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Exploring the Nexus between Information Technology, Supply Chain and Organizational Performance: A Supply Chain Integration Approach

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The prime objective of the current study is to investigate the relationship between a long-term relationship with supplier, information technology integration, information sharing integration, logistic integration and organizational performance in the Indonesian manufacturing industry. This paper aims to explore the relation between logistics integration, information integration, effects on performance, and long-term relationships, using the constructs that have been verified and developed by previous studies. The present study has assumed from the beginning that both the materials and information have contrasting flows; i.e. physical material flows takes place through forward integration and information flow takes place through backward integration within the supply chain. Although, in modern times, the material and information flows take place in both directions. The emergence of reverse logistics explains that material flow goes back to the manufacturer during the recycling, disposal or remanufacturing process. This study will be helpful for supply chain experts, operation managers, academicians, researchers and other policy makers in formulating policies.

Key words: *Information Technology, Supply Chain Integration, Organizational Performance.*

Introduction

Predominantly, the supply chain integration concepts have explicitly expressed the two major flows within the supply chain, namely; the goods flow and the information flow (Fayezi, et al., 2017). Therefore, supply chain integration must include both these flows for smooth functioning of supply chain operations (Prajogo and Olhager, 2012). Higher logistics integration is identified as the increase in a firms and suppliers' logistics activities, obscured organizational differences among customers, increased logistic-oriented communication, and better coordination level in logistic activities, between the customers and suppliers (Prajogo, et al., 2018). Cooperation, collaboration and coordination are the terms that can interchangeably be used for defining the integrative efforts of supply chain partners, in an attempt to enhance its overall efficiency (Zhu, et al.,2018), in the form of CPFR, forecasting and replenishment, and collaborative planning (Zhu, et al.,2018); (Singh, et al., 2018).

Integrated logistics is defined as the specific operational and logistics practices which can efficiently harmonize the material flows from the suppliers to their customers along the value stream (Prajogo and Olhager, 2012). It provides space and time utilities to the industrial firms by delivering the required quantity of goods at the right place (Janaki, et al.,2018) and at a specified period of time (Basheer, et al., 2019). The theoretical construct for the logistic integration is developed using previous research as a foundation for incorporating seamless logistics operations by the supply chain partners (Michalski, et al., 2018).

Information sharing is defined as the distribution of important data, through Information Technology, within the supply chain network. A principal reason for integrating information is to develop real-time transmission as well as the processing of information that is needed in the decision making of supply chain operations. Information sharing could result in lower costs by overcoming the shortages and reducing inventories (Kwak, et al., 2018). Major changes are needed to incorporate in the logistics system for realizing its actual value, through time reductions, Vendor-managed Inventory, frequent deliveries, and quantity reductions (Trkman, et al., 2010). Keeping in view the concept of SCI, the information and logistics integration basically revolves around two associated forms of integration i.e. backward integration and forward integration, which flow contrary to each other. The backward integration represents the flows of information from the manufacturers to the suppliers, and the coordination of IT; whereas the forward integration represents the physical

material flows from the suppliers to the manufacturer, also commonly referred to as logistics integration.

Supply chain integration was modelled by incorporating eight variables from the information sharing, IT sector, and logistics integration, considering both material and information flows (Qrunfleh and Tarafdar, 2013). The study concluded that positive association exists among performance improvement and the wider scope of integration. However, the study failed to observe any considerable association among logistics integration and information integration, because of the unification of variables in a single construct. Similarly, in a Taiwan based study, including five pairs of retailers and suppliers, a conceptual model was proposed adding supplier-retailer partnership, long-term association, performance, and a supply chain architecture involving IT capabilities, and information sharing (Li, et al., 2006). The study suggested that better communication and improved IT capabilities help to develop a finer platform for the involved parties to take part in SC participation, coordination, and solution-based activities.

The effects of information sharing were observed on the supply chain operations (Li, et al., 2005) where the supply chain practices have been taken as a variable concerning the production, delivering, and planning practices. The significant effect of information sharing is found on the SC operations, and the influence of delivery activities on the performance of delivery. In a similar manner, another study showed significant direct effects of information sharing and IT capabilities on the logistics operations, having an indirect influence on the performance of the supply chain (Prajogo, et al., 2016). However, no direct influence of IT adoption was found on the performance. This paper aims to explore the relation between logistics integration, information integration, effects on performance, and long-term relationships, using the constructs that have been verified and developed by Liu et al (2016). The study analyses the relationships among variables and proposes a set of hypotheses. Finally, the study presents the future implications for researchers and managers (Ralston, et al., 2015). The originality of this research is that the variables that are used to consider this relationship have never been used before (Vanpoucke, et al., 2017). Therefore, it is the first research which has incorporated a set of these variables for observing these relationships (Cao, et al.,2015).

Theoretical background and hypotheses

In this section we discuss the contribution of SC information i.e. information sharing and IT adoption in the integration of material flow (Kaliani. et al.,2016). Furthermore, the discussion about the long-term association with the suppliers is presented as a descendent of SC

information management as well as its direct influence on the supply chain performance. Finally, we aim to establish the research hypotheses that could explain the long-term linkage among information integration, suppliers, performance, and logistics integration.

According to Karim and Arif-Uz-Zaman (2013) and Wong et al (2015), supply chain integration can be classified along different aspects and dimensions. A broad arrangement or practices are covered by integration i.e. sharing operational information (stock levels), and strategic activities (collaboration in product development) (Karim and Arif-Uz-Zaman (2013); Tseng and Liao (2015) and Mackelprang et al (2014) suggested that the concept of integration can be observed from the perspective of a company's boundary. With respect to this, integration can only be expressed with an internal perspective if it reflects, how companies integrate along with its downstream and upstream partners, i.e. suppliers and customers (Wong, et al., 2015). Research involving the investigation of SCI's impact of performance of firm has been quite extensive (Mackelprang, et al., 2014). Whereas, the framework for the arcs of integration can be considered as seminal article, which has measured and conceptualized the supply chain integrations' performance implications (Prajogo and Olhager, 2012). Their study conceptualized it using extent and direction towards suppliers and customers. Also, they identified an outward facing technique which is characterized with high level supplier and customer integration, thus leading towards higher firm performance against lower integrated companies (Kojo & Paschal 2018).

Logistics integration

Firms have been seeking to enhance the internal operations and suppliers in the value chain activities of SC, due to increased competition in the market. Hence, the suppliers' contribution to add values to its customers and developing efficient capabilities such as cost, flexibility, delivery, and quality have been well observed in this study. According to Kaliani et al (2016) logistics integration is defined as a systematic flow of physical goods from the suppliers' end, enabling a smooth functioning of production activities. This firm-supplier collaboration develops a seamless interrelationship among suppliers and firms in a manner that the dividing line between them gradually starts disappearing (Karim and Arif-Uz-Zaman, 2013). A solid logistics integration has long been argued to reduce several problems, for instance bullwhip effect (Karim and Arif-Uz-Zaman, 2013). It also enables organizations to implement lean production systems presenting inventory reduction and efficient reliable cycles (Wong, et al., 2015). Predominantly, logistic integration also enables firms and their partners to function in the form of a single entity, thus leads to better performance along the SC (Karim and Arif-Uz-Zaman, 2013). Put differently, under logistics integration, organizations can yield several benefits of vertical integration such as planning,

dependability, lower costs, and quality (Tseng and Liao, 2015). Moreover, several operational benefits such as lead time, reduction in cost, improvement in distribution, sales, service level, customers' service, and risks, and customer satisfaction can also be gained through improved logistics integration among the supply chain partners (Ralston, et al., 2015).

Most empirical research that has been conducted to observe the nature of association among performance and integration, have indicated a positive association among the two variables (Vanpoucke, et al., 2017). Furthermore, improved performing plants show greater logistics integration (Kaliani, et al., 2016). In addition, the strongest association exists among performance improvement and the widest arcs of integration (Tseng and Liao, 2015). Similarly, higher degrees of collaboration will lead to operational efficiency within the supply chain (Karim and Arif-Uz-Zaman, 2013). On the other hand, a significant relation is found between supply chain performance and supply chain integration (Cao, et al., 2015). Thus, the first hypothesis is stated as follows:

H1. Logistics integration is in significant relationship with operational performance.

Information integration

The flow of information from the downstream to the upstream must reinforce the flow of materials from the upstream towards the downstream (Vanpoucke, et al., 2017). A set of five case studies, on supplier-retailer relationship, indicated that better communication and IT capabilities provide both parties a better platform for participation, solution-oriented activities, and coordination (Mackelprang, et al., 2014). Thus, the information sharing, and technology are taken as descendent of the material flow. Therefore, the literature review of SC information integration provides two aspects, namely social aspects and technical aspects. For instance, numerous studies (Wong, et al., 2015) have been conducted to explore the significance of implementing e-business technologies, whereas other researches (Tseng and Liao, 2015); (Mackelprang, et al., 2014); (Ralston, et al., 2015); (Prajogo, et al., 2016) have emphasized upon the importance of communication and information sharing among the suppliers and firms. This paper considers both aspects, i.e. information technology and information sharing as essential components of information integration. High technological dependence as well as unwillingness to share important information about the supply chain will lead to meaningless connections among the firms and thus result in poor logistics integration. However, those firms which can develop social and technical aspects would be able to yield maximum advantages from the logistics integration (Li, et al., 2005); (Prajogo, et al., 2016); (Wong, et al., 2015).

The production planning, scheduling, delivery status, and inventory level assists firms in controlling and managing the activities of the supply chain. Information technology also assists organizations in the alignment of scheduling and forecasting of operational activities, thus allowing improved coordination among the firms and suppliers. According to Prajogo and Olhager (2012) the issues in coordination of supply chain activities that arise due to spatial and time constraints can somehow be minimized. Incorporating information technology has gained considerable traction by introducing various technologies for the purpose of business (Khemili & Belloumi 2018). These technologies include B2Bprivate, Electric Point of Sale, and the internet. Several researches have indicated that effective implementation of IT coordination enhances the material flow integration among the partners of a supply chain (Tseng and Liao, 2015). Hence, IT plays a crucial role in the supply chain processes namely procurement (Wong, et al., 2015) order fulfilment, and sourcing (Wong, et al., 2015). Therefore, the hypothesis is proposed as:

H2. The logistic integration is in significant relationship with the intensity of information technology connection between firms and their suppliers.

Information sharing

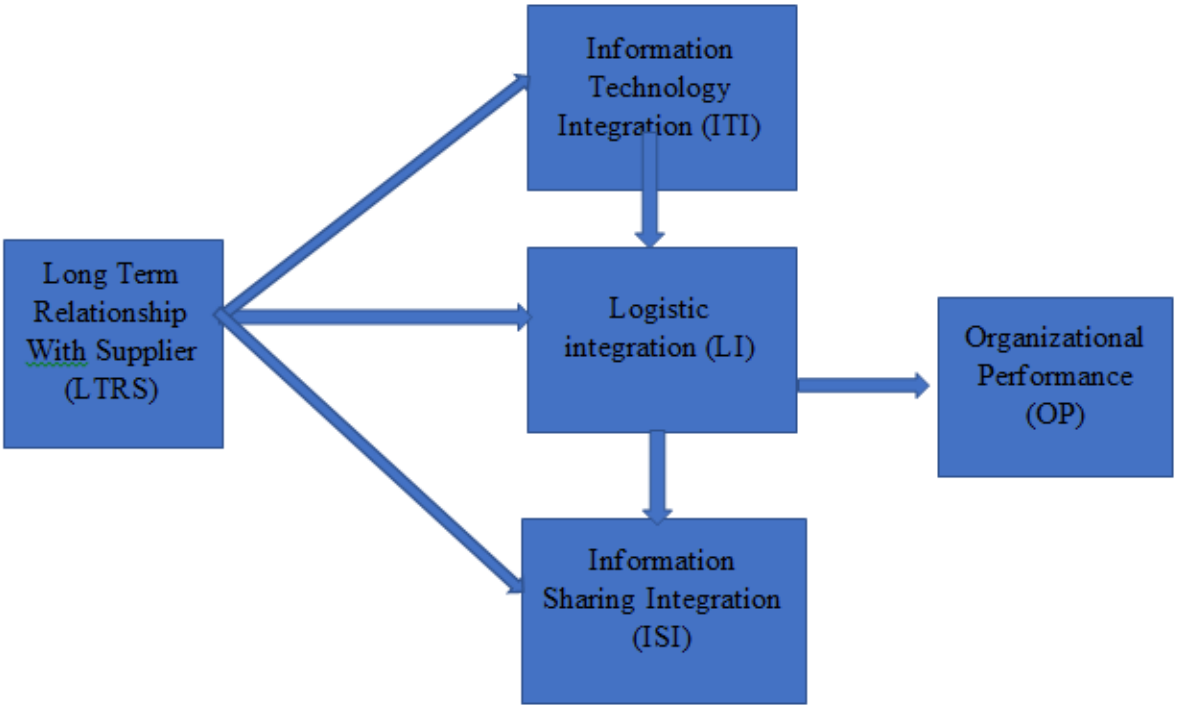
Besides the technological aspect, it is the frequency, the volume and the quality of shared information which is important and that actually matters. Greater volume of IT investment, if not carried out by willingness to share information, may fail to bring expected or potential benefits (Tseng and Liao, 2015). The Information sharing not only demands the transmission of transactional data, in the form of product or material orders, but also the transmission of strategic supply chain information. Therefore, this strategic information helps the SC partners in strategic decision making; demand can be easily forecasted through point of sale history, resulting in enhanced efficiency and better service to customers (Prajogo and Olhager, 2012). Similarly, the position of real-time inventory facilitates in planning the delivery schedules and replenishments, resulting in reduced costs of inventory and enhanced services (Wong, et al., 2015). Therefore, achieving such benefits demand intense and frequent communication among the suppliers and firms. The magnitude and extremity of communication comprises of enhanced cooperative behaviour among the partners of SC, which consequently brings symmetry and the higher strategic transmission of information (Huo, B. 2012). Various logistics information sharing benefits regarding inventory management (Wieland and Marcus Wallenburg, 2013) Bullwhip effect (Qrunfleh and Tarafdar, 2013) flexibility and agility (Wieland and Marcus Wallenburg, 2013); (Hadid and Afshin Mansouri, 2014). For instance, according to Liu et al (2013), the bullwhip effect can be reduced by the integration with suppliers and Vendor-managed Inventory. As such we propose a hypothesis as:

H3. The logistic integration is in significant relationship with the intensity of information sharing between firms and their suppliers.

Long term relationships

The nature and ways through which the suppliers and firms connect with each other has considerably changed in recent decades. Therefore, firms have been seeking to improve their core capabilities and are depending more on strategic suppliers (Liu, et al., 2013). The three important aspects have been discussed here. Firstly, more emphasis has been given in developing long-term association with the suppliers and not on short-term relationships (Lampel and Giachetti, 2013). Besides long-term relationships, firms try to interact with a smaller base of suppliers than interacting with large number of suppliers over a long time. This enables firms to get connected with new suppliers in every new contract. Due to large volume and long-term purchases, the low price competition among suppliers has now been changed to reduction in total ownership costs (Lampel and Giachetti, 2013). Thirdly, the firm-supplier connection has been extended to a strategic relationship (Kiken, et al., 2015) where suppliers occupy central position in the firms' processes (Fuller, et al., 2016). Such a relationship change offers different avenues for partnership, such as early supplier integration during the process of product design, profit and risk sharing, and joint improvement program. Another important aspect of strategic supplier association is the extended longevity. Furthermore, long-term connections provide different implications for the firms, i.e. it shows a firms readiness to make large investments for the purpose of establishing relationships, such as information sharing and information technology (Kiken, et al., 2015). According to Fuller et al (2016) higher levels of trust bring greater customization, resulting in increased flow of strategic information. Long-term orientation is found to influence the structure of supply chain through information sharing and IT capabilities (Kiken, et al., 2015). Similarly, a significant long-term relationship is found between information sharing and suppliers (Henseler, et al., 2015).

Figure 1. Conceptual framework



A long-relationship has been established in a model as an extraction of the buyer performance (Hafeez, et al., 2018). A study exhibited that long-term partnerships lead to the better performance of an organization (Vickery et al., 2003) whereas better performing plants are expected to show better utilization of long-term agreements with supply sources (Lampel and Giachetti, 2013). In addition, competitive performance of a firm is found to be directly influenced by effective supplier connections (Hadid and Afshin Mansouri, 2014). Thus, we developed the following two hypotheses:

H4. LTRS is in significant relationship with information technology connection between firms and their suppliers.

H5. LTRS has a significant relationship with information sharing between firms and their suppliers.

Methodology

The items that are added for constructing the scales for this study have been taken from previous research (Hafeez, et al., 2018) to confirm the content validity. Furthermore, a Likert scale is employed to collect the responses.

A scale of 1-7 is used where 1 represents 'strongly disagree' and 7 represents 'strongly agree', for the long-term relation of variables of logistic integration, information sharing, and information technology. Original names of the constructs are used except for the variable of communication which is then replaced with information sharing. Only one item from the logistics integration has been excluded, as that item comprises material and information flow, having conflict with the developed framework, since this study aims to distinguish and observe the nature of the relationship among these flows. Furthermore, the operational performance consists of four dimensions, i.e. cost, delivery, flexibility, and quality. Therefore, in this context, respondents were guided to assess their level of performance from 1-7 as compared to their competitors, where 1 represents weakest in the industry and 7 represents the strongest.

Results

Confirmatory factor analysis is used to simultaneously assess the validity of all the variables involved. Table 1 shows the outcomes of Cronbach's alpha and confirmatory factor analysis. The items are found to be significantly loaded on their constructs. Therefore, the item loadings as well as the overall model fit indices demonstrate acceptable convergent validity and unidimensional (Lampel and Giachetti, 2013). The Cronbach alpha values for five constructs turned out to be satisfactorily reliable, whereas the Cronbach alpha value for performance is 0.7 that is slightly less than the acceptable level, due to the multidimensional composition of performance. Therefore, flexibility, cost performance, delivery, and quality have been considered in the performance construct indicating that a few organizations usually specialize in certain dimensions of performance.

Common method variance and discriminant validity

Harman's single factor test is employed for considering common method variance. It is conducted by taking 26 item loadings on one factor and employing a principal component analysis. The test aims to assess whether a single factor appears as a result of factor analysis, thus pointing towards the common method bias. The results from the factor analysis exhibited less than 25 percent of extracted variance. In addition, almost half of the items exhibited poor factor loadings i.e. less than 0.5. Thus, common method variance was not found to be a significant issue in the current data. In addition, the discriminant validity test was also conducted to explore whether the dependent and explanatory variables significantly intersect with each other. Following Hair, et al., (2016), The test for discriminant validity was undertaken on each pair, using a confirmatory factor analysis. Thus, CFA is applied twice on each pair. In the first CFA, the association among the two constructs are estimated freely,

followed by a chi-square test. The second round of CFA is performed by fixing the correlation to 1.0 among the two constructs, and chi-square is also estimated. The value of chi-square is at a significance level of p = 0.01 with df = 1, it is found to be less than the difference of chi-square value from the first and second confirmatory factor analyses i.e. Dw2, it then confirms the presence of discriminant validity (Hair, et al., 2015).

Table 1: Reliability

	CR	AVE	Cronbach Alpha
LTRS	0.975	0.872	0.885
ITI	0.702	0.737	0.924
LI	0.960	0.871	0.893
ISI	0.802	0.832	0.916
OP	0.860	0.871	0.834

Ten chi-square tests are performed for five constructs in our study. Therefore, the difference of chi-square values for all the five constructs verified the discriminant validity and indicated the absence of common method variance

Table 2: Discriminant Validity

	1	2	3	4	5
LTRS	**0.709**				
ITI	0.680	**0.727**			
LI	0.657	0.676	**0.712**		
ISI	0.632	0.654	0.682	**0.832**	
OP	0.601	0.621	0.623	0.732	**0.834**

Structural model

Table 3 shows the outcomes of the structural equation modelling. The ratio of w2 = 497.14 with df =309, which is lower than the suggested value i.e. 3.0 to be an acceptable model fit (Hair, et al., 2016). The fit indices for this study are: NNFI= 0.963, NFI= 0.923, CFI= 0.967 & RMSEA= 0.051 at confidence interval CI = 90% having a range of values between 0.043-0.060. All the indices are interpreted as acceptable following the guidelines of Hair et al (2015). For the operational performance, the size of an organization and the process type are added as control variables in the model, where size of an organization is taken in terms of total employees. No significant impact of these variables is found on operational performance

with a value of 0.00 for organizational size and 0.08 for process type at p = 0.05. Thus, the following are the results of hypotheses for this study.

Table 3: Direct Effect

	(β)	**SD**	**T-value**	**P-Values**
H1	0.211	0.135	3.211	0.000
H2	0.357	0.152	3.678	0.000
H3	0.321	0.178	3.321	0.000
H4	0.342	0.165	3.234	0.000
H5	0.453	0.187	3.768	0.000
H6	0.457	0.173	3.657	0.000

Overall the findings of the current study have shown the agreement with our hypothesis.

Conclusion

The present study shows the significance of material and information flow in the supply chain integration, which is found to have a significant correlated with performance. Meanwhile, the supply chain integration (SCI) is a challenging process having several aspects of soft and hard exchange of information, advocating the logistics integration processes, regarding the material flow from one party to the other. However, these kinds of complex problems can only be addressed in case of long-term association among the SC partners. The present study thus supports the significance of developing long-term firm-supplier associations, as it has been previously promoted by researchers and authors since the introduction of the quality management concept.

Taking everything into consideration, competitive performance is found to be positively influenced either indirectly or directly, by all the involved constructs in this study. Thus, the integration of SC partners indicates a multi-dimensional process showing that several competencies interdependently act to attain higher levels of performance. The forward and backward integration are the interrelated forms of information integration, having contrasting flow from each other. Forward integration involves the material flows from the suppliers end to the manufacturers, commonly known as logistics integration, whereas, the backward integration involves the integration of information technologies as well as the information flows from the manufacturers to the suppliers. This study has assumed from the beginning that both the materials and information have contrasting flows, i.e. physical material flows

takes place through forward integration and information flow takes place through backward integration within the supply chain. Although, in modern times the material and information flows take place in both directions. The emergence of reverse logistics explains that material flow goes back to the manufacturer during the recycling, disposal or remanufacturing process (Tseng and Liao, 2015). Similar to the backward flow of material, the information flow also needs to pass on to the manufacturer, since manufacturers need clear information about the product during the recycling process (Hair et al., 2015); (Chienwattanasook and Jermsittiparsert, 2018); (Dawabsheh, et al., 2019). Bi-directional flows of both information and material can be explored in future studies through different supply chain integration modelling. Like other studies, this study also has a limitation i.e. this study involves only Australian firms as a sample population. Future researches can be conducted by adding broader population sample of firms from other countries, in order to observe potential effects of country and for generalization of outcomes. In addition, this study relied on the relationship perception of focal firms. Therefore, it will be beneficial to observe the different parties that are involved in the SC relationships, and having stories about the mutual effects and reciprocity from both sides.

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