry, especially in emerging economies. Our findings enrich 3PL literature by explaining how logistics providers achieve better performance in China.

Managerial implications

Our findings also have important managerial implications. It emphasizes the essential role that IT plays in the operations of 3PL business. Now in the era of artificial intelligence, proactive adoption of advanced IT systems, such as Radio Frequency Identification (RFID), Data logger, Machine learning, Automated Storage and Retrieval System (ASRS) and automatic guided vehicle (AGV), will enable 3PL firms to manage their operations more effectively and efficiently. 3PL firms should invest to improve their IT capability and strengthen their IT collaborations with customers. Then our findings validate the importance of customer collaboration in converting logistics IT into financial and operational performance. The significant impacts of customer collaboration on financial and operational performance suggest that 3PL firms should attach great importance to strategies that foster collaboration and integration with customers to obtain the competitive edge against their competitors.

The moderation effects of government policy support suggest that 3PL managers should balance their operational and financial objectives when utilizing the supportive government policy. While for policy makers, our results also encourage governments of emerging economies to implement supportive policies, such as providing professional training and services related to logistics and information technologies, improving the effectiveness of laws and regulations, and making full use of online information platforms to modernize the logistics industry.

Limitations and future research

The limitations of this study and the future research directions are notified as follows. First, this study focuses on the impact of IT adoption in general, rather than classifying IT into different types of systems. Future work may consider to investigate the impact of different IT systems on different types of collaboration in the supply chain so that managers can find more appropriate forms of IT to adopt. Second, the data in this study were mainly obtained from "developed" cities in China, although the Chinese economy as a whole is still considered as an emerging economy. There are still rural areas in which IT investments and adoptions are very basic and premature, thus initial investments may not contribute to firm performance in the short term, and governments may need to provide more supportive policies to encourage IT adoptions of logistics firms. Further research is therefore needed to examine whether the findings reported here are applicable to the underdeveloped regions of China and to other emerging economies. Finally, cross-sectional data were used to analyze the relationships, and future longitudinal studies are called for to verify the causal relationships dynamically over time.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Table 1. Respondent profile

Annual operating income (RMB)	Percentage (%)
Under 500,000	0
500,000 to 10 million	26.38
10 to 20 million	10.64
20 to 50 million	17.02
50 to 100 million	12.77
100 to 500 million	20.85
More than 500 million	12.34

Table 2. Construct reliability and validity

Item	Factor loading	AVE	CR	Cronbach's alpha
Logistics IT adoption		0.628	0.835	0.702
LITA1	0.810			
LITA2	0.724			
LITA3	0.840			
Customer collaboration		0.704	0.905	0.860
CC1	0.794			
CC2	0.854			
CC3	0.866			
CC4	0.843			
Financial performance		0.774	0.932	0.903
FP1	0.925			
FP2	0.871			
FP3	0.863			
FP4	0.857			
Operational performance		0.654	0.883	0.823
OP1	0.787			
OP2	0.865			
OP3	0.780			
OP4	0.800			
Government policy support		0.692	0.899	0.852
GPS1	0.800			
GPS2	0.766			
GPS3	0.864			
GPS4	0.890			

Table 3. Correlation between the constructs

	LITA	CC	FP	OP	GPS
Logistics IT adoption (LITA)	1				
Customer collaboration (CC)	0.151	1			
Financial performance (FP)	0.128	0.382	1		
Operational performance (OP)	0.133	0.517	0.289	1	
Government policy support (GPS)	0.182	0.298	0.128	0.293	1

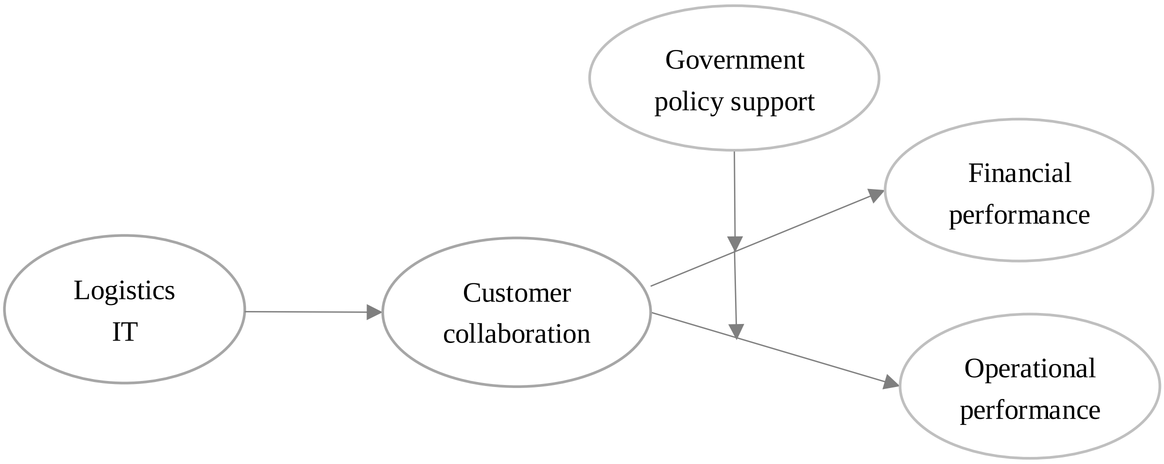
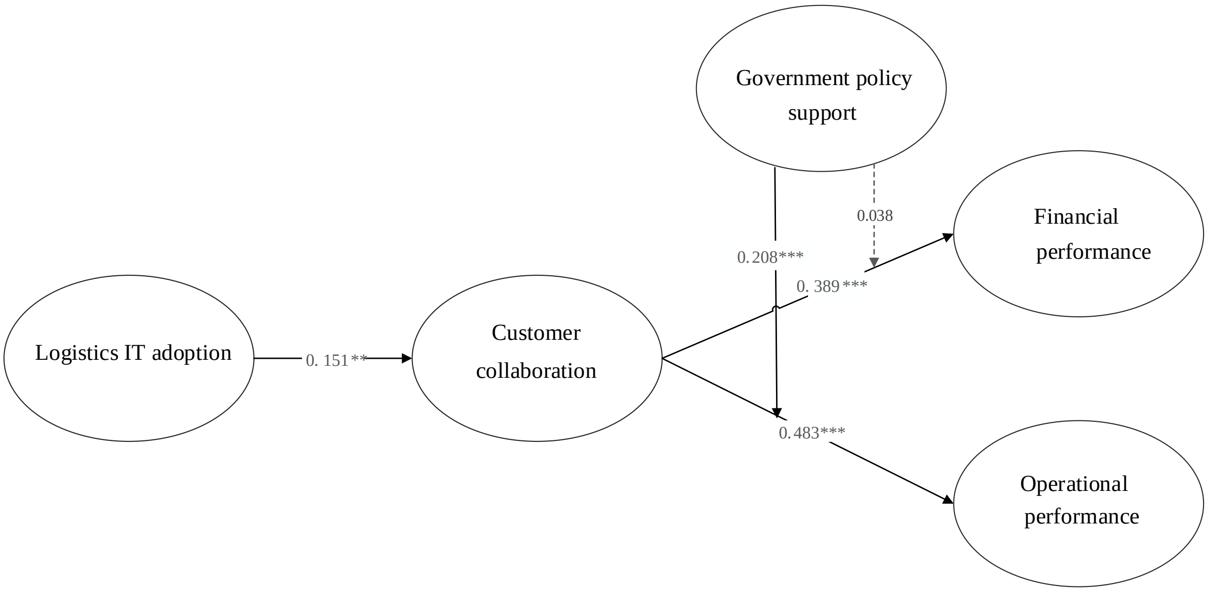


Figure 1. Conceptual model



***p<0. 001; **p<0.01; *p<0.05

Figure 2. Structural estimation

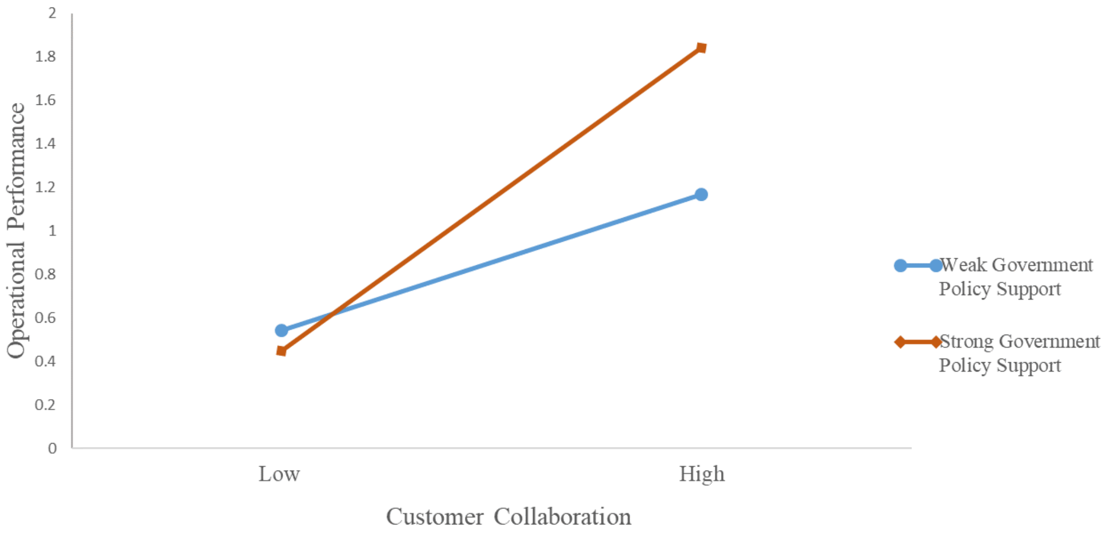


Figure 3. Moderating effect

Appendix A. Measurement Items

Logistics IT adoption:

LITA1: Our firm has widely adopted Internet of Things technology.

LITA2: Our firm has widely adopted big data technology.

LITA3: Our firm has widely adopted logistics information management platforms.

Customer collaboration:

CC1: We shared information with key customers about the plans and capabilities of the services we provide.

CC2: We worked with key customers to forecast demand and resolve operational issues through joint programs.

CC3: We worked with key customers to improve overall cost-effectiveness through joint decision-making.

CC4: We worked with key customers to customize the bill processing.

Government policy support:

GPS1: The municipal government strongly supports the development of the whole logistics industry in the city.

GPS2: The municipal government can make full use of the online information platform to provide related services to logistics enterprises (e.g., electronic customs clearance, approval, licensing, etc.).

GPS3: Municipal logistics industry association can effectively report the current status and challenges of the industry to the city government.

GPS4: Municipal logistics industry association can effectively strive for government support to implement or improve logistics-related policies.

Operational performance:

OP1: Our delivery is faster.

OP2: Our delivery is more punctual.

OP3: Our service is more convenient.

OP4: We are more flexible to handle customers' specific requirements.

Financial performance:

Compared to your major competitors, please evaluate your company's performance in the following areas:

FP1: Average growth rate of turnover over the past two years.

FP2: Average growth rate of market share over the past two years.

FP3: Average rate of return on sales over the past two years.

FP4: Average rate of return on investment growth over the past two years.