Logistics quality management practices and performance of international distribution centre operators

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Abstract: This study quantitatively examines the enabler and performance outcomes of logistics quality management in the context of international distribution centre operators based on absorptive capacity theory. A total 110 usable surveys were collected by the questionnaire survey and a two-step structural equation modelling (SEM) approach including confirmatory factor analysis (CFA) was subsequently employed to evaluate the values of logistics quality management. The results of SEM show that logistics information integration is positively related to the implementation of logistics quality management, which in turn has a positive impact on logistics services and organisational performance. Findings also confirm the mediating roles of logistics quality management and logistics service performance in this study.

Keywords: absorptive capacity theory; logistics information integration; logistics quality management; LQM; structural equation modelling; SEM.

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1 Introduction

Quality management (QM) practices are widely employed by enterprises to increase their competitiveness (Soltani et al., 2011; O'Neill et al., 2016). Poor quality reflected in product defects or service failures cause not only financial losses and production shutdown, but also irreparable damage of reputation and customer loyalty (Yang and Sung, 2016; Subhashini and Preetha, 2018; Huo et al., 2019). It was found that the cost of poor quality is as high as 20% of sales for manufacturing and service companies in the 1980s (Crosby, 1980). In a logistics network, international distribution centres (IDC) are intermediate storage points for the receipt of materials shipped by suppliers to support manufacturing. An IDC thus can be defined as a place that integrates operations of manufacturing with logistics activities aiming to achieve efficient and reliable distribution of commodities (International Maritime Organization, 1991; Lu and Yang, 2010). By providing a large number of logistics services to shippers such as storage, consolidation, documentation services, cargo tracking and value-added services, it can integrate the entire logistics systems and delivering high-quality services to customers (Lu, 2003; Ecklund, 2010; Gotzamani et al., 2010). Although outsourcing logistics activities to third-party logistics providers seems to be a win-win strategy, it is imperative for enterprises to be concerned about the issue of hidden costs of outsourcing (Burton, 2013).

Notably, service failures are not amenable to rework and often result in losing the customers. For example, the logistics service failures at Boeing caused them to fall behind on their production schedule of its 787 Dreamliner and resulted in the financial losses of 10 billion USD (Huo et al., 2019). The Interactive Media in Retail Group's (IMRG) research also indicated that poor-quality deliveries cost the UK economy £771 million in direct costs in 2014, and hidden cost of poor deliveries is approximately £5,300 per lost customer (MacLeod, 2015). Given the fact that logistics costs account for between 20% and 50% of a firm's total operating expenses (Estavillo, 2006), ensuring the quality of logistics activities are crucial for firms to gain competitive advantage (Brah and Lim, 2006.)

The attention to logistics service quality has shifted from intra-organisational focus to supply-chain-wide focus (Soltani et al., 2011; Soares et al., 2017). Particularly, all logistics activities in the international supply chain largely depend on the speed of information exchange. Thus, by adopting information and communication technologies, IDC operators effectively integrate their logistics activities and operations in the logistics system. Information integration is essential to ensure partners work together to provide high-quality services in a logistics system. Notably, the implementation of logistics quality management (LQM) requires organisational capacity to maintain and mobilise inter-organisational resources across the supply chain (Sirmon et al., 2011). To successfully implement LQM to improve logistics performance, it is imperative for IDC operators to have an ability to coordinate with other parties via information integration to exploit and share external information and further to assimilate and apply it to implement LQM ends (Cohen and Levinthal, 1990; Frohlich and Westbrook, 2001). In particular, absorptive capacity theory asserting integration can help firms assimilate and apply new knowledge and practices can support the relevance of this theory to LQM for IDCO operators (Cohen and Levinthal, 1990).

The best way to avoid quality-related costs is to practice proactive prevention by adopting QM. While the topic of QM has gained considerable attention and found its values on logistics and organisational performance (Lin et al., 2005; Brah and Lim, 2006; Kaynak and Hartley, 2008; Xie et al., 2011; O'Neill et al., 2016; Soares et al., 2017; Huo et al., 2019), most of these studies were conducted from the view of manufactures. Obviously, investigations on QM from the logistics service providers' view are very limited and the important role of information was seldom examined. Since the implementation of QM practices requires organisational capacity and result in poor financial performance in short-term (Klingenberg et al., 2013; O'Neill et al., 2016), it is reasonable and worthy to investigate the mediating effect of QM between information integration and performance outcomes. It is also important to note that China-based logistics research on the topic of QM is limited and few papers that have applied the theory to address logistics issues in logistics journals (Liu, 2014). Thus, the purpose of this study is applying the absorptive capacity theory as theoretical background to assess the antecedent and performance outcomes of LQM practices for IDC operators.

This study contributes to the literature in three ways. First, while previous studies have extended QM to the logistics filed, this paper applied the organisational theory to theorise the antecedent and performance outcomes of LQM in the logistics sector and collected quantitative data to validate relationships. Second, all logistics activities in international supply chain management largely depend on speed of information sharing and exchange. A major contribution of this study is thus applying absorptive capacity to examine how firms coordinate with other parties via internal and external information

integration to improve logistics and organisational performance. Lastly, an in-depth examination into the mediating effect of LQM on the relationship between information integration and performance outcomes can provide insights into the business value of LQM. Thus, drawing on absorptive capacity theory, this study contributes to a better understanding of the origination antecedent of LQM and examines its effect on logistics service and organisational performance in the context of IDC operators.

2 Theoretical background and research hypotheses

2.1 Absorptive capacity theory

Given an open logistics system, logistics service providers coordinate with other organisations for providing high quality logistics service. Information sharing across organisations is particularly needed for decision-making when coordinating activities under such an uncertain environment (Cegielski et al., 2012). Thus, the need for providing high quality services is driving logistics service providers to leverage intra-organisational and inter-organisational partnerships for sharing information and, ultimately QM knowledge creation (Malhotra et al., 2005; Wong et al., 2011). In other words, a firm improves its organisational absorptive capacity to exploit external information. The concept of absorptive capacity originates in the macroeconomics. It referees to the ability of an economy to absorb and apply external information and resources (Adler, 1965). Cohen and Levinthal (1990, p.128) extending this concept to organisations and defining absorptive capacity as "the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends".

Absorptive capacity is embodied in a firm's communication capabilities – spanning both internal and external communication. It has been proven to have a direct impact on organisational innovation (Lee and Song, 2015) and a moderating effect on the relationship between supply chain integration and supply chain performance (Tarifa-Fernández et al., 2019). Given the fact that integration and connectedness help identify, assimilate and apply new and valuable external knowledge, logistics service providers thus coordinate with other organisations via the integration of information (Lai et al., 2010), which in turn facilitate the implementation of LQM. Hence, the absorptive capacity theory is useful for explaining the relationship between a firm's logistics information integration and its QM system enables the organisations to make use of the information they collect from their activities to boost their performance.

2.2 Logistics information integration

Logistics information integration has garnered attention among both logistics practitioners and academics (Wei et al., 2012). It is characterised by electronic linkages and integrated information sharing within and beyond organisational boundaries to facilitate coordination with logistics partners (Kulp et al., 2004). Well-integrated logistics information can provide timely, accurate, and standardised data exchanges across internal and external organisational functions to improve logistics service performance (Bernstein and Hass, 2008).

Major linkages in a logistics system are supplier linkage, internal linkage, and customer linkage (Flynn et al., 2010). Typically, two levels of logistics information

integration are identified: internal and external information integration (Zhao et al., 2011; Wong et al., 2011). Internal information integration refers to spanning internal functional boundaries and facilitating the sharing of timely and accurate logistics information across the key functions within business units (Wong et al., 2011). External information integration goes beyond organisational boundaries to facilitate logistics information sharing and communication between logistics partners, including customers (Wong et al., 2011, 2015).

2.3 Logistics quality management

As logistics quality is viewed as a key component in achieving competitive advantage, the concept of total quality management (TQM) has been extended into the logistics and supply chain management context (Sohal et al., 1999; Brah and Lim, 2006; Kaynak and Hartley, 2008; Huo et al., 2019). LQM is a set of management activities that focus on managing and delivering a consistent logistics service quality to customers. Accordingly, LQM can be defined as a system-based approach to the continuous improvement of all logistics processes, logistics services, and work cultures for creating total customer value and satisfaction through the participation of all members in the supply chain (Foster, 2008).

Although prior studies did not meet a consensus of a common set of LQM practices, LQM is typically operationalised as a multidimensional construct (Nair, 2006). Aquilani et al. (2017) conducted a systematic literature review on critical success factors of TQM. They found that leadership, customer focus, training and education, quality data and reporting, supplier management, process management, continuous improvement, strategic planning, organisational culture, and employee involvement were the most important ten critical success factors of QM. They also found that despite the different approaches and samples, the most important components of QM identified by researchers were relatively similar. Basically, researchers can measure LQM practices from internal and external perspectives. The internal view mainly focuses on process management, employees, continuous improvement, data and information usage, and strategic planning. Conversely, the external view emphasises relationships with customers, suppliers, and other partners (Kaynak and Hartley, 2008).

To effectively integrating their logistics activities in the logistics system, a close relationship with supply chain partners should be built. Thus, the partner relationship was considered and adopted in this study to measure the LQM. Moreover, it is important to note that most previous studies on developing QM practices have been based on the management principles of the international standard for QM (ISO 9000: 2008) and the criteria of the Malcolm Baldrige National Quality Award (MBNQA, 1995) (Loke et al., 2012). Based on Aquilani et al.'s (2017) work and criteria of MBNQA and ISO, our study thus adopts an eight-dimension scale consisting of both internal and external perspectives to comprehensively measure LQM.

2.4 Logistics service performance

Service performance refers to the value that is added to a logistics service provider through the delivery of a number of services, such as storage, cargo tracking, an inland transport service, a custom clearance service, a packing, and documentation service to customers (Lu and Yang, 2010). The value added typically should be reflected in the

cost, quality, flexibility, and delivery (Ho et al., 2002). Thus, to bridge a logistics service quality gap and increase customer satisfaction, performance analysis is needed during the process of providing these services. Moreover, several service performance indicators, such as reliability, customer response, quality, cost, and flexibility were viewed as crucial criterial to the selection of 3PLs (Ho et al., 2002; Brah and Lim, 2006; Chu et al., 2016; Yang, 2016).

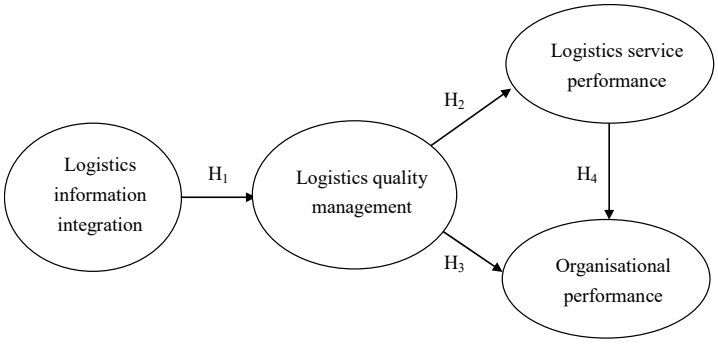
Thus, to comprehensively measure the performance of logistics service activities, logistics service providers must incorporate multiple indicators in defining their performance (Dess and Robinson, 1984; Chow et al., 1994). The indicators most commonly used by researchers to measure logistics service performance were also identified as availability, reliability, flexibility, timeliness, responsiveness, reduced costs, and value-added services (Brah and Lim, 2006; Rodrigues et al., 2011; Yang, 2016).

2.5 Organisational performance

Performance analysis helps an organisation to measure the efficiency of resource allocation and the outcome of corporate objectives. To systematically manage an organisation's performance, a composite measure of performance is widely used (Dess and Robinson, 1984). Financial and non-financial measures are the dimensions most commonly adopted by researchers and practitioners to measure organisational performance (Venkatraman and Ramanujam, 1986; Chow et al., 1994).

QM has been acknowledged as a crucial driver to superior organisational performance, specifically in terms of customer service and business performance (Yeung, 2008; Yang, 2016). Customer service performance, the recommended and commonly used performance measures in QM research are service quality, customer complaints, customer relations, and customer satisfaction (Yeung, 2008; Sadikoglu and Zehir, 2010; Yang, 2016; Pang and Lu, 2018). Financial performance is mainly measured in terms of market share, sales growth, productivity, and profit growth (Yeung, 2008; Kaynak and Hartley, 2008; Yang, 2016; Pang and Lu, 2018).

Figure 1 Conceptual model



2.6 Research framework and hypotheses

Drawing on absorptive capacity theory and previous studies on QM, Figure 1 shows a conceptual model portraying the network of relationships among the latent factors and the research hypotheses. A rationale for the proposed linkages is provided below.

2.6.1 The relationship between logistics information integration and LQM

Good integration and collaboration with suppliers and customers is one of the most efficacious means of extending QM practices to a whole logistics system (Anderson et al., 1994). The implementation of LQM depends on a substantial amount of information on the design, production and service activities of firms (Matta et al., 1998). Advanced information technology and information sharing have been proven to facilitate the implementation of LQM (Prajogo and Olhager, 2012; Tran et al., 2012). Accordingly, high levels of logistics information integration can enable the timely dissemination of logistics information to relevant logistics partners and greater coordination of the firms' logistics activities with these partners, hence improving the overall worth of LQM. Therefore, we propose that:

H1 Logistics information integration has a positive effect on the implementation of LQM.

2.6.2 The relationships between LQM, logistics service performance, and organisational performance

QM practices have been proven to improve logistics operations and organisational performance (Lin et al., 2005; Pantouvakis and Psomas, 2016). Brah and Lim (2006) found that TQM firms had good performance on quality, technology, and overall business than non-TQM companies. In addition, high technology TQM firms performed significantly better than low technology firms on operational and overall business performance. Ecklund (2010) noted that warehousing efficiency and effectiveness lead to optimise the existing production and distribution processes which in turn reduce costs and improve service quality.

Improving the quality of logistics operations thus will improve operational performance in relation to product/service quality, customer response, system efficiency, service flexibility and reliability, and reduced logistics costs (Closs and Savitskie, 2003; Brah and Lim, 2006; Gotzamani et al., 2010; Pantouvakis and Psomas, 2016). A higher QM performance is thus expected to lead to high quality logistics services (Gotzamani et al., 2010). Moreover, several studies have concluded that there is a positive correlation between QM and organisational performance (Gotzamani et al., 2010). Thus, a higher level of LQM implementation can contribute to superior organisational performance in terms of financial and non-financial performance. Accordingly, we have formulated the following propositions:

H2 LQM has a positive effect on IDC operators' logistics service performance/

H3 LQM has a positive effect on IDC operators' organisational performance.

Service quality is viewed as the crucial factor influencing the choice of logistics service providers. Thus, a high-quality logistics service is the key driver in superior

organisational performance (Gotzamani et al., 2010). Specifically, logistics service quality has been proven to contribute to customer satisfaction (Anderson et al., 1998), and to customer loyalty (Saura et al., 2008; Kumar et al., 2011). Moreover, Green et al. (2008) argued that logistics service performance has a positive impact on marketing and financial performance. Therefore, we propose that:

H4 Logistics service performance has a positive effect on IDC operators' organisational performance.

2.6.3 The mediating role of LQM and logistics service performance

Integrated information sharing within and across organisations can facilitate the coordination in the logistics systems (Wong et al., 2015). Such integration thus makes information available for timely dissemination to implement QM which in turn influences organisational performance. QM has been proven to play a mediating role and indirectly influence organisational performance in prior studies (Musenze et al., 2013; Al-Dhaafri et al., 2014). Moreover, information integration is a strategic action that beneficial to implement LQM by enhancing a firm's ability to better coordinate their operations which in turn influences organisational performance (Wong et al., 2011). Therefore, we propose that:

H5 LQM mediates the relationship between logistics information integration and organisational performance.

Although a direct relationship between QM and organisational performance has been proven in previous studies (Gotzamani et al., 2010; Shafiq, 2014), several researchers had also considered the indirect effect of QM. For example, Kaynak (2003) noted that the effect of QM practices on financial performance and marketing performance was mediated by operating performance. Kersten and Koch (2010) also pointed out that the QM had a positive effect on logistics service quality, which in turn influences business success. Accordingly, the effect of LQM on organisational performance could be indirect and be mediated through logistics service performance. Therefore, we propose that:

H6 Logistics service performance mediates the relationship between LQM and organisational performance.

3 Methodology

3.1 Questionnaire design and measures

Data for this study were collected by a questionnaire survey which was designed based on Churchill and Iacobucci's (2010) study. All measures in this study were drawn from previous studies and discussed with logistics experts for ensuring the validity. The questionnaire has been replicated in Appendix A. Two-dimensional with a ten-item instrument was used to measure logistics information integration in terms of internal and external information integration. As regards LQM, an eight-dimension scale with 32 items identified from previous studies was used in this study. The participants were asked for their response to items pertains to logistics information integration and LQM using a

five-point Likert scale, ranging from 1 meaning 'strongly disagree' to 5 meaning 'strongly agree'.

The four-item and six-item scales were adapted from previous studies to measure logistics service and organisational performance, respectively. The respondents were asked to rate how well they considered their company's performance in respect to logistics service and organisational performance relative to their major competitors, using a five-point Likert scale where 1 corresponded to 'worse than competitors' and 5 to 'better than competitors'.

The final step of questionnaire design is pre-testing and a pilot study. A three-stage pre-test was conducted for improving questionnaire design and seeking to enhance the validity and reliability of the survey instrument. First, the draft questionnaire was discussed with three logistics experts who are studying EMBA program on Shipping and Transportation Management in National Kaohsiung University of Science and Technology. Second, personal interviews with five logistics executives and experts from IDCs in Taiwan were conducted. Finally, we conducted a pilot test with 20 logistics executives from the aforementioned IDCs for improving the questionnaire. After combining all their opinions and suggestions, no particular confusion with respect to format or wording used was found. Thus, the content validity was deemed adequate.

3.2 Sampling techniques

The sample of IDC operators was selected from the *Directory of Members of Taiwan Association of Logistics Management*. In total, 418 IDCOs which were involved in distribution centre and warehousing businesses were identified and selected as our research samples. An initial mailing of the survey with a covering letter and a postage-paid return envelope was distributed to 418 managers or their executives which were listed as contact members in the director in Taiwan. After two rounds of mailings, 117 questionnaires had been received, a response rate of 28.0%. However, seven responses were disqualified due to significant incompletion. Thus, the total number of usable responses was 110, a response rate of 26.3% that is comparable to empirical studies in supply chain and operations management (Yu and Cooper, 1983).

3.3 Bias issues

It is important to deal with the potential problem of non-response bias in this study. A t-test recommended by Armstrong and Overton (1977) was performed to compare early (n = 78, 70.9%) and late (n = 32, 29.1%) respondents based on response wave. Results, as shown in Appendix A, show there were no significant differences between the two groups' perception of agreement with the various measures at $p < 0.05$, suggesting non-response bias does not seem to be a problem in this study.

Another issue is that as data was collected from single informants, this could have led to common method variance (CMV) bias (Podsakoff et al., 2003). First, the respondents were assured that they would be anonymous, in order to encourage them to answer as honestly as possible. Moreover, as 68.2% of the respondents were managers or held even more senior positions, they were considered to be knowledgeable enough to provide the information required. Finally, a Harman's one factor test was conducted to evaluate if a

significant amount of variance was common across all items. Results indicate that common method bias is not a significant problem with this data, because the independent and dependent variables loaded on different factors, with the first factor only accounting only accounted for 22.26% of total variance. The CMV problem was therefore mitigated in this study (Podsakoff et al., 2003).

3.4 Research methods

Considering structural equation modelling (SEM) approach is a more powerful method than other multiple methods because it can effectively deal with multicollinearity and has been widely employed to validate the hypotheses (Rigdon, 1998), a two-step SEM approach was employed to test the hypotheses. The first step involved performing the confirmatory factor analysis (CFA) to assess the validity of the measurement model. Once the measurement model was refined and validated, the second step required estimating the structural model between latent variables. All analyses were carried out using the SPSS 18.0 for Windows and AMOS 18.0 statistical packages.

3.5 Characteristics of responses

Profiles of the respondents' companies and their characteristics were displayed in Table 1. Results indicate that more than 68% of responses held managers/assistant managers or more senior positions at their organisations. Moreover, nearly 73% of the respondents had worked for their organisations for more than six years. As managers are actively involved in and anchor operations, combined with the high percentage with long employee tenure, this indicates they had sufficient practical experience and knowledge about their firms' QM practices, implying the reliability of the survey findings.

Table 1 Demographic characteristics of respondents

Demographic characteristics	*Number of respondents*	*Percentage of respondents*
Job title		
Vice president or above	40	36.4
Manager/assistant manager	35	31.8
Director/vice director	16	14.6
Clerk	7	6.3
Other	12	10.9
Employee tenure (years)		
1–5	30	27.3
6–10	23	20.9
11–15	19	17.3
16–20	16	14.5
Over 21	22	20.0

Notes: [a] One U.S. dollar equals approximately 30.0 New Taiwanese (NT) dollars.
[b] Represents six respondents who did not provide this information.

Table 1 Demographic characteristics of respondents (continued)

Demographic characteristics	*Number of respondents*	*Percentage of respondents*
Age of firm (years)		
1–5	17	15.5
6–10	19	17.3
11–15	15	13.6
16-20	10	9.1
Over 21	49	44.5
Number of employees		
Less than 50	48	43.6
51~100	13	11.8
101~500	35	31.8
Over 501	14	12.8
Annual revenue of firm (million NT$[a])[b]		
Less than 50	28	26.9
50~100	20	19.2
101~500	35	33.7
Above 501	21	20.2

Notes: [a] One U.S. dollar equals approximately 30.0 New Taiwanese (NT) dollars.
[b] Represents six respondents who did not provide this information.

Table 1 shows that 44.5% of the respondents' firms had been in operation for more than 21 years at the time of the questionnaire. Approximately 43.6% of the firms employed fewer than 50 employees, and 12.8% had more than 501 employees. The respondents were also asked to provide their companies' annual revenue. Results show 33.7% of the respondents reported their firm's annual revenue as between NT$101 million and NT$500 million, while 20.2% of the companies' annual revenue was greater than NT$501 million.

4 Analysis and results

4.1 Descriptive statistics, correlation analysis, and reliability test

Table 2 summarises the descriptive statistics, corrected item-total correlation (CITC) coefficients, and Cronbach's alpha values. Customer focus (mean = 4.330) was perceived as the most agreeable dimension of LQM implemented by the IDC operators, followed by leadership (mean = 4.317), involvement of employees (mean = 4.173), continuous improvement (mean = 4.152), process management (mean = 4.141), strategic planning (mean = 4.109), partner relationships (mean = 4.075), and quality data reporting (mean = 4.073).

Table 2 Correlations, mean, standard deviations and reliability test

Dimensions	*II*	*EI*	*CF*	*LS*	*IOE*	*PM*	*CI*	*SP*	*QD*	*PR*	*LSP*	*FP*	*CSP*
Internal information integration (II)	1												
External information integration (EI)	0.734**	1											
Customer focus (CF)	0.660**	0.673**	1										
Leadership (LS)	0.707**	0.741**	0.804**	1									
Involvement of employees (IOE)	0.664**	0.623**	0.738**	0.800**	1								
Process management (PM)	0.698**	0.707**	0.684**	0.809**	0.709**	1							
Continuous improvement (CI)	0.678**	0.691**	0.767**	0.839**	0.766**	0.790**	1						
Strategic planning (SP)	0.688**	0.693**	0.717**	0.779**	0.685**	0.825**	0.858**	1					
Quality data reporting (QD)	0.733**	0.732**	0.697**	0.807**	0.711**	0.845**	0.858**	0.893**	1				
Partner relationships (PR)	0.625**	0.704**	0.707**	0.776**	0.694**	0.753**	0.842**	0.828**	0.840**	1			
Logistics service performance (LSP)	0.537**	0.518**	0.526**	0.584**	0.507**	0.538**	0.578**	0.590**	0.589**	0.564**	1		
Financial performance (FP)	0.249**	0.166	0.261**	0.267**	0.328**	0.273**	0.334**	0.324**	0.291**	0.275**	0.445**	1	
Customer service performance (CSP)	0.370**	0.360**	0.396**	0.410**	0.384**	0.410**	0.447**	0.451**	0.466**	0.414**	0.696**	0.495**	1
Number of items	5	5	4	4	4	4	4	4	4	4	4	3	3
Mean	4.095	3.824	4.33	4.317	4.173	4.141	4.152	4.109	4.073	4.075	4.009	3.715	4.048
S.D.	0.709	0.793	0.609	0.657	0.644	0.656	0.691	0.715	0.71	0.71	0.605	0.564	0.602
Cronbach alpha	0.916	0.944	0.914	0.918	0.902	0.924	0.903	0.926	0.904	0.912	0.862	0.787	0.892
Range of corrected item-total correlation	0.679 ~ 0.852	0.782 ~ 0.920	0.759 ~ 0.853	0.802 ~ 0.822	0.736 ~ 0.832	0.758 ~ 0.874	0.748 ~ 0.803	0.753 ~ 0.869	0.732 ~ 0.839	0.707 ~ 0.835	0.659 ~ 0.748	0.552 ~ 0.719	0.731 ~ 0.838

Note: ** Correlation is significant at the 0.001 level (two-tailed).

The correlation analysis was performed to have an initial understanding of whether correlations exist between 13 research dimensions. Table 2 showed that with the exception of one correlation pair (external logistics information and financial performance), the significant correlations were found among the variables at the 0.01 level. Results also indicate that eight LQM practices were found to have significant positive relations with the logistics service and customer service performance at the medium correlations levels, whereas a significant low correlation level was found between LQM practices and financial performance.

A reliability test based on CITC and Cronbach's alpha statistics was performed to examine the internal consistency and reliability of each dimension. Table 2 shows that all the CITC scores were well above 0.5, confirming that each item measured the same underlying construct (Koufteros, 1999; Hair et al., 2010). Moreover, the Cronbach alpha values of the 13 factors were well above the suggested threshold of 0.7, confirming a satisfactory level of reliability in research (Churchill and Iacobucci, 2010). However, the aforementioned techniques do not allow either for the assessment of unidimensionality, convergent validity, or discriminant validity (Koufteros, 1999). A CFA, discussed in Section 4.2, with a multiple-indicator measurement model was therefore used to ensure validity (Anderson and Gerbing, 1988).

4.2 Analysis of the measurement model

Prior to testing the research hypotheses, a CFA was conducted to justify the measurement model. With the exception of logistics service performance construct, other constructs were treated as higher order constructs (second-order) in this study. Therefore, a summated scale was created by combining several individual items into a single composite measure. Thus, separate items respect to each dimension were summed and averaged as observed variables for SEM analysis.

The chi-square (χ^2 = 140.686) is the basic index to measure model fit. Moreover, a number of fit indices were also commonly used to examine the model fit. Results show an adequate model fit with the fit indices of normed chi-square (χ^2/df = 1.436), goodness-of-fit index (GFI) = 0.855, adjusted goodness-of-fit index (AGFI) = 0.799, comparative fit index (CFI) = 0.973, normed fit index (NFI) = 0.917, incremental fit index (IFI) = 0.973, Tucker-Lewis index (TLI) = 0.967, root mean square residual (RMR) = 0.016, and root mean square error of approximation (RMSEA) = 0.063 (Hu and Bentler, 1999; Hair et al., 2010). Though the GFI and AGFI were below the recommended level of 0.9, the incremental fit indices such as CFI, NFI, TLI, were well above the recommended level of 0.9, suggesting a marginal acceptance can be given to this measure (Iacobucci, 2010). In addition, the normed chi-square (χ^2/df) also had a value of 1.436 and fell well within the recommended range of 2 for model parsimony, and the RMR and RMSEA values were all below the cut-off value of 0.08. Accordingly, all these fit indices for the proposed model provided sufficient support for the results to be deemed an acceptable representation of the hypothesised constructs.

The measurement model was further assessed for its unidimensionality, validity, and reliability. Unidimensionality was assessed by a CFA. Table 3 shows the results: the CFI, TLI, IFI, and NFI values were well above the recommended cut-off value of 0.90, and the RMR and RMSEA values bellowed the recommended threshold of 0.08, suggesting all the constructs were unidimensional (Anderson and Gerbing, 1998; Hu and Bentler, 1999).

Table 3 Results of CFA analysis

Latent variables	*Factors*	*Standardised factor loading*	*S.D.*	*Critical ratio*	*R2*	*AVE*
ξ1 LII	Internal logistics information integration	0.847	0.080	10.980	0.718	0.734
	External logistics information integration	0.866	-	-	0.751	
η1 LQM	Customer focus	0.812	0.060	12.540	0.659	0.781
	Leadership	0.898	0.055	16.345	0.806	
	Involvement of employees	0.807	0.063	12.380	0.651	
	Process management	0.882	0.057	15.470	0.777	
	Continuous improvement	0.927	0.053	18.165	0.859	
	Strategic planning	0.918	0.057	17.541	0.842	
	Quality data reporting	0.932	-	-	0.868	
	Partner relationships	0.886	0.061	15.687	0.785	
η2 LSP	LSP 1	0.716	0.127	7.832	0.512	0.612
	LSP 2	0.792	0.097	8.866	0.627	
	LSP 3	0.823	0.099	9.298	0.678	
	LSP 4	0.795	-	-	0.632	
η3 OP	Financial performance	0.559	0.113	5.244	0.313	0.547
	Customer service performance	0.884	-	-	0.782	

Notes: LII: logistics information integration; LQM: logistics quality management; LSP: logistics service performance; OP: organisational performance; Fit index: χ^2 = 140.686, df = 98, χ^2/df = 1.436, RMR = 0.016, RMSEA = 0.063, NFI = 0.917, RFI = 0.899, IFI = 0.973, TLI = 0.967, CFI = 0.973.

Convergent validity can be assessed by the critical ratio (CR) values that are statistically significant for the factor loadings, item reliability, and average variance extracted (AVE) (Koufteros, 1999; Hair et al., 2010). Table 3 shows that all the CR values were significant for the factor loadings at the 0.05 level. All the item reliability values (R^2 values) met the 0.3 criterion, providing evidence of convergent validity (Yang et al., 2009). In addition, a complementary measure used alongside convergent validity is the AVE showing directly the amount of variance captured by the construct in relation to the amount of variance due to the measurement error. Table 3 shows that the AVE values ranged from 0.547 to 0.781, exceeding the 0.50 threshold value (Fornell and Larcker, 1981; Hair et al., 2010). Thus, all of the above indices effectively suggest all the indicators measured the same construct and provide satisfactory evidence of convergent validity and unidimensionality for each one (Anderson and Gerbing, 1988).

To assess discriminant validity, we compared the AVE with the squared correlation between the constructs. Table 4 shows that the highest squared correlation was observed between LII and LQM at 0.677. This is apparently lower than their individual AVEs: 0.734 and 0.781, respectively, implying the items share more common variance with their respective construct than any variance shared with other constructs (Fornell and Larcker,

1981; Hair et al., 2010). Accordingly, the results demonstrate the discriminant validity of the study constructs. Finally, to assess whether the specified indicators sufficiently represented the construct, an estimate of composite reliability was conducted. Table 4 shows that all of the constructs displayed composite reliabilities in excess of the 0.7 recommended value (Hair et al., 2010).

Table 4 Discriminant validity and composite reliability

Constructs	*Composite reliability*[a]	*ξ1: LII*	*η1: LQM*	*η2: LSP*	*η3: OP*
ξ1: LII	0.846	*0.734*[b]			
η1: LQM	0.966	0.677[c]	*0.781*		
η2: LSP	0.863	0.320	0.388	*0.612*	
η3: OP	0.697	0.128	0.215	0.441	*0.547*

Notes: [a] Composite reliability = (sum of standardised loading)^2 / [(sum of standardised loading)^2 + (sum of indicator measurement error)]; indicator measurement error can be calculated as 1 – (standardised loading)^2; [b] The AVE value is on the diagonal; [c] squared correlation.

4.3 SEM: hypotheses testing

After confirming and establishing a good model fit for the proposed model, we examine the hypothesised relationships. The data adequately supports the estimated model with good fit indices of χ^2/df = 1.426, GFI = 0.854, CFI = 0.973, NFI = 0.916, TLI = 0.968, RMR = 0.017, and RMSEA = 0.063.

Table 5 Results of SEM

Relationships	*Unstd. estimate*	*S.E.*[a]	*CR*[b]	*P*	*Supported*
LII → LQM	0.744[c]	0.083	8.926	0.000**	Yes
LQM → LSP	0.717	0.108	6.637	0.000**	Yes
LQM → OP	–0.049	0.076	–0.637	0.524	No
LSP → OP	0.545	0.129	4.213	0.000**	Yes

Notes: [a] SE is an estimate of the standard error of the covariance.
[b] CR is the critical ration obtained by dividing the covariance estimate by its standard error.
[c] The underlined values are critical ratios exceeding 1.96 at the 0.05 level of significance.
Fit indices: χ^2 = 142.593 (p = 0.003), df = 100, χ^2/df = 1.426, CFI = 0.973, IFI = 0.973, TLI = 0.968, RFI = 0.899, RMR = 0.017, RMSEA = 0.063.

Table 5 summarises the results of the hypotheses testing, showing that all the hypothesised relationships were significant, except for the path from LQM to organisational performance. As can be seen in Table 5, logistics information integration (β estimate = 0.744, C.R. > 1.96) was found to have a significantly positive impact on LQM. LQM (β estimate = 0.717, C.R. > 1.96) was found to have a significantly positive influence on logistics service performance, and logistics service performance (β estimate = 0.545, C.R. > 1.96) was also found to have a significantly positive influence on organisational performance. However, we did not find a significant positive relationship between LQM (β estimate = –0.049, C.R. < 1.96) and organisational performance.

4.4 Analysis of mediating effect

Although there is a lack of support for a relationship between LQM and organisational performance, a significant relationship exists between the former and logistics service performance. This work finds that LQM may influence logistics service performance, which in turn indirectly affects organisational performance. A mediation analysis was therefore conducted to determine whether LQM and logistics service performance play an intermediary role in the relationship between logistics information integration and organisational performance. Following the works of James et al.'s (2006) and Paulraj (2011), the proposed model was compared with two models in SEM, namely a full mediation model (Model 1) and a partial mediation model (Model 2).

Table 6 shows that Model 2 exhibited a better model fit than the proposed model and Model 1. All the hypothesised relationships in Model 1 are significant, whereas the paths from LII to LSP, LII to OP, and LQM to OP are not significant after LQM and LSP were treated as a mediating variable. Moreover, Model 1 and Model 2 produce a similar chi-square value ($\Delta\chi^2 = 2.317$, df = 3), thus the full mediating effect is supported (Hair et al., 2010). Furthermore, two direct models (Model 3 and Model 4) were proposed to examine the mediating roles of LQM and LSP. As shown in Table 6, only the effect of LII on OP is not significant. Hence, there is evidence that LQM fully mediates the relationship between logistics information integration and logistics service performance (H5) and that logistics service performance fully mediates the relationship between LQM and organisational performance (H6).

Table 6 Results of SEM-based mediation analysis

Paths	*Proposed model*	*Model 1*	*Model 2*	*Model 3*	*Model 4*
LII → LQM	0.871**	0.871**	0.870**	-	-
LQM → LSP	0.629**	0.624**	0.432*	0.552**	-
LQM → OP	–0.063	-	0.170	-	0.146**
LSP → OP	0.802**	0.744**	0.822**	-	0.704**
LII → LSP	-	-	0.204	0.148**	-
LII → OP	-	-	–0.256	-	–0.105
χ^2 (df)	142.593 (100)	143.003 (101)	140.686 (98)	242.078 (75)	319.586 (101)
CFI	0.973	0.973	0.973	0.888	0.862
RMR	0.017	0.017	0.016	0.147	0.179
RMSEA	0.063	0.062	0.063	0.143	0.141

Notes: **significant at the $p < 0.05$ level; *significant at the $p < 0.1$ level.

5 Discussion and conclusions

5.1 Discussion

As service quality plays an increasingly important role in a logistics system, it is essential to better understand the antecedent and effect of LQM in the context of IDCs. The main findings of this study are as follows.

Using SEM, a positive significant relationship was found between logistics information integration and LQM (H1), implying a high level of information integration within business units and between organisations can facilitate the implementation of QM in a logistics system. In particular, information integration is the critical driver for successful IDC operations and the IT has been widely applied in QM, which is consistent with that of previous studies (Wong et al., 2011; Prajogo and Olhager, 2012).

The results also demonstrate that LQM has a significantly positive effect on logistics service performance (H2). Thus, extending QM practices to the supply chain level can ensure logistics service quality and make logistics service providers more proactive in meeting customers' requirements (Love et al., 2003). Again, this finding is consistent with that of previous studies (Brah and Lim, 2006; Gotzamani et al., 2010; Pantouvakis and Psomas, 2016; Soares et al., 2017).

Providing high-quality logistics services is logistics service providers' core remit. A significantly positive effect was found between logistics service performance and organisational performance (H4) in this study. This implies IDC operators have to provide a high-quality service in terms of accuracy, reliability, and speed in the logistics value-added process to sustain long-term relationship with customers, which in turn improves organisational performance. This finding is also consistent with that in previous studies (Anderson et al., 1998; Green et al., 2008; Saura et al., 2008; Gotzamani et al., 2010; Rashid and Haris Aslam, 2012).

The direct influence of LQM on IDC operators' organisational performance (H3) is not supported in this study. The plausible reason for this is the application of IT for QM increase costs in short term. Thus, there is no significantly positive effect existing between LQM and organisational performance, which is consistent with previous studies (Klingenberg et al., 2013). The findings also show a significantly positive relationship associated with logistics service performance. Accordingly, there is evidence to believe that the implementation of LQM can indirectly affect IDC operators' organisational performance, mediated by logistics service performance. Thus, H6 is supported in this study, which is consistent with previous studies (Kaynak, 2003; Lin et al., 2005; Kersten and Koch, 2010). Moreover, this study also demonstrates that LQM mediates the relationship between logistics information integration and logistics service performance (H5), which is consistent with previous studies (Musenze et al., 2013; Al-Dhaafri et al., 2014; Wong et al., 2015). The result is also in line with the absorptive capacity theory positing logistics service providers can assimilate and apply the information collected from logistics activities to effectively implement LQM practices which in turn enhance logistics service quality and organisational performance.

5.2 Research and practical implications

This study has a number of practical implications for IDC operators. First, logistics information integration is found to have a positive impact on LQM, consisting with previous studies asserting that information technology is the critical driver for successful QM and distribution centre operations (Ecklund, 2010). Considering the importance of logistics information integration, IDC operators might consider integrating new IT in their logistics and having a well-established information system for delivering high-quality services to customers. Specifically, to make a data-oriented supply chain, the new technologies in handling big data and block chain might be acquired to assimilate

logistics information internally and externally across international supply chains to facilitate the logistics operations.

Second, LQM was found to have a positive impact on logistics service performance. Thus, IDC operators are advised to adopt a LQM system for improving their service quality in the logistics value-added processes. Moreover, in line with prior studies, customer focus was ranked as top one LQM practices in this study and IDC operators were therefore suggested to build a closer and long-term relationship with their customers for information sharing. Meanwhile, there is evidence to suggest that closer links with partners ensures high logistics services quality and improves organisational performance for the supply chain partners.

Third, this study indicates that IDC operators can enhance the accuracy in data and documentation, logistics service reliability, and customer response speed by implementing LQM practices, significantly improving organisational performance. Creating a culture to ensure high logistics service quality through advanced information technology and LQM practices is a requirement for IDC operators in this competitive marketplace (Srinivasan and Kurey, 2014).

Finally, although LQM was not found with a direct positive impact on organisational performance, a mediating role of LQM and logistics service performance was proved in this study. Result implies that the implementation of LQM indirectly affects organisational performance. It is imperative for IDC operators to adopt information integration and LQM practices to improve their logistics service performance, which in turn enhance organisational performance. Hence, logistics information integration can help IDC operators assimilate and apply new knowledge to QM and improvement in service performance, market share, customer satisfaction, and competitive advantage.

From a theoretical perspective, this study contributes to the literature by the theoretical development of the absorptive capacity theory to examine the relationship between information integration and LQM, demonstrating that logistics information integration is one of the antecedents to the successful implementation of LQM. Moreover, this study has found that LQM mediates the relationship between logistics information integration and logistics service performance and that the latter mediates the relationship between LQM and organisational performance.

5.3 Limitations and future study

Like other empirical studies, this study has a number of limitations. First, this study examines the LQM issue mainly from the view of logistics service providers specifically focused on IDC operators. Future research including other supply chain members is needed to generalise the results. Second, different sized logistics service providers may have different resources and capabilities for implementing LQM practices (Lu and Yang, 2010). Thus, future research could examine the drivers and barriers to implementing such LQM practices. Finally, the application of IT in QM might impose additional costs to the enterprises (Klingenberg et al., 2013; O'Neill et al., 2016). Future research should examine under what extend it is good to have IT in QM program and what degree of information integration LQM affects performance.

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Appendix A

Questionnaire items

1 Logistics information integration measures. (Please indicate how much you agree to the following statements relating to information integration practices in your company based on a five-point scale; 1 = strongly disagree to 5 = strongly agree). (*Source:* Wong et al., 2011).

Item no.	*Measures*	*Early (N = 78)*	*Late (N = 32)*	*P value*
		Mean	*Mean*	
1	IT applications within our company are linked to a centralised database.	4.269	4.094	0.302
2	Electronic information shared within our company is accurate.	4.233	3.969	0.091
3	Electronic information shared within our company is timely.	4.064	3.938	0.506
4	Our company's IT infrastructure is capable of meeting our current business needs.	4.064	3.969	0.593
5	Our company has formal procedures to manage our IT infrastructure.	4.115	3.844	0.106
6	Our company exchanges information with our suppliers and customers electronically.	3.923	3.778	0.413
7	Our company works with our suppliers and customers electronically on cross-organisational business activities.	3.756	3.711	0.817
8	Electronic information shared between our company and our suppliers and customers is accurate.	3.830	3.649	0.357
9	Electronic information shared between our company and our suppliers and customers is timely.	3.840	3.618	0.231
10	Electronic information shared between our company and our suppliers and customers is standardised.	3.948	3.936	0.941

2 Logistics quality management measures. (Please indicate how much you agree with the following statements relating to logistics quality management practices in your company based on a five-point scale where 1 = strongly disagree to 5 = strongly agree). (*Sources*: Sadikoglu and Zehir, 2010; Aquilani et al., 2017).

Item no.	*Measures*	*Early (N=78)*	*Late (N=32)*	*P value*
		Mean	*Mean*	
1	Our company knows our customers' current and future needs.	4.231	4.063	0.258
2	Our company frequently contacts our customers.	4.282	4.125	0.280
3	Our company maintains a close and long-term relationship with our customers.	4.397	4.156	0.117
4	Satisfying our customers and meeting their expectations is the most important thing we do.	4.654	4.375	0.092
5	Top managers set clear goals for improving logistics service quality.	4.346	4.156	0.235
6	Top managers efficiently allocate resources to improve logistics service quality.	4.321	4.125	0.193
7	Top managers are supportive of suggestions for improving the way things are done.	4.389	4.219	0.278
8	Top managers commit to logistics service quality improvement through involvement in quality activities.	4.423	4.250	0.251
9	Employees are encouraged to propose ideas for improving logistics service quality in our company.	4.231	4.188	0.777
10	Employees are strongly committed to logistics service quality improvement in our company.	4.077	4.125	0.749
11	Employees are involved in making decisions on how to improve quality in our company.	4.038	4.125	0.595
12	Our company is committed to informing employees of the importance of logistics service quality.	4.385	4.156	0.136
13	Our company establishes a continuous logistics service improvement program of processes based on objective analysis of operational performance.	4.115	4.188	0.618
14	Our company employs processes capability to reduce time spent on logistics operations.	4.179	4.188	0.959
15	Our company employs processes capability to reduce the costs of logistics operations.	4.208	4.188	0.891
16	Our company uses statistical techniques to reduce the occurrence of logistics service failures.	4.064	4.000	0.703
17	Continuous logistics service quality improvement is an important goal of our company.	4.474	4.188	0.110
18	Our company continually looks for better ways of providing logistics services, to avoid errors.	4.372	4.219	0.345
19	Our company implements comprehensive logistics service quality improvement plans.	4.013	3.906	0.529

Item no.	*Measures*	*Early (N=78)*	*Late (N=32)*	*P value*
		Mean	*Mean*	
20	Our company uses reports from internal and external audits for logistics service quality improvement.	3.949	3.813	0.431
21	Our company emphasises continuous improvement in our logistics service quality system.	4.167	4.094	0.661
22	Our company has a clear logistics service quality manual and documentation procedure.	4.026	3.906	0.496
23	Our company has a clear set of logistics operation instructions.	4.143	4.063	0.630
24	Our company ensures logistics service quality throughout the supply chain.	4.218	4.094	0.437
25	Our company manages data/information (e.g., on customer complaints, defects, errors) to support logistics service quality improvement efforts.	4.115	3.875	0.190
26	Data/information on quality management is accessed and applied in a timely manner in our company.	4.115	4.000	0.462
27	Our company employs procedures to ensure the reliability and consistency of data/information gathering.	4.091	4.031	0.717
28	Senior managers regularly review the company's performance and use it as a basis for decision-making in our company.	4.128	4.000	0.464
29	Our company maintains long-term relationships with our supply chain partners.	4.269	4.125	0.377
30	Our company sets service quality as the major criteria for selecting supply chain partners.	4.194	4.000	0.254
31	Our company regularly audits supply chain partners' service quality to improve our organisational performance.	4.091	4.000	0.577
32	Our company makes supply chain partners involved in the logistics service development process.	3.857	3.906	0.785

3 Logistics service performance measures. (Please evaluate your company's logistics service performance in the following areas relative to your major competitors based on a five-point scale where 1 = worse than competitors to 5 = better than competitors). (*Sources:* Brah and Lim, 2006; Rodrigues et al., 2011).

Item no.	*Measures*	*Early (N = 78)*	*Late (N = 32)*	*P value*
		Mean	*Mean*	
1	Accuracy in data and documentation.	4.026	4.250	0.097
2	Service reliability.	4.103	4.094	0.950
3	Customer response speed.	4.038	4.000	0.808
4	Value-added service.	3.805	3.844	0.826

4 Organisational performance measures. (Please evaluate your company's performance in the following areas relative to your major competitors based on a five-point scale where 1 = worse than competitors to 5 = better than competitors). (*Sources:* Lin et al., 2005; Yeung, 2008; Kaynak and Hartley, 2008; Pang and Lu, 2018).

Item no.	*Measures*	*Early (N = 78)*	*Late (N = 32)*	*P value*
		Mean	*Mean*	
1	Service quality.	4.051	4.125	0.618
2	Customer satisfaction.	4.077	4.031	0.723
3	Customer loyalty.	4.051	3.906	0.315
4	Profit rate.	3.705	3.750	0.750
5	Sales growth rate.	3.731	3.813	0.503
6	Market share.	3.628	3.781	0.352