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Impact of information technology on the performance of logistics industry: the case of Hong Kong and Pearl Delta region

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Over the last decade, a number of research studies have advocated the use of information technology (IT) in different aspects of logistics and distribution operations. This study examines the current state of the use of IT and its impact on logistics service performance through a survey of 210 logistics companies in Hong Kong and the Pearl River Delta region. A hypothetical model is also proposed in which the theories of the market-based view and the resource-based view are applied to link up the implications of IT capabilities with logistic performance. The model was tested using structural equation modelling. The findings suggested that (i) IT implementation directly enhances the service quality of the logistics companies; (ii) the impact of IT implementation improves service quality thereby creating competitiveness.

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1. Introduction

As the world is becoming increasingly interconnected and interdependent, the logistics industry continues to look for strategic elements and information technology (IT) solutions to bridge three flows (physical goods, cash and information), streamline the Supply Chain and build up the networked logistics services (Yan *et al*, 2008). In addition, the penetration of technologies into different domains of logistics management greatly increases the efficiency of the logistics process by enhancing the utilization of resources and by reducing operating costs. Regarding the facilitating role of technology in developing and sustaining competitive advantage, how to strategically select and implement technology through an accurate analysis has become the most pressing concern in the current logistics industry.

Since the 1990s, the launch of the open economic policy of China has continuously attracted a large number of world-wide enterprises to invest and build production factories in China. By taking advantage of its geographical position, the Pearl River Delta (PRD) region in China has become the major centre for the development of manufacturing, while Hong Kong (HK) has changed its role and has developed into a logistics and enterprise headquarters hub to support the logistics and supply chain activities of the enterprises. During the global recession, the position of HK was downgraded from a transhipment hub of the PRD region to a regional freight centre (Chang and Lee, 2007). Collaboration in the physical flow of products in the two regions, accompanied by a large information flow in different logistics operations, has resulted in the emergence of a complex logistics network. Hence, in the context of the logistics industry of HK and the PRD, the most critical challenges are how to evaluate, select and implement the appropriate IT and information systems to maintain the desired quality of service and quality of logistics performance. IT has become the key to success in strategic management (SM), so it is essential to examine its impact on today's logistics companies. This study focuses on investigating the impact of IT on the SM of the logistics industry in HK and in the PRD region. In order to do this, a hypothetical model for testing the contribution of current IT implementation to various aspects of the performance of the logistics services has been constructed. The alignment of IT with the SM has also been developed. The SM is embodied in theories of the market-based view (MBV) and the resource-based view (RBV) to provide a complete picture of logistics management. According to Makhija (2003), MBV refers to an external market orientation and customer perspective of an end-product to achieve higher company value. In contrast, RBV focuses on how to allocate a company's internal resources and capabilities so that it can explain its profitability and value. Thus, service quality in terms of time reliability, customer

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satisfaction, information visibility and competitive advantage such as cost control are significant dimensions that can be used to measure the performance of the logistics industry in terms of MBV and RBV respectively. A model showing the hypothesis is then developed to explore the impact of the contribution of IT on performance of these two dimensions, that is, service quality for MBV, and competitive advantage for RBV. In MBV, service quality can be defined as two major capabilities, operational capabilities and relational capabilities (Zhao and Stank, 2003). Operational capabilities are the product availability and delivery reliability, whereas relational capabilities relate to communication and responsiveness, both of which ultimately result in increased customer satisfaction (Closs and Savitskie, 2003; Kim, 2009). To improve the service quality, customer satisfaction and time reliability should be included as criteria of performance measures regarding the relational oriented capability. In RBV, good logistics performance is associated with efficient and reliable operations, which imply overall cost efficiency and long-term customer relationships (Töyli *et al*, 2008). Regarding the operation measurement of logistics service providers, four key competitive success factors (eg quality, delivery, service, and flexibility) and internal indicators (eg defects and schedule realization) are included (Panayides, 2007; Liu and Lyons, 2011). In this paper, the data collected from a survey of 210 logistics companies is used in the model where it is measured and evaluated. The proposed model is tested through a structural equation and implications are drawn from the results.

2. Literature review

The trend towards globalization and increase in competitive pressure has prompted many business firms to develop logistics as a part of their corporate strategy to achieve cost and service advantages (McGinnis and Kohn, 2002). Different researchers have identified the contribution of IT to business performance as it has enhanced competitiveness (Lewis and Talalayevsky, 2000). Wang *et al* (2006) concluded that technological capability has both a direct and an indirect impact on overall business performance. Currently, the trend of logistics management is to increase IT adoption and development, since the overall logistics competencies are clearly significantly influenced by IT capabilities (Lai *et al*, 2010). The logistics contribution of IT implementation are specifically: timeliness, formatted to facilitate usage, flexibility (Naim *et al*, 2010), overall cost efficiency, customer satisfaction (Janoff, 2000), high service quality and ultimately, cost reduction (Wong *et al*, 2009).

2.1. IT adoption in the current logistics industry

The proficiency of IT adoption in managing information flow, facilitating operational processes and supporting decision making can be measured by examining how IT has an impact on logistics performance. Li *et al* (2009) stated that the IT and information-sharing capabilities have a direct effect on the supply chain integration ability of the logistics system. The benefit of instant information sharing provides electronic links that support communication and collaboration along the supply chain. In the short-term perspective, the information is provided to managers for optimally allocating and utilizing available resources for increasing the efficiency and effectiveness of daily logistics operations. In the long term, IT with intelligent systems provides the ability to analyse business information in order to support and improve management decision making across a broad range of business activities (Elbashir *et al*, 2008). This characteristic requires most LSPs to employ decision support systems for understanding customer behaviour from analysing massive data resources, establishing IT-based strategies and monitoring the business performance of daily operations. To this end, the framework of technology implementation includes three dimensions of technology: ICT, LIS and BI. These constitute a systematic approach to measure the application of IT in the logistics industry using information collection, process-oriented facilitation and decision-making support.

2.1.1 Information and communication technology (ICT). The convergence of telecommunication and computer technology has resulted in the emergence of ICT, which is a general term used to describe a large number of different technologies and applications to capture, store, process and provide data and to establish communication over long distances (Bouwman *et al*, 2005). The globalized supply chain management (SCM) model and e-business practices need the resource capability of logistics service providers. Furthermore, since ICT shortens the channel, reduces the intermediaries and generates direct contact with customers in terms of information and communication, it is viewed as an important tool for improving communication speed and reducing information transmission costs (Saura *et al*, 2008). ICT is generally divided into positioning and tracking technology, and communication technology infrastructure. The positioning and tracking technology tools include: (i) Barcode and Radio frequency identification (RFID); (ii) Closed Circuit Television; (iii) Geographical information system (GIS); and (iv) Global positioning system. On the other hand, for the communication technology infrastructure, (v) Electronic Data Interchange (EDI); (vi) Web Portal and (vii) Wireless Fidelity (Wi-Fi, 802.11a/b/g) help support business practice and implementation of demand information and echelon inventory policies in logistics practices, such as a continuous replenishment program, vendor management inventory and point of sale application (Barlas and Gunduz, 2011).

2.1.2. Logistics Information System (LIS) and decision support system. LIS is a computer-based information system (IS) that supports all aspects of logistics management including the coordination and management of various activities such as fleet scheduling, inventory replenishment and flow

planning. Instead of using human analysis and relying on the accumulated experience of people, LIS supports various automated decision-making processes that produce fewer human errors and lower costs as well as more accurate results, hence increasing the overall profitability and operational efficiency. Gu *et al* (2010) addressed a heuristics model to solve forward-reserve allocation problems within the warehouse order picking system. Shi *et al* (2011) introduced an efficient optimization-based heuristics model based on the real-time information to support the decision-making process of a freight transportation network. With the perceived benefits of using LIS in the support of logistics daily operations, seven kinds of LIS are widely applied in the logistics industry: (i) load planning system (LPS); (ii) a terminal management system (TeMS); (iii) a vendor selection system; (iv) a warehouse management system (WMS); (v) a financial management system; (vi) electronic Customer Relationship Management; and (vii) a transportation management system (TMS).

2.1.3. Business intelligence (BI). BI is a data-driven decision support system. It transforms data into meaningful information about market positions, resource consumption, capability and goals to enable companies to compete. This information is then turned into useful knowledge that improves the enterprise's competitive advantage. In a situation where the global market is rapidly changing, business enterprises today need to analyse information accurately and in a timely manner (Gangadharan and Swamy, 2004). From another perspective, enterprises need to be able to take advantage of BI to predict market characteristics, find market opportunities, and make decisions that create value. A new term, Supply Chain Intelligence, has now come into use that integrates BI in SCM and provides the supply chain partners with visibility of information and online analytical capabilities along the chain (Dyson and Koruth, 2004). BI facilitates the processes from sourcing data, manipulating and mining data, monitoring and analysing performance, to providing a visual view of corporate performance measures through its four major components: (i) a data warehouse; (ii) online analytical processing (OLAP); (iii) data mining (DM); and (iv) corporate performance management (CPM).

2.2. IT contribution to the current performance of logistics

IT is an enabler to make electronic transactions with vendors, manage the inventory and track shipments in real-time, place orders and exchange information online. Some researchers functionally divide IT into (i) externally focused applications and (ii) internally focused applications (Savitskie, 2007). The external applications refer to information sharing, EDI and inter-firm planning systems that connect the firm with customers and suppliers. The internal applications include order management, logistics operations and firm-level planning systems which improve internal efficiencies (Closs and Savitskie, 2003). Competitive advantage is one of the logistic capabilities that come from improved service performance through the adoption of IT. These factors include customer commitment (Sanders and Premus, 2002; Kent and Mentzer, 2003), financial performance (Liu and Lyons, 2011), delivery efficiency (Hsiao *et al*, 2010), collaborative relationships (Knoppen *et al*, 2010; Hofenk *et al*, 2011) and corporate reputation. In the literature certain key performance measuring criteria have been identified that can be categorized into two dimensions of performance outcome:

(i) *Dimensions of service quality.* In the development of logistic electronic services, supply chain transparency has become one of the most critical logistic service qualities. Different functions are supported regarding orders, deliveries, shipments and inventories (Kilgore *et al*, 2002). With order and delivery visibility, collaborative order management coordinates transportation execution across organizations and enables the connectivity of order capture systems with multiple fulfilment systems. This network facilitates the scheduling of production and assists decision making of different parties along the supply chain (Alt *et al*, 2000). In addition, logistics visibility provides the functions of tracking and tracing documents and shipments, as well as creating alerts and reporting consolidated status information across various carriers (Teach, 2002). In this research, logistics service performance is specified as having a visibility property. The specific service-related performance considerations include: delivery visibility and loading/unloading visibility. Owing to the fact that LSP always wants to keep a long-term and reliable relationship with its customers, it is important to maintain the service quality so that customers would be satisfied with the services provided. Hence, LSPs tend to measure the internal operations performance based on the defined key performance indicators (KPIs). Through reviewing the KPIs value to customers on a regular basis, the customer satisfaction rate can be measured directly. Therefore, time reliability, customer satisfaction rate, delivery visibility and loading/unloading visibility are classified as belonging in the dimension of service quality.

(ii) *Dimensions of competitive advantage.* Competitive advantage refers to the capabilities that the company has which enable it to outperform its competitors (Jensen *et al*, 2010). It can be classified into two categories: (i) internal competitive capabilities and (ii) external competitive capabilities (Bobillo *et al*, 2010). Internal variables include financial measurement and management resources within the company while external variables are related to the establishment of good relationships between business partners and customers. In summary, there are three items that are useful in measuring the competitive advantage of a logistics firm: cost control, customer relationship and corporate image. Cost reduction is achieved by a reduction in in-transit products, lower safety stock levels and reduced freight charges, in visible inventory and transport systems (Holter *et al*, 2008). With the ability of better cost control, LSP can provide better resources allocation to its customers at a reasonable cost. As cost is one of the major considerations in selecting business partners, customers are

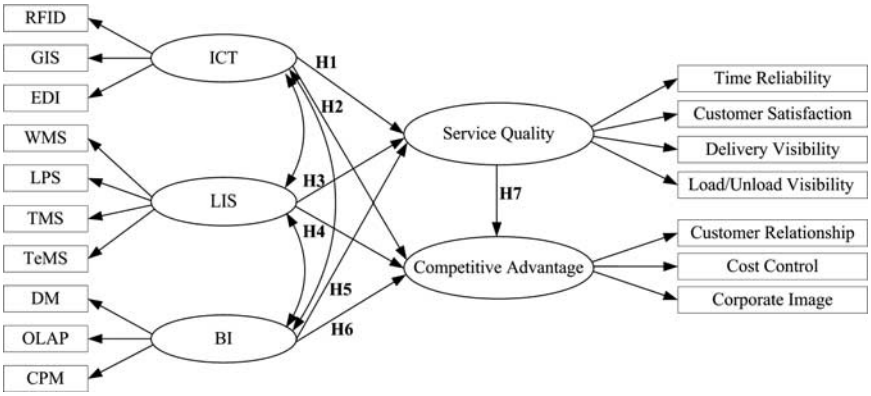

Figure 1 Research model for the study.

always requested to make a service commitment at a low cost. Thus, having better cost control is the competitive advantage of LSP. Besides, customers always want to build a good relationship with the service provider in order to increase the efficiency of the operation. With good communication between customer and LSP, LSP would have a deeper understanding of what the customer needs so it can make appropriate arrangements to meet the customer's standard. Thus, the success of a large-scale project between the company and the LSP will become a reference case of the LSP to help it further develop its business. By accumulating more successful business cases, the LSP is able to build its own corporate image which will be one of its competitive advantages. Therefore, the proposed three items are the major categories for measuring competitive advantage.

(iii) *Impact of IT on strategic management*. In order to understand how IT contributes to creating and sustaining strategic positions, two major issues related to SM are reviewed in the theories of RBV and MBV: (1) From the perspective of an RBV, a strong competitive position is achieved within an industry by fully utilizing strategic resources to create inimitable and firm-specific capabilities (Wong and Karia, 2010); (2) From the perspective of an MBV, the market barriers to the new competitor's entrance and the bargaining power of customers are analysed. The RBV theory enables researchers to investigate the relationship between the firm's strategy and performance as well as the value of the IS's resources (Wade and Hulland, 2004). As every company has its own unique culture that distinguishes it from others, the company should develop their own and inimitable IT capability so as to compete in the market. To form unique IT capability, each company should have its own IT resources, such as infrastructure and software; IT human resources, such as managerial skill and IT-enabled intangible resources (Bharadwaj, 2000). Such unique IT capability can be viewed as a firm's strategic resource to help further leverage the company performance to differentiate themselves from competitors. In the MBV, new companies are always deterred from entering into the market by the presence of barriers. Acur and Bititci (2004) found that in order to satisfy the market requirements and generate competitive advantage, LSPs build themselves a knowledge-base by using IT. Pires and Aisbett (2003) also argued that such knowledge referred to the adoption of ICT which was considered to be the source of the competitive advantage. In the practical situation, it is observed that there is a time lag between the building of the technological infrastructure and the reaping of the benefits. There is also some difficulty in implementing technological change, which fuzzes up the influence of technology on the competitive advantage (Webb and Schlemmer, 2008). Such difficulties may become the barrier that prevents a company from adopting ICT as a competitive advantage. On the other hand, a company with strong bargaining power is able to charge a reasonably high price to customers by providing a satisfactory level of service. This can be achieved through providing high customer value delivery, a high quality of customer service and technology owned by service providers in the logistics field (Aktas *et al*, 2011). Therefore, the logistics company that is able to provide IT support to their customers can increase its competitive advantage. Hence, the company's bargaining power can also increase.

2.3. Summary

It is known that the achievement of improved service quality will lead to great success in long-term competitiveness. In the literature, IT is generally seen as the driving force of superior business performance; however, few investigators have gone into detail about the impact that each specific IT category has on the two core performance dimensions. With the purpose of examining the linkage between the IT deployment (ICT, LIS and BI) and the two performance outcomes (i) service quality and (ii) competitive advantage for the logistics firms in HK and the PRD regions, the present research model for the study, shown in Figure 1, has been specifically designed. In this research study, several hypotheses are stated in order to investigate the relationship between IT implementation and the two performance measures. The research results will help

logistics companies to build and refine their IT-focused strategies and manage different logistics processes in pursuit of improved performance and business success.

3. Research framework and hypothesis setup

In this study, a hypothetical model is developed to explore the predicted relationships between the contributions of ICT, LIS and BI made on the two specified logistics performances: service quality and competitive advantage.

3.1. The ICT and LIS contribution to the logistics performance outcomes

With good communication of information and cooperation along the supply chain, ICT and LIS enable the combination of operational and information flow, which provides transparent networks for suppliers and customers. According to Zhang *et al* (2011), supply chain visibility can increase the collaboration among supply chain members via real-time data sharing (Golicic *et al,* 2002) and enhance time-based delivery (Iyer *et al*, 2004). With sufficient information and with increased visibility and communication between various logistics operations and shareholders, different parties along the supply chain can promptly make appropriate decisions. In fact, the recent advanced developed ICT such as RFID, GPRS, wireless mesh network and smart sensors are able to provide real-time tracking information on moving objects such that logistics firms can enhance its delivery accuracy and tracking ability (Bardaki *et al*, 2011). Furthermore, high service performance enhances the bargaining power of LSPs thus improving their competitive positions. Therefore, the following hypotheses relating ICT and LIS with service quality and competitive advantage are defined.

Hypothesis 1 *In the logistics firms of HK and PRD, ICT is positively related to logistics service quality.*

Hypothesis 2 *In the logistics firms of HK and PRD, ICT is positively related to competitive advantage.*

Hypothesis 3 *In the logistics firms of HK and PRD, LIS is positively related to logistics service quality.*

Hypothesis 4 *In the logistics firms of HK and PRD, LIS is positively related to competitive advantage.*

3.2. The BI contribution to the logistics performance outcomes

The main features of BI refer to the extraction, integration and analysis of data through mathematical and artificial intelligence techniques to support operational and strategic decision making (Thomsen, 2002; Hannula and Pirttimaki, 2003). In order to increase their competitiveness, firms strive to reconcile all their operational data related to each business process, measure the process performance and identify the opportunities for improvement (Seufert and Schiefer, 2005). Furthermore, the improved logistics service quality leads to higher customer satisfaction that helps increase customer loyalty and builds up a good corporate image, finally sustaining a competitive position. The following hypotheses are then derived:

Hypothesis 5 *In the logistics firms of HK and PRD, BI is positively related to logistics service quality.*

Hypothesis 6 *In the logistics firms of HK and PRD, BI is positively related to competitive advantage.*

3.3. The mediating role of service quality

Service quality measurement assists in directing management attention to revising the goals of the firm and also helps in the re-engineering of business processes in those areas where operations are inefficient and services are of unsatisfactory quality. These goals are closely related to the creation and reconstruction of corporate strategy (Bourne *et al*, 2000; Kuwaiti and Kay, 2000). Hence, the measurement of quality is indispensable to an understanding of the current situation of systems and for taking action that is appropriate for maintaining competitiveness. In an attempt to improve service quality, many scholars have investigated how effectively the firm is using IT to support core competences. In further investigations, strategic and operational roles as well as social issues were discussed as the mediators between the benefits of investment in IT and the enhancement of competitiveness (Sriram and Stump, 2004). Then this leveraging role of IT was specified as being related to superior service quality in the logistics industry (Byrd and Davidson, 2003). Thus, this serves as the foundation of the seventh hypothesis:

Hypothesis 7 *In the logistics firms of HK and PRD, service quality is positively related to competitive advantage.*

4. Research methodology

The research model that consists of totally seven hypotheses is evaluated by using a large sample of data from an email survey from logistics companies in HK and the PRD region. The construction of the survey instrument, description of the sample population, data collection procedures and variable measures are discussed in detail. Moreover, several techniques of structural equation modelling (SEM) are used to test the statistical validity of the model and of the related hypotheses. There are mainly three instruments employed in the model assessment. Exploratory factor analysis (EFA) is used to identify the measurement items included in the hybrid model. Confirmatory factor analysis (CFA) is used to assess the reliability and validity of the initial model and helps modify the selected items so that they will fit the overall structure of the hybrid model. Finally, using path analysis, the direct and indirect causal

effects in the hypothesis are shown in the results for further analysis of the practical relationships between different latent variables.

4.1. Data collection

Data was collected through a large-scale survey of logistics companies in both HK and the PRD regions by the Hong Kong Logistics Association. Owing to the geographical separation between HK and the PRD, the models of logistics operations of these two regions are different. Owing to limited space combined with high rental cost, suitable logistics facilities in HK are scarce. Most LSPs in HK focus on retail business that provides local distribution of finished goods and high value-added services to their customers. On the other hand, LSPs in the PRD region focus on industries such as suppliers and manufacturers to deliver mainly raw materials and work-in-progress products in bulk. However, since HK has become a special administrative region of China, logistics operations between HK and the PRD region are frequent. In addition, the Closer Economic Partnership Agreement signed between HK and Mainland China allows tariff-free trade on goods and many concessions on services and investments. As a consequence, more business transactions between these two regions have been developed in what is now known as the cross-border supply chain model. This supply chain model provides opportunities for business development between the two regions. Therefore, data collected from these regions has been combined and considered together to help develop this cross-border supply chain which is based on the impact of IT on the performance of this logistics industry. A sample frame was prepared for use in both highly respected large companies and developing medium-sized ones. Most questions in the questionnaire reflect the measurement of real-life items in actual practice. For the measurement of the IT application level in different logistics operational processes, the scale in each technological question is a 10-point scale with the endpoints 'without implementation' (=0) and 'full implementation' (=10). On the other hand, when measuring the current business performance, 10-point scales are applied with the endpoints 'strongly disagree' (=0) and 'strongly agree' (=10) in each performance-related question. Both a pre-test and a pilot test were conducted before the large sample was used. As it is important to clarify the wording of the questionnaire so that the questions can be understandable by the respondents, a pre-test was conducted in the University. Comments, including questionnaire design and layout, interpretation of questions and available choices of answers, and difficulties people found when completing the questionnaire were collected from professors in the University. The questionnaire was finalized after adjustments had been made. After that, a pilot test was conducted in a class of postgraduate students who are working in logistics/IT industry and who have background knowledge of logistics management. The procedure of conducting the survey was similar to that of a test that included distributing and collecting the questionnaires, answering queries related to the questions and sample data processing to ensure that the survey ran smoothly. After a pre-test and a pilot test, two mailings were made with a reminder email as a follow-up and all target respondents were required to be knowledgeable regarding logistics process technology and performance strategy.

In order to improve the validity, the targeted respondents were either experts in the IT department or operators at managerial level, so that they were deemed to be knowledgeable enough to provide accurate feedback on the practical conditions of the industry. A total of 612 questionnaires were distributed with 210 usable surveys returned, representing a response rate of 34.3%. A first group mailing of the questionnaire was sent and produced a return of 184 valid respondents. One month later, the second mailing was sent to those who had not responded and then 26 more questionnaires were returned. The responding organizations represented a range of logistics services, including air transport (50%), marine (62%), rail-cargo (24%) and sea-air service (34%); the services of warehousing and distribution (55%), cargo marine insurance (26%), customer clearance and brokerage (55%), fair and exhibition (15%), contract logistics (41%) and lead logistics (25%). All logistics companies covered more than one kind of service. Their headquarters are located in HK (22%), Mainland China (64%) and Overseas (14%), respectively. The majority of responding organizations are large-size with more than 100 employees. The detailed distribution of number of employees is provided in Table 1.

4.2. Exploratory factor analysis

EFA is an analytical method to identify which empirical indicators are strongly linked to a particular latent variable with a minimum loss of information (Hair *et al*, 1995). In this exploratory study, it was not certain whether the selected items were able to successfully measure the five factors as there was insufficient research support and the academic suggestions were inadequate. Therefore, the factor analysis was conducted through the method of varimax rotation and the results are presented in Table 2. Seventeen items were classified into four components. Most components successfully included the measurement indicators of corresponding latent variables. There were two exceptions: it was suggested that the four indicators of service quality and the three indicators of competitive advantage be combined into one component; TeMS was classified as the component that included all the items for measuring BI. However, though the indicators of the two performance dimensions have been combined into one component, the differences between their scores also enable them to be classified into two separate groups: the top four scores in this group make up one group and the remaining three items make up a second group. In terms of misplacement of TeMS, this is understandable as its scores in component 2 and 3 were very similar. Since theoretically it belongs to the group of component 3, it should be

Table 1 Frequency distribution of number of employees

No. of staff	*Hong Kong*		*Mainland*		*Overseas*	
	Number	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*
1–10	15	23	4	4	3	9
11–20	6	9	10	9	3	9
21–50	7	11	23	21	3	9
51–100	9	14	17	15	2	5
100 +	28	43	57	51	23	68
Total	65	100	111	100	34	100

Table 2 Rotated component matrix

	Component			
	1	2	3	4
Time reliability	0.833			
Customer satisfaction rate	0.833	0.118		
Loading unloading visibility	0.785	0.149	0.288	
Delivery visibility	0.756	0.288	0.199	
Corporate image	0.719	0.107	0.158	0.139
Customer relationship	0.690		0.201	0.161
Customer value	0.608	0.299	0.348	
Online analytic processing (OLAP)	0.160	0.874		0.180
Data mining (DM)	0.151	0.788	0.254	0.105
Corporate performance management (CPM)	0.318	0.705	0.241	0.149
Terminal management system (TeMS)	0.105	0.495	0.441	0.121
Transportation management system (TMS)	0.200	0.174	0.760	0.211
Warehouse management system (WMS)	0.193	0.157	0.754	0.138
Load planning system (LPS)	0.163	0.257	0.724	0.140
Radio frequency identification (RFID)				0.849
Real-time locating system (RTLS)	0.139	0.119	0.314	0.696
Electronic data interchange (EDI)		0.263	0.323	0.592

actually placed in component 3 for measuring the factor of business application.

4.3. Assessment of reliability

Reliability is the accuracy or precision of a measuring instrument, which is the extent to which the respondent is able to answer the same or similar questions in the same way each time (Hong and Kim, 2002). The internal consistency reliability was assessed by calculating Cronbach's alpha. The results are given in the third column of Table 3. Since the values range from 0.529 to 0.885 with most of them greater then 0.8, the result is acceptable and the reliability of the construct is verified.

Table 3 Summary of reliability and validity of measurement

Measurement	*Items*	*Reliability (Cronbach's alpha)*	*Convergent validity*	*Discriminant validity*
Technology infrastructure	3	0.529	0.47, 0.47, 0.60	0.76, 0.72, 0.31, 0.38
Business application	4	0.783	0.75, 0.74, 0.62, 0.67	0.76, 0.68, 0.50, 0.49
Business intelligence	3	0.833	0.83, 0.78, 0.77	0.68, 0.72, 0.48, 0.51
Service quality	4	0.886	0.83, 0.84, 0.82, 0.76	0.48, 0.50, 0.31, 0.79
Strategic advantage	3	0.809	0.80, 0.75, 0.75	0.79, 0.51, 0.49, 0.38

4.4. Assessment of construct validity

Validity analysis is concerned with whether the random and systematic errors of the model are acceptable. Apart from the assessment of content validity in the pilot test section, the construct validity needs to be established. O'Leary-Kelly and Vokurka (1998) pointed out that construct validity enables

readers to assess whether a construct sufficiently measures the intended concept without measurement error. This procedure has been shown to be a necessary component of the research process. Furthermore, in considering the method of CFA, Vickery *et al* (2003) concluded that good convergent and discriminant validities are indicators of construct validity.

Kline (1998) summarized the standard of good validities by these desired results: (1) convergent validity is indicated when indicators specified to measure a common underlying factor all have relatively high loadings on that factor, and (2) discriminant validity is indicated when estimated correlations between the factors are not excessively high. The results of convergent validity and discriminant validity assessments are summarized in the fourth and fifth column of Table 3, respectively. The test indicated a high level of convergent validity for the measures as the value of all indicators' intercorrelations were above 0.5 showing they are at least moderate in magnitude. The correlations between different factors were all below 0.8 with the average value of 0.5, suggesting the measurement model has discriminant validity.

4.5. Evaluation of the model

The path analysis technique is used to identify the relationships among technology infrastructure, business application, BI, service quality and strategic advantage in the logistics companies in the regions of HK and the PRD. All the relationships were considered in the seven hypotheses illustrated in Figure 1 and the score for each relationship is reported in Figure 2.

Hoyle (1995) pointed out that a path diagram is a primary form to communicate an SEM hypothesis and results. The final

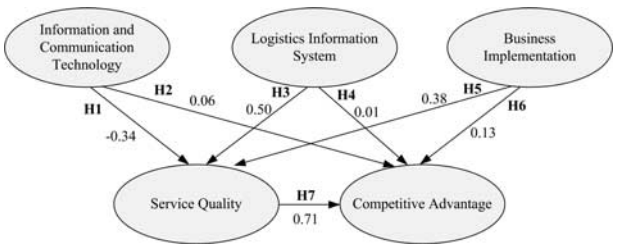

Figure 2 Path analysis coefficients related to the proposed relationships.

results were analysed by using Amos software and achieved a satisfactory fit for the model. The result ($x^2 = 172.220$, d.f. = 109, $p = 0.001$) indicated that there is not a significant difference between the proposed and actual matrices (Hair *et al*, 1995). The value of fit index GFI (0.873), AGFI (0.822) and NFI (0.851) indicated a reasonable fit of the data with the hypothesized model while other statistical tests (CFI = 0.938; RMSEA = 0.065; IFI = 0.940; TLI = 0.923) all indicated an overall good fit. The hypothesis is supported when the value of significant value for regression weight under the non-standardized estimates is less than 0.05 (Kline, 1998). In this model, there are three theoretical causal relationships (H3, H5 and H7) supported with the path loadings of 0.50, 0.38 and 0.71, respectively. This means that both business application and BI have a medium influence on the service quality, whereas service quality has a large effect on the building of strategic advantages in the logistics organizations. A summary of the seven causal relationships is shown in Table 4.

(i) *Perform validity check on the existence of common method variance*. Common method variance (CMV) is the level of correlation when two or more constructs are measured and data is collected from the same participants at the same time (Avolio *et al*, 1991). The presence of CMV can influence the empirical results which can result in wrong conclusions being drawn. However, there are different views on the use of CMV from researchers. Podsakoff *et al* (2003) reported that 'CMV is often a problem and researchers need to do whatever they can to control it'. Chang *et al* (2010) suggested that any analysis from the same data source should include validity checks so as to resolve any CMV issues before submission. However, some researchers argue that the CMV problem may be overstated and, in any event cannot be totally avoided (Lindell and Whitney, 2001; Spector, 2006). Craighead *et al* (2011) reviewed 248 published surveys and found that 178 of them (71.77%) did not address CMV and that no CMV remedies were performed. In order to detect the presence of CMV, the most commonly used method is Harman's single factor test (Podsakoff and Organ, 1986). This is a *post-hoc* statistical technique that is used to examine the degree of variance that can be explained by a single factor (Richard *et al*, 2009).

The results of this study make the probability of bias apparent when data is collected from the same respondents at the same time. A one-factor analysis is performed on the suggested

Table 4 Results of path analysis for seven hypotheses

Hypothesis	*Dependent variables*	*Independent variables*	*Path coefficients*	*Significant level (p)*	*Results*
1	Service quality	ICT	−0.34	0.286	Reject
2	Competitive advantage	ICT	0.06	0.807	Reject
3	Service quality	LIS	0.50	0.034	Support
4	Competitive advantage	LIS	0.01	0.971	Reject
5	Service quality	BI	0.38	0.043	Support
6	Competitive advantage	BI	0.13	0.419	Reject
7	Competitive advantage	Service quality	0.71	0.010	Support

hypotheses to test against company size. The three supported hypotheses specify that (i) LIS and (ii) BI are positively related to logistics service quality while (iii) service quality is positively related to competitive advantage. Raw data is tested using both large- and small-sized companies. The former refers to a company with 100 or more staff members while the latter is a company with less than 100 staff members. Based on these hypotheses, the results show that there is no significant difference between a large size company and a small size company. This suggests that the influence on common method bias is not significant.

(ii) *Perform validation check on the mediating role of service quality*. In addition to clarifying the relationship between the contribution of IT and logistics performance, it is believed that the former can influence service quality, which in turn will influence competitiveness. This means that improvement in service quality with an IT contribution can further enhance competitiveness in the logistics industry. Therefore, in the hypothesis, service quality is defined as the mediator variable between ICT, LIS and BI (the independent variables), and competitive advantage (the dependent variable). In order to prove the existence of a mediation relationship, Howell (2009) applied a three-step model that was proposed by Baron and Kenny (1986) to test for the explicit inclusion of the mediator variable. In the first step, the direct relationship between each independent variable and dependent variable was tested using regression analysis, that is, between ICT, LIS and BI, with competitive advantage respectively. The second step was to test whether the independent variables (ICT, LIS and BI) influence the mediator variable (service quality) also using regression analysis. The final step was to test the relationship between the dependent variable (competitive advantage) on both mediator variable (service quality) and independent variables (ICT, LIS and BI) using multiple regression analysis. The results in Step 1 and Step 2 confirmed that all three independent variables (ICT, LIS and BI) are significant predictors of competitive advantage as well as of service quality respectively. After performing Step 3, it was found that the coefficient of independent variables is smaller in absolute value than the coefficient value, without considering the mediator variable. Therefore, this demonstrates that service quality plays an important role in governing the relationship between IT contribution and competitive advantage.

In the next section, the results of the theoretical model are analysed from two major perspectives: theoretical contributions and managerial implications. Both MBV and RBV are employed in explaining the results in detail with the findings of previous researchers. Some suggestions for the findings will be presented in the context of the logistics industry in HK and PRD region.

5. Discussion of results and managerial implications

The empirical results presented in the previous section provide empirical support for the hypothesis that implementation of certain IT technologies has a beneficial impact on the logistics service quality and ultimately drives the building and sustaining of competitive advantage for LSP. Furthermore, this is the first research study to investigate specifically how each category of IT impacts on the logistics service quality and its relationships to other IT categories and on competitive advantage. In accordance with the causal relationships derived from the hypothesis model, some practical suggestions regarding the formulation of a technology-based strategy and management techniques will be provided in detail.

5.1. The practical implications of this research study: The implementation of LIS, BI and service quality

The results showed that there are two determinant technologies for logistics companies in HK and PRD for improving the quality of their service. LIS and BI positively affect service quality indicating that LIS and BI are important factors for adjusting the service performance level. It is expected that better service quality will be achieved when higher levels of LIS and BI are implemented. Moreover, the findings show the path coefficients between LIS and service quality with the value of 0.5 are 0.12 greater than that obtained from BI. In reality, it is reasonable that strategic direction is necessary when implementing IT. As a large investment has to be made in building technological capability, companies have to make sure that the value created by such investment is cost effective. Hence, regarding the rate of return, the results show that when a logistics company with limited resources decides to improve its service performance, the investment is best used for the implementation of LIS. The service quality is measured by four operational systems: customer satisfaction rate, time reliability, loading and unloading visibility, and delivery visibility. Therefore, it is not surprising that a strong relationship between LIS and service quality is found as LIS is used to streamline and control daily processes while BI is adopted in long-term SM to identify business opportunities and increase competitiveness with optimal decision making. The adoption of BI supports LIS innovation to help LSPs think critically about how to enhance the service quality, and improve the performance with strategic guidance. For instance, the customer segmentation supported by BI can help LSPs allocate resources more efficiently with LIS so as to delivery higher customer value in different areas of logistics services.

5.2. The theoretical implication of this research study

In this empirical study, research is focused on investigating the relationship between the implementation of three core technologies and different service performances in the logistics firms in HK and the PRD regions. Therefore, the concept of whether strategic logistics technology contributes significantly to superior service performance and sustainable competitive advantage needs to be discussed.

5.2.1. The implications of using technology for gaining competitive advantage in the MBV. In the MBV, the empirical findings generally support the idea that a company's profitability and competitiveness are explained by the characteristics of an industry (Makhija, 2003). In this project, the impact of ICT adoption is analysed after including the competitive force of barriers to entry, while the impacts of LIS and BI are analysed after including the competitive force of bargaining power.

(i) *Barriers to entry regarding the ICT adoption.* ICT, as a monitoring tool, provides real-time information of partners and customers along the supply chain to support better decision making and to increase operational efficiency (Morgan and Inks, 2001). However, most firms see this information as proprietary and fear losing their independence when asked to share this information. This resistance to sharing then becomes a critical challenge to the adoption of ICT (Baraldi and Nadin, 2006). Therefore, one of the questions investigated in this study '*ICT and competitive advantage has no direct relationship*' supports the view that the creation of competitive advantage cannot be achieved directly via the implementation of ICT. Furthermore, the results support the views of Webb and Schlemmer (2008) and Helfat and Peteraf (2003) that there is a time lag between the awareness of ICT's effects on building competitiveness and the implementation of ICT. Moreover, the results verify the view of Baraldi and Nadin (2006) who pointed out that most LSPs view their private information as proprietary and are not willing to share it with other partners along the supply chain. The failure of ICT to be widely used may further lead to knowledge deficit regarding the other stakeholders and dynamic market change. This may result in the firm's inability to increase service quality and so leads to loss of competitive advantage.

(ii) *Bargaining power created by LIS and BI.* Herschel and Jones (2005) pointed out that the BI metadata repository implements a technical solution that gathers, retains, analyses and disseminates corporate 'knowledge' in order to generate competitive advantage in the market. The above research studies illustrate that both LIS and BI sufficiently support the establishment of market power and competitive advantage through high service quality by establishing high bargaining power. The research results of this study support previous researches and indicate LIS and BI achieve better cost control, customer value and corporate image as a consequence of the improvement of service quality. In other words, the implementation of LIS and BI is positively related to the establishment of competitive advantage with the mediating role of service quality in the logistics industry in HK and the PRD region. Moreover, with a higher factor coefficient between LIS and logistics competence, the contribution of LIS to enhance the logistics competencies is greater than that of BI.

5.2.2. The implications of technology implementation for competitive advantage in the RBV. In this study, logistics performance is measured by service quality while logistics capabilities are specified as being the adoption of ICT, LIS and BI. The relationships of technology implementation on logistics performance and competitive advantages in the results of these hypotheses are analysed. Two topics are addressed in the following discussion: (i) the inimitable nature of strategic resources and (ii) superior service performance and greater competitiveness are created by better allocation and utilization of resources.

(i) *The inimitability of resources regarding the adoption of ICT.* Regarding the effects of ICT on creating a high strategic position, implementing ICT solutions mirrors the shift in the managerial focus from inside the enterprise to the connections with other firms and improves efficiency through supporting a better interplay between the firms in the surrounding business network (Kalakota and Robinson, 2000). The results generated from the hypothetical model support the conclusion that ICT cannot make a direct contribution to increasing service quality and competitive advantages. Corresponding to previous views, it is found that ICT is solely applied in the internal communication within the firm. Given the heterogeneity of information formats, it is difficult to apply a uniform ICT infrastructure to a firm which needs to communicate with different participants in the industry who have different formats of data and different designs of IT infrastructure (Baraldi and Nadin, 2006). A time-consuming and complex analysis along with expensive investment on developing different ICT infrastructures is needed in order to fit all communication needs across the network. Hence, the deployment of an ICT solution in the logistics industry is severely obstructed.

(ii) *Competitiveness created by utilizing and allocating LIS and BI.* Our research results support the view that competitive advantage is achieved by the implementation of LIS through improving the quality of the service provided. Moreover, based on the results of path analysis, LIS has the greatest impact on service quality among other determinants (with the path coefficient of 0.50). This implies that current LSPs will focus on the adoption of LIS as their first concern during the expansion and reengineering of their logistics business. By instant information tracking and sharing, LIS facilitates the transportation routing and scheduling, inventory replenishment and terminal management so as to increase the flexibility and responsiveness of logistics services. Tallon *et al* (2000) stated that BI systems would facilitate the development of the business process and organizational performance through their efficient performance measurement and optimal decision making regarding the reallocation of resources. The findings in this study make a contribution by supporting previous research by affirming that the implementation of BI contributes to the improvement of service quality and leads to the firm establishing a strong competitive advantage in the logistics companies.

6. Conclusion

In this study, we investigated the current state of IT deployment from two strategic perspectives (MBV and RBV theories) in the context of the logistics industry in HK and the PRD region. We developed a hypothetical model with totally seven hypotheses the aim of which was to investigate empirically the relationships between the adoption of three technologies (ICT, LIS and BI) and two dimensions of service performance (service quality and competitive advantage). The empirical results demonstrate that the implementation of LIS and BI are critical attributes to improving the quality of the logistics service. In addition, a positive relationship is shown between service quality and competitive advantage, which implies that as an important determinant, service quality motivates the enhancement of competitiveness.

Regarding the theoretical view, the results show that ICT has no direct relationship with either service quality or competitive advantage. Drawing from MBV, the previous findings are supported that as most firms fear losing their privacy by sharing information through ICT, the adoption of ICT facilitates solely the internal operations but cannot provide real-time information sharing with other participants in the supply chain. This failure to use ICT throughout the region leads to a knowledge deficit regarding the external environmental changes and finally causes the loss caused by a high market barrier and loss of competitiveness. Drawing from the RBV, it is clear that since logistics companies do not adopt the same information-sharing formats, the ICT infrastructures of these companies are different from each other in the business network. Therefore, LSPs need to invest much time and money in designing, purchasing and managing new ICT infrastructure continuously, which severely obstructs the deployment of ICT solutions in a collaborative strategy along the supply chain.

From a practical standpoint, this study makes several contributions. At first, the results show that most LSPs have not realized the value of GIS and RFID in core logistics operations. Although many researchers stated that RFID has widely been applied in the logistics industry, the descriptive results of this study indicate that the implementation level of RFID technology is low in most of the logistics companies in HK and the PRD region. Second, the implementation level of four types of LIS (WMS, TeMS, LPS and TMS) shows a progressively decreasing pattern in the current logistics companies. However, the results show that WMS and TMS are considered to be the tools necessary for supporting the warehouse and delivery processes in the logistics industry.

Third, the results of the hypothetical model successfully serve as a roadmap for helping LSPs to improve their competitive competencies by highlighting the importance of logistics technologies. It is strongly suggested that LSPs focus on investing in the adoption of BI and LIS as both these technological capabilities can improve various logistics processes and service performance, and finally achieve long-term competitive advantage.

6.1. Limitations of this study

This study has a number of limitations that affect the consistency of the results. First, during the survey distribution period in year 2008, there was a serious economic crisis around the world. Hence, some of the responses might have been affected by such turbulence in the economy. Moreover, some reporting errors may have arisen due to a variety of personal or positional characteristics such as the respondent's job satisfaction, tenure, or lack of awareness of detailed operations throughout the organization (Bagozzi *et al*, 1991). Second, the statistical technique used to test the hypotheses was SEM, which has some limitations. Although the model of logistics technologies in improving service quality was built on a theory-based inference of causality between variables, the SEM cannot truly test for causality. Third, in the design of the questionnaire, there is still room for improvement in both content and format. With such improvement respondents could probably provide more practical and more accurate feedback.

6.2. Future research

There are a number of areas that can be explored as part of future research work in this subject area. First, in this study, the influences of technology implementation on service quality and competitive advantage demonstrate the concerns of MBV and RBV respectively, but a combined and holistic view is lacking. Hence, a second-order consequence factor, which presents a company's ability to make their market strategy compatible with the corporate competences, could be included in the model in some future research study. Second, since the adoption of technologies is not likely to succeed without human intervention and guidance, the success of the organization depends upon the alignment of the people with the appropriate tools and techniques to produce valued service based on a full understanding of the competitive market (Rosenzweig and Roth, 2007). Hence, a further study can focus on human factors (such as skills and expertise of IT employees) rather than technology development as determinants of superior logistics performance.

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References

Acur N and Bititci U (2004). A balanced approach to strategy process. *International Journal of Operations and Production Management* **24**(3/4): 388–408.

Aktas E, Agaran B, Ulengin F and Onsel S (2011). The use of outsourcing logistics activities: The case of Turkey. *Transportation Research Part C* **19**(5): 833–852.

Alt R, Fleisch E and Österle H (2000). Electronic commerce and supply chain management at ETA fabriques d'Ebauches. *Journal of Electronic Commerce Research* **1**(2): 67–78.

Avolio BJ, Yammarino FJ and Bassm BM (1991). Identifying common methods variance with data collected from a single source: An unresolved sticky issue. *Journal of Management* **17**(3): 571–587.

Bagozzi RP, Yi Y and Phillips LW (1991). Assessing construct validity in organizational research. *Administrative Science Quarterly* **36**(3): 421–459.

Baraldi E and Nadin G (2006). The challenges in digitalising business relationships. The construction of an IT infrastructure for a textile-related business network. *Technovation* **26**(10): 1111–1126.

Bardaki C, Kourouthanassis P and Pramatari K (2011). Modeling the information completeness of object tracking systems. *Journal of Strategic Information Systems* **20**(3): 268–282.

Barlas Y and Gunduz B (2011). Demand forecasting and sharing strategies to reduce fluctuations and the bullwhip effect in supply chains. *Journal of the Operational Research Society* **62**(3): 458–473.

Baron RM and Kenny DA (1986). The moderator-mediator variable distinction in social psychological research—Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology* **51**(6): 1173–1182.

Bharadwaj A (2000). A resource-based perspective on information technology capability and firm performance: An empirical investigation. *MIS Quarterly* **24**(1): 169–196.

Bobillo AM, López-Iturriaga F and Tejerina-Gaite F (2010). Firm performance and international diversification: The internal and external competitive advantages. *International Business Review* **19**(6): 607–618.

Bourne M, Mills J, Wilcox M, Neely A and Platts K (2000). Designing, implementing and updating performance measurement systems. *International Journal of Operations and Production Management* **20**(7): 754–771.

Bouwman AF, Van Drecht G and Van der Hoek KW (2005). Surface nitrogen balances and reactive N loss to the environment from global intensive agricultural production systems for the period 1970–2030. *Science in China. Ser. C. Life Sciences* **48**(2): 767–779.

Byrd TA and Davidson NW (2003). Examining possible antecedents of IT impact on the supply chain and its effect on firm performance. *Information and Management* **41**(2): 243–255.

Chang SC and Lee MS (2007). The effects of organizational culture and knowledge management mechanisms on organizational innovation: An empirical study in Taiwan. *The Business Review, Cambridge* **7**(1): 295–302.

Chang SJ, Van Witteloostuijin A and Eden L (2010). From the editors: Common method variance in international business research. *Journal of International Business Studies* **41**(2): 178–184.

Closs DJ and Savitskie K (2003). Internal and external logistics information technology integration. *The International Journal of Logistics Management* **14**(10): 63–76.

Craighead CW, Ketchen DJ, Dunn KS and Hult GTM (2011). Addressing common method variance: Guidelines for survey research on information technology, operations, and supply chain management. *IEEE Transactions on Engineering Management* **58**(3): 578–588.

Dyson LE and Koruth S (2004). Improving business performance through supply chain intelligence: An Australian perspective. In: Soliman KS (ed). Information Technology and Organizations in the 21st Century: Challenges & Solutions. *Proceedings of the 2004 International Business Information Management Conference*. IEEE, published online pp 342–348.

Elbashir MZ, Collier AP and Davern MJ (2008). Measuring the effects of business intelligence systems: The relationship between business process and organizational performance. *International Journal of Accounting Information Systems* **9**(3): 135–153.

Gangadharan GR and Swamy NS (2004). Business intelligence systems: Design and implementation strategies. *Proceedings of 26th International Conference on Information Technology Interfaces*. Cavtat, Croatia.

Golicic SL, Davis DF, McCarthy TM and Mentzer JT (2002). The impact of e-commerce on supply chain relationships. *International Journal of Physical Distribution and Logistics Management* **32**(10): 851–871.

Gu J, Goetschalckx M and McGinnis LF (2010). Solving the forward-reserve allocation problem in warehouse order picking systems. *Journal of the Operational Research Society* **61**(6): 1013–1021.

Hair JF, Anderson RE, Tatham RL and Black WC (1995). *Multivariate Data Analysis with Readings*. Prentice-Hall: Englewood Cliffs, NJ.

Hannula M and Pirttimaki V (2003). Business intelligence empirical study on the top 50 Finnish companies. *American Academy of Business* **2**(2): 593–599.

Helfat CE and Peteraf MA (2003). The dynamic resource-based view: Capability lifecycles. *Strategic Management Journal* **24**(10): 997–1010.

Herschel RT and Jones NE (2005). Knowledge management and business intelligence: The importance of integration. *Journal of Knowledge Management* **9**(4): 45–55.

Hofenk D, Schipper R, Semeijn J and Gelderman C (2011). The influence of contractual and relational factors on the effectiveness of third party logistics relationships. *Journal of Purchasing and Supply Management* **17**(3): 167–175.

Holter AR, Grant DB, Ritchie J and Shaw N (2008). A framework for purchasing transport services in small and medium size enterprises. *International Journal of Physical Distribution and Logistics Management* **38**(1): 21–38.

Hong KK and Kim YG (2002). The critical success factors for ERP implementation: An organization fit perspective. *Information and Management* **40**(1): 25–40.

Howell DC (2009). *Statistical Methods for Psychology*. 7th edn. Cengage Learning: Belmont, CA.

Hoyle RH (ed) (1995). Structural equation modeling approach: Basic concepts and fundamental issues. In: *Structural Equation Modeling: Concepts, Issues and Applications*. Sage Publications: Thousand Oaks, CA, pp 1–15.

Hsiao HI, Kemp RGM, Vorst JGAJ and Omta SWF (2010). A classification of logistic outsourcing levels and their impact on service performance: Evidence from the food processing industry. *International Journal of Production Economics* **124**(1): 75–86.

Iyer KN, Germain R and Frankwick GL (2004). Supply chain B2B e-commerce and time-based delivery performance. *International Journal of Physical Distribution and Logistics Management* **34**(8): 645–661.

Janoff B (2000). Click and stick. *Progressive Grocer* **79**(2): 61–64.

Jensen HS, Poulfelt F and Kraus S (2010). Managerial routines in professional service firms: Transforming knowledge into competitive advantages. *The Service Industries Journal* **30**(12): 2045–2062.

Kalakota R and Robinson M (2000). *e-Business*. Addison-Wesley: Reading, MA.

Kent JT and Mentzer JT (2003). The effect of investment in interorganizational information technology in a retail supply chain. *Journal of Business Logistics* **24**(2): 155–175.

Kim SW (2009). An investigation on the direct and indirect effect of supply chain integration on firm performance. *International Journal of Production Economics* **119**(2): 328–346.

Kilgore SS, Orlov LM and Nakashima T (2002). Grading apps for inventory and order visibility, *Forrester Research*, Cambridge.

Kline RB (1998). *Principles and Practice of Structural Equation Modeling*. The Guilford Press: New York.

Knoppen D, Christiaanse E and Huysman M (2010). Supply chain relationships: Exploring the linkage between inter-organisational

adaptation and learning. *Journal of Purchasing and Supply Management* **16**(3): 195–205.

Kuwaiti ME and Kay JM (2000). The role of performance measurement in business process re-engineering. *International Journal of Operations and Production Management* **20**(12): 1411–1426.

Lai KH, Wong CWY and Cheng TCE (2010). Bundling digitized logistics activities and its performance implications. *Industrial Marketing Management* **39**(2): 273–286.

Lewis I and Talalayevsky A (2000). Third-party logistics: Leveraging information technology. *Journal of Business Logistics* **21**(2): 173–185.

Li G, Yang H, Sun L and Sohal AS (2009). The impact of IT implementation on supply chain integration and performance. *International Journal of Production Economics* **120**(1): 125–138.

Lindell HK and Whitney DJ (2001). Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology* **86**(1): 114–121.

Liu CL and Lyons AC (2011). An analysis of third-party logistics performance and service provision. *Transportation Research Part E* **47**(4): 547–570.

Makhija M (2003). Comparing the resource-based and market-based views of the firm: Empirical evidence from Czech privatization. *Strategic Management Journal* **24**(5): 433–451.

McGinnis MA and Kohn JW (2002). Logistics strategy – revisited. *Journal of Business Logistics* **23**(2): 1–17.

Morgan AJ and Inks SA (2001). Technology and the sales force: Increasing acceptance of sales force automation. *Industrial Marketing Management* **30**(5): 463–472.

Naim M, Aryee G and Potter A (2010). Determining a logistics provider's flexibility capability. *International Journal of Production Economics* **127**(1): 39–45.

O'Leary-Kelly S and Vokurka RJ (1998). The empirical assessment of construct validity. *Journal of Operations Management* **16**(4): 387–406.

Panayides PM (2007). The impact of organizational learning on relationship orientation, logistics service effectiveness and performance. *Industrial Marketing Management* **36**(1): 68–80.

Pires GD and Aisbett J (2003). The relationship between technology adoption and strategy in business-to-business markets: The case of e-commerce. *Industrial Marketing Management* **32**(4): 291–300.

Podsakoff PM and Organ DW (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management* **12**(4): 531–544.

Podsakoff PM, MacKenzie SB, Lee JY and Podsakoff NP (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology* **88**(5): 879–903.

Richardson HA, Simmering MJ and Sturman MC (2009). A tale of three perspectives: Examining post hoc statistical techniques for detection and correction of common method variance. *Organizational Research Methods* **12**(4): 762–800.

Rosenzweig ED and Roth AV (2007). B2B seller competence: Construct development and measurement using a supply chain strategy lens. *Journal of Operations Management* **25**(6): 1311–1331.

Sanders NR and Premus R (2002). IT applications in supply chain organizations: A link between competitive priorities and organizational benefits. *Journal of Business Logistics* **23**(1): 65–83.

Saura IG, Molina MER and Francés DS (2008). Logistic service quality and technology: A comparison between supplier-retailer and retailer-consumer relationships. *The International Review of Retail, Distribution and Consumer Research* **18**(5): 495–510.

Savitskie K (2007). Internal and external logistics information technologies: The performance impact in an international setting. *International Journal of Physical Distribution and Logistics Management* **37**(6): 454–468.

Seufert A and Schiefer J (2005). Enhanced business intelligence – supporting business processes with real-time business analytics. In: *Proceedings of the 16th International Workshop on Database and Expert System Applications-DEXA'05*, pp 919–925. IEEE computer Society, doi:10.1109/DEXA.2005.86.

Shi N, Cheung RK, Xu H and Lai KK (2011). An adaptive routing strategy for freight transportation networks. *Journal of the Operational Research Society* **62**(4): 799–805.

Spector PE (2006). Method variance in organizational research: Truth or urban legend? *Organizational Research Methods* **9**(2): 221–232.

Sriram V and Stump R (2004). Information technology investments in purchasing: An empirical investigation of communications, relationship and performance outcomes. *Omega: The International Journal of Management Science* **32**(1): 41–55.

Tallon PP, Kraemer KL and Gurbaxani V (2000). Executives' perceptions of the business value of information technology: A process-oriented approach. *Journal of Management Information Systems* **16**(4): 145–174.

Teach E (2002). Working on the chain. *CFO* **18**(9): 83–90.

Thomsen E (2002). *OLAP Solutions: Building Multidimensional Information Systems*. 2nd edn John Wiley & Sons: New York.

Toyli J, Hakkinen L, Ojala L and Naula T (2008). Logistics and financial performance: An analysis of 424 Finnish small and medium-sized enterprises. *International Journal of Physical Distribution and Logistics Management* **38**(1): 57–80.

Vickery SK, Jayaram J, Droge C and Calantone R (2003). The effects of an integrative supply chain strategy on customer service and financial performance: An analysis of direct *versus* indirect relationships. *Journal of Operations Management* **21**(5): 523–539.

Wade M and Hulland J (2004). Review: The resource-based view and information systems research: Review, extension, and suggestions for future research. *MIS Quarterly* **28**(1): 107–142.

Wang N, Zhang N and Wang M (2006). Wireless sensors in agriculture and food industry—recent development and future perspective. *Computer and Electronics in Agriculture* **50**(1): 1–14.

Webb BR and Schlemmer F (2008). Predicting web services performance from internet performance: An empirical study of resources and capabilities in e-business SMEs. *Journal of Knowledge Management* **12**(6): 137–154.

Wong CWY, Lai K-H and Cheng TCE (2009). Complementarities and alignment of information systems management, and supply chain management. *International Journal of Shipping and Transport Logistics* **1**(2): 156–171.

Wong CY and Karia N (2010). Explaining the competitive advantage of logistics service providers: A resource-based view approach. *International Journal of Production Economics* **128**(1): 51–67.

Yan L, Zhang Y, Yang LT and Ning HS (2008). *The Internet of Things: From RFID to the Next-Generation Pervasive Networked Systems*. Auerbach Publications: New York.

Zhang AN, Goh M and Meng F (2011). Conceptual modeling for supply chain inventory visibility. *International Journal of Production Economics* **133**(2): 578–585.

Zhao M and Stank TP (2003). Interactions between operational and relational capabilities in fast food service delivery. *Transportation Research E* **39**(2): 161–173.

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