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Logistics Innovation and Integration: Impact on Supply Chain Adaptability

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Purpose: *This study investigates the relationships among innovation by logistics services provider (LSP), user's supply chain (SC) adaptability, and the level of the user-provider relationship integration. Using low integrated, standard contractual relationships as a reference group, this study assesses how moderately integrated partnerships and highly integrated strategic relationships moderate the impact of LSP's innovation on the user's SC adaptability.*

Methodology: *Moderated partial least squares structural equation modeling (PLS-SEM) was performed on survey data collected from 48 Sudanese companies.*

Findings: *The findings revealed that innovation by LSPs had the greatest positive impact on SC adaptability in firms maintaining a moderate level of logistics integration. Interestingly, firms highly integrated with their LSPs witnessed a reduced effect of logistics innovation on their SC adaptability. In other words, while user-provider partnerships reinforced the impact of LSPs' innovation on user's SC adaptability, strategic relationships weakened this impact.*

Originality: *Extant literature advocates fully integrating with LSPs to build a responsive, efficient SC. Nevertheless, the complexities of managing a highly integrated relationship with LSPs may pose challenges that exceed the expected benefits of such relationships. This study provides empirical evidence that moderate, rather than full, integration with LSPs may yield greater benefits for the users of logistics services.*

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1 Introduction

Fueled by population urbanization and the increasing prevalence of e-commerce, the demand for logistics services is exploding (Amling and Daugherty, 2018), placing tremendous pressure on logistics services providers (LSPs) to enhance their processes and become as competitive as never before. Broadly defined as all helpful services that are new in the eye of the beholder (Flint et al., 2005), logistics innovation is therefore becoming an imperative in the new economy in order to improve the bottom-lines of LSPs and win customers loyalty (Chapman, Soosay and Kandampully, 2002; Flint et al., 2005; Grawe, Chen and Daugherty, 2009; Wallenburg, 2009; Wagner and Sutter, 2012; Asian et al., 2019).

Over the past decade, logistics services user-provider relationships have witnessed a remarkable shift away from the traditional short-term transactions toward relationships that are strategic in nature (Premkumar, Gopinath and Mateen, 2020). Such integration is emerging as an innovative approach in inter-firm relationship management (Yang and Zhao, 2016) since standard contractual logistics relationships are not expected to foster innovation (Chen, Jin and Huo, 2020). Due to their short-term and adversarial nature (Cox, 1996; Halldórsson and Skjøtt-Larsen, 2004), firms now strive to go beyond such “arm's length” relationships with a minimum of information interchange (Skjoett-Larsen, 2000) to build closer relationships with competent LSPs to reap the benefits of their competence (Bhatnagar and Viswanathan, 2000).

With an accelerated pace of change in the business landscape, building efficient supply chains (SCs) is no longer sufficient (Christopher and Holweg, 2011). SC adaptability is therefore considered a prerequisite for sustaining competitive advantage (Eckstein et al., 2015; Feizabadi, Gligor and Alibakhshi Motlagh, 2019; Gligor et al., 2020). The purpose of this study is to examine how SC adaptability is affected by LSP’s innovation and integration. Specifically, this study investigates the effect of LSPs innovation on SC adaptability at moderate and high levels of user-provider relationship integration, compared to low level of integration.

The remaining of this study is organized as follows. First, the theoretical underpinnings and subsequent hypotheses development are presented. Next, the methodology of the

study is explained, followed by presentation of the findings and their discussion. Finally, the managerial implications, limitations and future research directions are provided.

2 Theory and Hypotheses

To enable greater focus on core competencies and service improvement, firms outsource their logistics function (Maloni and Carter, 2006). Having some or all of the logistics activiteis managed and executed by LSPs makes the users increasingly dependent on their LSPs as their entire SC perfromance is affected by the quality of LSPs‘ services (Giri and Sarker, 2017). Following a Resource Denedepnce perspective (Pfeffer and Salancik, 1978), integraion is therefore proposed as an effective strategy to manage inter-organizational relationships and mitigate adverse consequences of asymmetric power/dependencies and uncertainties in a SC (Zhang and Huo, 2013; Huo et al., 2015; Perdana, Ciptono and Setiawan, 2019).

2.1 Logistics Services User-Provider Relationships

A common understanding in literature is that logistics services user-provider relationships are placed on a continuous scale ranging from single transactions to integrated service agreements, and that the degree of logistics integration, including the level of formalization and mutual obligations, is proportional to the level of required skills and the associated asset specificity (Bowersox, 1990; Cox, 1996; Hertz and Alfredsson, 2003; Halldórsson and Skjøtt-Larsen, 2004; Hsiao et al., 2010; König, Caldwell and Ghadge, 2019).

The lowest level of user-provider relationships is the contractual relationships. These merely transactional arrangements offer standardized services and are characterized by short-term orientation and low asset specificity, targeting mainly cost reductions (Cox, 1996; Halldórsson and Skjøtt-Larsen, 2004). User-provider partnerships represent a higher level of logistics relationships. Offering customized services selected from a broad range of standard services, this type of relationships typically targets access to complementary skills, and usually involves low/medium asset specificity since the

services can easily be adjusted to other clients (Halldórsson and Skjøtt-Larsen, 2004; Hsiao et al., 2010). The highest level of user-provider relationships are the strategic relationships. Unlike previous engagements, the logistics solutions provided in this relationship are unique and jointly developed. The two parties invest in long-term oriented specific assets often involving human as well as physical assets. The innovation capabilities are "essential" in this type of relationships, and both parties are willing to share information, coordinate processes, and solve problems jointly (Halldórsson and Skjøtt-Larsen, 2004; Hsiao et al., 2010; König, Caldwell and Ghadge, 2019).

2.2 Innovation in Logistics Services User-Provider Relationships

Firms innovate to face the accelerating change and competition in today's turbulent environment. A provider of logistics services is no exception (Grawe, Chen and Daugherty, 2009), as it strives to design superior solutions that "exceed those of its competitors and of the customer itself [to] survive the selection process" (Wallenburg, 2009, p.77). Logistics innovation refers to everything that is different from a company's current practice, and is used for improving logistics operations (Flint et al., 2005; Grawe, 2009; Daugherty, Chen and Ferrin, 2011). This includes ideas, technology, and services, as well as procedures, processes, and practices (Flint et al., 2005; Grawe, 2009). The advantages of logistics innovation are numerous, as it can improve LSPs' relationships with its customers (Flint et al., 2005), promote customer satisfaction and loyalty (Asian et al., 2019), and help LSPs expand their businesses and achieve higher profitability (Wagner and Sutter, 2012).

The mere reaction to expressed customer demands was prevalent in the logistics industry (Flint et al., 2005; Wagner, 2008). This conduct is no longer sufficient in logistics services user-provider relationships, as users increasingly expect new and innovative solutions from their LSPs (Langley and Infosys, 2020, 2021). Improvements specified to customer requirements help LSPs maintain a stronger user-provider relationship and an overall better performance (Large, Kramer and Hartmann, 2011), especially when initiated by the LSPs (Deepen et al., 2008). This type of proactive innovation that occurs in an ongoing user-provider relationship is a special type of LSP's innovation

(Wallenburg, 2009). Unlike "pure" innovation targeting operational efficiency of the LSPs themselves, or "market" innovation intended to increase the competitiveness of the LSPs, this relationship-specific innovation directly impacts a single customer and is directed towards the improvement of logistics solutions without prior request from the customer (Wallenburg, 2009). Proactive innovation in logistics relationships does not only lead to the achievement of goals, but it also result in benefits exceeding the main targets (Deepen et al., 2008), resulting in increased customer loyalty (Wallenburg, 2009).

Logistics Innovation and SC Adaptability

The logistics outsourcing decision was previously driven by efficiency targets and better resource allocation (Skjoett-Larsen, 2000). Today's driving forces are more strategic in nature, and are directed towards facing increasing SC complexity (Hsiao et al., 2010) and improving flexibility towards the changing market conditions (Langley and Infosys, 2019). LSP's innovation capability enables it to incorporate logistics innovation to solve problems and adapt in such fluctuating SC environment (Wang et al., 2020). LSPs can utilize unique and innovative solutions to achieve the targeted adaptability without sacrificing their bottom-lines (Amling and Daugherty, 2018). The use of Open E-Logistics Standards (OELS), for example, were proposed as an "effective boundary-spanning mechanism" to integrate various SC activities and leverage process adaptability (Pu, Wang and Chan, 2020). Another example is the technology-based, on-demand pick-up locations that enable highly adaptable networks (Amling and Daugherty, 2018).

As discussed above, general innovation is expected to improve the logistics outsourcing performance. This study investigates the effect of proactive innovation on a specific aspect of the user's performance, i.e., its SC adaptability. This study thus proposes the following hypothesis:

H1. LSP's proactive innovation is positively associated with the user's SC adaptability

2.3 The Role of Logistics Integration

Integration is the essence of supply chain management (SCM) (Perdana, Ciptono and Setiawan, 2019). It can be described as the collaborative management of independent value-adding processes both inside and outside firms' boundaries (Flynn, Huo and Zhao,

2010). Firms integrate, i.e., create linkages and share knowledge and resources, internally among different departments as well as externally with their suppliers, customers, and logistics service providers (Flynn, Huo and Zhao, 2010).

Driven by volatility of the business environment and the increasing demands of customers, the development of strategic orientation is taking root in logistics services user-provider relationships (Yang and Zhao, 2016; Premkumar, Gopinath and Mateen, 2020). Users of logistics services invest in relationship specific assets with their LSPs to face uncertainties of demand and supply (Huo et al., 2018). Coupled with a high level of integration, this recipe is expected to trigger innovation is logistics services user-provider relationships (Wagner and Sutter, 2012; Pedrosa, Blazevic and Jasmand, 2015). Thus, a logistics services user can boost its operational performance when integrating with its LSPs (Hofer, Smith and Murphy, 2014). From an LSPs perspective, integration improves operational performance (Hemstrom, 2014) and financial performance (Huo et al., 2017). Offering integrated logistics solutions also enables LSPs to negotiate a higher price for their services (König, Caldwell and Ghadge, 2019). Ultimately, integration will bring benefits for both the user and provider of logistics services.

Since integrated logistics relationships put the user-provider relationship "at the center of a firm's strategic and operational thinking" (Panayides and So, 2005), this study proposes that when firms advance their relationship with LSPs into higher levels of integration, i.e., engage into partnerships or strategic relationships, the positive impact of LSPs innovation on users' SC adaptability will be strengthened. More specifically, the following hypotheses are proposed:

- H2a. The relationship between LSP's proactive innovation and user's SC adaptability is stronger for firms engaging in user-provider partnerships compared to contractual relationships.
- H2b. The relationship between LSP's proactive innovation and user's SC adaptability is stronger for firms engaging in strategic user-provider relationships compared to contractual relationships.

The figure below (Figure 1) illustrates the conceptual framework of the study.

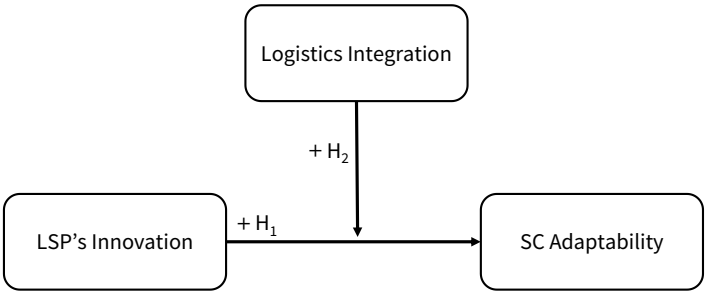

Figure 1: Conceptual framework

3 Methodology

3.1 Sample and Data Collection

The data was collected from a sample of Sudanese companies via a survey instrument. The city of Khartoum was the target for data collection. Questionnaires were hand-delivered to 146 managers from 66 firms. A total of 134 questionnaires were retrieved. Six questionnaires were discarded due to incompleteness, yielding a response rate of 88 percent. Since the unit of analysis for this study is the firm, responses from the same firm were reduced to one using the criteria of 'the middle manager with the longest experience', resulting in 64 responses. Out of the 64 remaining firms, 16 firms did not use logistics outsourcing, so they were also excluded from the analysis. The final sample of Sudanese companies included 48 companies.

The analysis of the sample demographics showed that a quarter of the firms were from the Food and Beverages industry, and another quarter were from the Petroleum, Chemical, and Medical industries. The sampled firms were relatively new, as 57 percent of them were founded after the year 2000. Finally, the majority of firms (63%) were of medium size (100 – 999 employees). Table 1 provides the details of the sample demographics.

Table 1: Sample Demographics

Industry	N	%	Firm size	N	%
Food and Beverages	12	25.0	Less than 100	6	12.5
Petroleum, Chemical, and Medical Products	12	25.0	100 – 999	30	62.5
Nonmetallic Products	1	2.1	More than 1000	8	16.7
Electrical and Electronic Products	1	2.1	Missing	4	8.3
Metal Products and Machinery	2	4.2	Total	48	100.0
Finance and Insurance	3	6.3	Firm age	N	%
Wholesale and Retail	2	4.2	1951 – 2000	17	35.4
Telecommunication	7	14.6	2000 ~	25	52.1
Others	8	16.7	Missing	6	12.5
Total	48	100.0	Total	48	100.0

3.2 Measurement

Pre-validated measures were used in this study. Construct items were measured using a 7-points Likert scale (1 = strongly disagree/much worse, 7 = strongly agree/much better). SC adaptability (SCAdpt) was measured a three-item reflective construct. The items were adapted from Pu, Wang and Chan (2020). Respondents were asked to compare to their closest competitor(s) their firms' ability to adapt its SC relationships, business priorities, and activities to respond to different changes in the market and the external environment. Logistics innovation (LSPInn) was measured using a four-item reflective

construct. The items were adapted from Deepen et al. (2008). Respondents were asked to indicate their level of agreement with statements reflecting the innovativeness and proactive improvements made by their LSPs. Logistics Integration was measured using a categorical/factor variable developed based on previous literature (Hsiao et al., 2010; Liu et al., 2015; Halldórsson and Skjøtt-Larsen, 2004). Respondents were asked to choose one out of three statements describing the relationship with their LSPs, including the type(s) and nature of used services, and the major target for the engagement in the relationship. The statements correspond to three levels of integration: low integrated contractual relationships using standard services with a focus on efficiency (reference group), moderately integrated partnerships using customized services with a focus on access to complementary resources (PRTNship), and highly integrated strategic relationships using advanced services with a focus on flexibility (STREship). Firms' sizes (number of employees) and industry (Manufacturing = 1, non-manufacturing = 0) were included as control variables. Table 2 presents the descriptive statistics and correlations among the variables of the study.

Table 2: Descriptive Statistics and Correlations

	Mean	SD	1	2	3	4	5
1. Size	658.06	1272.54	1.000				
2. Industry	n.a	n.a	0.237**	1.000			
3. SCAdpt	5.278	1.153	-0.145	-0.037	1.000		
4. LSPInn	5.255	1.063	-0.101	-0.088	0.480**	1.000	
5. PRTNship	n.a	n.a	0.181	0.184	-0.022	-0.045	1.000
6. STREship	n.a	n.a	-0.189**	-0.108	0.181	0.255**	-0.475**

n = 48, **p<0.05

4 Analysis and Results

Partial least squares structural equation modelling (PLS-SEM) using SmartPLS (Ringle, Wende and Will, 2005) was used for the analysis of this study. PLS-SEM is a popular and powerful method in the Marketing and Management research (Hair et al., 2014) with the ability to handle small sample sizes (Hair, Ringle and Sarstedt, 2011; Hair et al., 2014, 2019). For these reasons, it was chosen as the analysis method in this study.

Since the data was collected from single informants, the presence of common method bias must be checked. The occurrence of a VIF greater than 3.3 is proposed as an indication that a model may be contaminated by common method bias (Kock, 2015). The highest VIF score among constructs was 1.25, indicating that the model is free of common method bias.

4.1 The Measurement Model Assessment

The indicator loadings of the two constructs, SCAdpt and LSPInn, ranged from 0.73 to 0.96, above the recommended level of 0.708 (Hair et al., 2019). Cronbach's alfa (α) and composite reliability (CR) scores were good, as they exceeded the recommended level of 0.70 and are below the level of 0.95, indicating internal consistency reliability (Hair et al., 2019). The convergent validity of the constructs was established as average variance extracted (AVE) scores exceeded 0.50 (Hair et al., 2019). Finally, the heterotrait-monotrait (HTMT) ratio of the correlations was 0.55, far below the threshold of 0.90 (Henseler, Ringle and Sarstedt, 2015) indicating discriminant validity. According to these results (see Table 3), the measurement model meets all the required criteria (Hair et al., 2019).

Table 3: Measurement Model Assessment

Constructs and Items	Loadings
LSPInn (α = 0.87, CR = 0.81, AVE = 0.64)	

LSPInn1	0.78
Constructs and Items	Loadings
LSPInn2	0.73
LSPInn3	0.89
LSPInn4	0.78
SCAdpt (α = 0.91, CR = 0.94, AVE = 0.85)	
SCAdpt1	0.96
SCAdpt2	0.92
SCAdpt3	0.88

4.2 The Structural Model Assessment

Before proceeding to the structural model assessment, the collinearity of indicators and constructs were examined using variance inflation factor (VIF) scores. Since none of the VIF scores exceeded 5 (Hair et al., 2019), no collinearity issue was detected.

To test the study's hypotheses, three models were developed (see Table 4). In all models, no effects of control variables (size and industry) were detected. In the Model 1, the direct effect of the independent variable, LSPInn, and the two moderators (PRTNship and STREship) on the dependent variable, SCAdpt were examined. The results presented in Table 4 show that LSPInn positively impacts SCAdpt (β = 0.459, p-value = 0.000) and explains about 20 percent of the variance in SCAdpt (R^2 = 0.242, adjusted R^2 = 0.191), providing support for the first hypothesis (H1). The two moderators show no effect on the dependent variable, SCAdpt.

In Model 2, the effect of LSP's innovation on user's SC adaptability at a moderate level of integration, i.e., the moderating effect of user-provider partnerships was tested. As

shown in Figure 2 and Table 4, the interaction term LSPInn*PRTNship was positive (β = 0.363, p-value = 0.004), indicating that the relationship between LSPInn and SCAdpt is strengthened in logistics services user-provider partnerships. The percentage of the explained variance in the dependent variable (SCAdpt) increased to almost 30 percent (R^2 = 0.369, adjusted R^2 = 0.294). This positive moderating effect renders the second hypothesis (H2a) acceptable.

In Model 3 (see Figure 3 and Table 4), the effect of LSP's innovation on user's SC adaptability at a high level of integration, i.e., the moderating effect of strategic user-provider relationships was tested. The interaction term LSPInn*STREship was, surprisingly, negative (β = -0.352, p-value = 0.004) with an improved percentage of explained variance from the original 20 percent in Model 1 (R^2 = 0.335, adjusted R^2 = 0.256). This result provides support for the exact opposite of the third hypothesis (H2b), meaning that the relationship between LSPInn and SCAdpt is weakened, rather than enforced, for firms engaging in strategic user-provider relationships compared to contractual relationships. Thus, H2b is not supported.

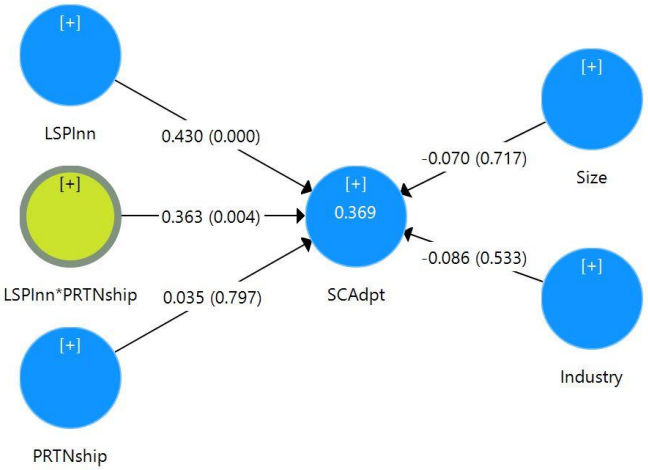

Figure 2: The effect of LSP's innovation on SC adaptability at a moderate level of integration

Table 4: Analysis Results

Path	Model 1	Model 2	Model 3
LSPInn→ SCAdpt	0.459***	0.430***	0.425***
PRTNship → SCAdpt	0.045	0.035	
STREship → SCAdpt	0.069		0.133
LSPInn*PRTNship → SCAdpt		0.363***	
LSPInn*STREship → SCAdpt			-0.352***

** p<0.05, ***p<0.01

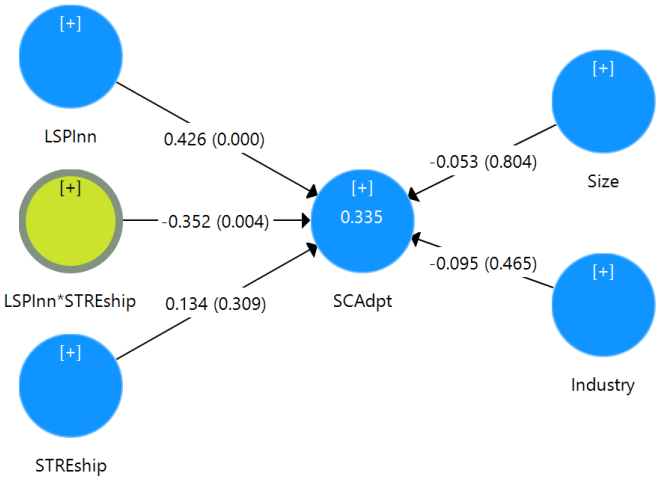

Figure 3: The effect of LSP's innovation on user's SC adaptability at a high level of integration

5 Discussion

Users of logistics services rely on LSPs' competencies, including their innovativeness, to enhance their own competitive positioning (Bhatnagar and Viswanathan, 2000). In strategic logistics relationships, such reliance is greater as users expect LSPs to drive innovation and continuously improve logistics solutions (Flint et al., 2005; Langley and Infosys, 2020, 2021).

This study investigated the impact of proactive innovation by LSPs on SC adaptability. The findings support previous research (e.g., Amling and Daugherty, 2018; Wang et al., 2020) that LSPs innovation drives higher capabilities, including adaptability. This study contributes to the literature by providing empirical evidence that such impact of LSP's innovation on SC adaptability is moderated by the depth of the relationship between the user and the provider of logistics services.

As suggested by the findings, a moderate, rather than high, level of logistics integration provides the highest benefit for the user in terms of SC adaptability. More specifically, logistics services user-provider partnerships characterized by a moderate level of integration reinforced the positive impact of LSPs innovation on SC adaptability.

Contrary to the proposed hypothesis, strategic user-provider relationships weakened the innovation-adaptability relationship. Although it may be puzzling at first glance, some explanations could be suggested to understand such unexpected finding.

From a context perspective, the findings were based on a sample from the Sudanese business environment, which is characterized by many sources of political and economic complexities (The World Bank, 2021). These traits may justify why the management of strategic, long-term relationships could be demanding and thus bring more challenges than benefits for the user. This conclusion is consistent with evidence found in the literature (e.g., Yang and Zhao, 2016) associating market volatility and uncertainty with decreased integration in logistics outsourcing relationships.

Additionally, the success of outsourcing advanced logistics services is contingent upon the availability of proper outsourcing management processes (Zhu et al., 2017). Basic logistics services, however, can provide benefits for the user in terms of cost reduction

and delivery performance without such management processes (Zhu et al., 2017). It is possible that users upgrading their relationships with LSPs from contractual to strategic relationships underestimate the need for appropriate selection, performance measurement and control processes based on their previous experiences with basic logistics services, leading to failure in achieving the required efficiency and flexibility targets when outsourcing advanced logistics services.

Furthermore, strategic user-provider relationships may prevent users from switching to other viable providers when necessary due to the creation of a "lock-in" effect (Schmitz, Schweiger and Daft, 2016), leading to reduced flexibility and adaptability to market changes. Based on the previous discussion of the study findings, we can conclude that, ironically, strategic relationships targeting flexibility do not only fail to achieve this target, but they also reduce logistics innovation's contribution.

6 Conclusion

The aim of this study was to investigate the impact of LSP's proactive innovation on SC adaptability, and to assess this impact on various levels of logistics services user-provider relationships. The findings confirmed the positive effect of LSP's innovation on SC adaptability, and revealed that this effect is strengthened in user-provider partnership characterized by a moderate level of logistics integration. An interesting finding was that, contrarily to the expectation of an even stronger positive effect, the relationship between LSP's innovation and SC adaptability was weakened at strategic relationships with LSPs, indicating a negative moderating effect of high logistics integration.

7 Practical Implications

User of logistics services usually extend their relationships with LSPs in order to flexibly gain complementary resources and improve their SC adaptability to various changes in the environment. However, as indicated by the findings of this study, these advantages may not always be attained. In managing logistics services user-provider relationships, users must pay attention to possible drawbacks of a strategic, long-term relationship

with an LSP and carefully balance these with the expected advantages. In a turbulent business environment such as what we witness nowadays, SC managers could be advised to engage in moderate integration with SC partners, including LSP's, in order to mitigate the adverse consequences associated with strategic long-term commitments.

8 Limitations and Future Research Directions

The limitations of this study can be used to direct future research. The results of this study were based on a single-country sample, imposing limitations to possible generalizability. Moreover, cross-sectional data used in the study may, by their very nature, prevent the exploration of longer-term effects. Also, the classification of logistics integration levels in this study was based on three distinct categories, i.e., contractual relationships, partnerships, and strategic relationships. In practice, however, such distinction is not as clear since "intermediate forms are often difficult to classify" (Skjoett-Larsen, 2000) and service providers' types can overlap (König, Caldwell and Ghadge, 2019). Future research can address these issues by conducting longitudinal studies that include samples from several business environments.

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