International Business Management 10 (9): 1768-1779, 2016
ISSN: 1993-5250

Information Technology for Supply Chain Performance: A Mediated Covariance Modeling Based on the Dynamic Capabilities Theory

[1]Hassan Barau Singhry, [2]Azmawani Abd Rahman and [2]Ng Siew Imm
[1]Faculty of Management Technology, Abubakar Tafawa Balewa University, Nigeria
[2]Faculty of Economics and Management, Universiti Putra Malaysia, Malaysia

Abstract: Information technology is an important supply chain innovation typology that enhances the integration of people and processes. Although, there is large body of literature on information technology, supply chain capabilities and supply chain performance, empirical studies on how innovation capability relates with information technology and supply chain performance is unknown. To cover this important research gap, the study proposesfour hypotheses on the relationship between information technology and supply chain performance, information technology and innovation capability, innovation capability and supply chain performance and the mediation effect of innovation capability between information technology and supply chain performance. The study followed post-positivism epistemology based on the methodology of cross-sectional survey. A cross-section of 286 top managers of manufacturing companies in Nigeria were examined based on cluster and stratified random sampling. A four-stage regression analysis in two models were performed to test the proposed hypotheses using structural equation modeling with Amos graphics. Result in model 1 found a significant relationship between information technology and supply chain performance. The findings in model 2 suggest that the relationship between information technology and innovation capability (X→M) as well as innovation capability and supply chain performance (M→Y) are both significant. The initial positive and significant relationship between information technology and supply chain performance became non-significant with the introduction of innovation capability as mediating variable. Therefore, it is concluded that innovation capability is a full mediator between information technology and supply chain performance. The study has both implication for the theory and practice. It, thus, provide guidelines to managers of manufacturing companies on strategies to improve supply chain performance.

Key words: Dynamic capabilities theory, information technology, innovation capability, supply chain performance, Malaysia

INTRODUCTION

Information Technology (IT) is one of the major elements influencing competitive advantage and Supply Chain Performance (SCP). As a paradigm shifts in Supply Chain Management (SCM), IT has transformed businesses from functional silos' to functional integration (Stank *et al*., 2011). It has changed businesses from inventory management to information management (Franks, 2000). An integrated Supply Chain (SC) heavily depends on IT to expedite information sharing, improve collaborative capabilities (Ageron *et al*., 2013), reinforce inter-organizational relationship, stimulates technical knowledge and technology innovation (Cheng *et al*., 2014) and subsequently reducescommunication and transaction costs (Soni and Kodali, 2012). Today, all aspects of innovation in supply chain requires an application of IT tool (Melnyk *et al*., 2009).

Although, IT is critical in supply chain management, previous literature such as Bolivar-Ramos and Garcia-Morales (2013) point that IT investment alone does not guarantee productivity, competitive advantage and business performance. In a similar line of argument, Ye and Wang (2013) caution the incident of information technology productivity paradox. Information technology productivity paradox occurs when some firms invest in IT solutions with colossal benefits while others without any significant results. Furthermore, certain barriers affect the implementation of information technology in the supply chain. These obstacles include lack of compatibility and connectivity of IT systems, strategic uncertainties

Corresponding Author: Hassan Barau Singhry, Faculty of Management Technology, Abubakar Tafawa Balewa University, Nigeria

(Queen *et al*., 2000). Other impediment include lack of adequate resources to sustain innovative IT solutions, high costs of networking, poor IT infrastructure and labour-intensive workforce (Ketty, 1994; Wendling *et al*., 2013).

In order to cover this important research gap and provides solution to the impediments of IT implementations in the supply chain, this study argues for the intervening role of innovation capability on the relationships between information technology and supply chain performance of manufacturing companies. Although Innovation capability is useful for knowledge creation, new product development and business performance (Hult *et al*., 2004) studies linking IT, innovation capability and supply chain performanceis not clear (Tan *et al*., 2015). Singhry *et al*. (2014) emphasize the importance of integration between technology and human capability in order to achieve business performance. Furthermore, the importance of human capability (social networks with the suppliers) to enhance technology performance have been emphasized (Abd Rahman and Bennett, 2009; Rahman *et al*., 2009). On top of that, Panayides (2006) suggests further research to examine other an tecedents of innovation capability in the supply chain context. Jean *et al*. (2010) emphasize the need for IT-specific knowledge and skills. Murray and Blackman (2006) show that most innovations studies have been in the knowledge-based and organizations need to improve their learning and innovation capabilities. As such, a question of whether firm's innovation capability play a role on the relationships between information technology and supply chain performance remain pertinent

Conceptual framework and research hypotheses: This study is underpinned in the theoretical lens of the Dynamic Capability Theory (DCT) (Teece, 2007). The DCT examines how firms build, integrate, configure and reconfigure their internal and external processes and competencies to encourage innovation and achieve competitive advantage. In this study, information technology is a structural capability which influences (innovation capability (knowledge-based capability). Both structural and knowledge-based capabilities must be continuously renewed through adoption, implementation and learning. The framework of this study is developed based on the dynamic capabilities theory. Although, Rajesh and Margaret (2012) examines supply chain capabilities as endogenous construct, we differ by examining the mediating effect of innovation capability on the relationship between information technology and supply chain performance. Figure 1 envisages the framework of this research.

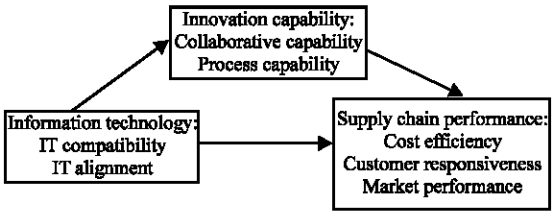

Fig. 1: Research framework of information technology for supply chain performance

Supply chain information system is defined as "computer and communication technology which facilitates the creation, storage, transformation and transmission of information between two or more companies". Information technology alignment is "the similarity, connectivity and compatibility of IT infrastructure between supply chain partners" (Seggie *et al*., 2006). Proliferation of IT tools makeits decision more complex. In this study, innovation capability is defined as ability of organization to continuously improve its technological processes and collaborative competences. It involves process capabilities, product capabilities, service capabilities, customer focus capabilities and problem-solving capabilities (Liao and Kuo, 2014). Past literature havefound positive and significant relationship between supply innovation capabilityand performance (Seo *et al*., 2014). Innovation capability is a 'learning-to-learn type', the "cultural readiness and appreciation of innovation' and the engine forces that boost performance. Innovation capability is the mechanism through which partners formulate strategies to achieve business performance (Hult *et al*., 2004). It is useful for developing unique knowledge, new product, innovation performance (Schweitzer, 2014) and firm growth (Yang, 2013).

Supply chain performance is one of the drivers of organizational performance. Yul and Kyu (2015) define supply chain performance as "the benefits derived from supply chainintegration, including efficiency improvement, cost reduction and enhancement in cycle time". According to Wu *et al*. (2014) supply chain performance can be measured based on both financial and non-financial metrics. The financial indicators include returns on investment, assets, market share, sales growth, production and inventory costs while non-financial indicators includes customer responsiveness, market change, customer service and dependability. Cost efficiency helps partners understand and reduce total expenses associated with supply chain and thus design strategies to achieve optimum supply chain performance. Knowledge of supply chain costs helps managers' negotiate fairly and equitably with supply chain partners.

Customer responsiveness is simply the ability of supply chain to be agile and flexible by responding to changes in the markets, efficient and effective launching of new products and on-time delivery to customers (Kurnaz *et al*., 2005). Green *et al*. (2014) measured supply chain market performance in terms average returns on investment, profit, sales over the last three years. Qrunfleh and Tarafdar (2013) show that market performance include growth of market share, return on investments, competitive positioning and profits. Gates and Langevin (2010) measured market performance based on market share, profit growth, investment returns, sales growth, returns on sales and business performance.

Hypotheses development

Information technology and supply chain performance: IT has long been acknowledge as major indicator of operational efficiency and process performance. It is used to foster coordination and knowledge-sharing in new product development teams. Other benefits includes increased quantity and quality of real-time information, as well as aiding Collaborative Forecasting, Planning and Replenishment CPFR) and business performance. Durmusoglu and Barczak (2011) suggested a positive relationship between information technology and new product development. It helps reduce distance, costs and make supply chain more agile align and adaptable. Ye and Wang (2013) found significant relationship between information technology alignment with cost efficiency and customer responsiveness. Despite these findings, Lee *et al*. (2012) point that IT investment could bring uncertainties. As such within the context of supply chain, it is hypothesized that:

- H_1; there is a significant relationship between information technology and supply chain performance

Information technology and innovation capability: IT has emerged as an important dynamic capability in SC operation. Structural dynamic capability such as information technology influences dynamic capabilities. Together, these two capabilities have to be constantly configured and reconfigured to achieve supply chain excellence. Liao and Kuo (2014) examines a mediating role of supply chain capabilities on collaboration for supply chain value innovation and firm performance. Even though, significant effects were found in the 3 paths relationship, mediation effect was not present. Chang *et al*. (2015) argue that IT investments influences supply chain dynamic capability and relational benefits. Rajesh and Margaret (2012) found that inter-organizational IT integration influence supply chain capabilities. Furthermore, supporting IT with complementary resources and process yield greater benefits (Wade and Hulland, 2004; Ye and Wang, 2013). While, the influence of IT is clear, how it influences innovation capability of a firm remain vague. Underpinned in the DCT, the following hypothesis is formulated:

- H_2; there is a significant relationship between information technology and innovation capability

Supply chain innovation capability and supply chain performance: Knowledge-Based view of DCT posits that "accessibility, creation, protection and usage of knowledge is a means toward achieving sustainable competitive advantage" (Knockaert *et al*., 2011). The theory postulates that a firm's success heavily depends upon how it improves its knowledge base, integrate knowledge within and outside the organization, apply knowledge to develop new products, improve current process or product, and innovate (Nonaka and Takeuchi, 1995). Jayaram *et al*. (2014) investigated supply chain capabilities of small and medium family firms and discovered positive and significant relationship with supply chain performance. Prajogo and Olhager (2011) suggested that IT capabilities positively influences logistics integration. Youn found a significant relationship between SC information capabilities and supply chain performance but suggest for more studies to investigate other types of supply chain capabilities. In view of these arguments, the following hypothesis is formulated:

- H_3; there is a significant relationship between innovation capability and supply chain performance

The relationship between information technology and supply chain performance in the presence of innovation capability: The need for IT to be renewed to build collaborative and process capability or competences across the supply chain has long been emphasized. Studies by Hortinha suggested that innovation capabilities mediates the relationship between technology orientation and performance of export manufacturers. Camison and Villar-Lopez found that process and product capabilities have complete mediating effects on the relationship between organizational innovation and firm performance. Furthermore, Liu and Wu suggested that innovation differentiation mediates the effects of structural and relational technologies on performance. Seo *et al*. (2014) suggested a mediation effect of SC integration on the relationship between innovativeness and SCP. Panayides (2006) found an indirect effect of innovativeness on the relationship between trust and

supply chain performance. Cheng *et al.* (2014) found that joint dynamic capabilities mediate between information technology investments and co-created or collaborative value. However, the mediating effect of innovation capability on the relationship between information technology and supply chain performance remains unclear. Based on the preceding arguments and the DCT, the following hypothesis is proposed:

- H_4; innovation capability mediates the relationship between information technology and supply chain performance

MATERIALS AND METHODS

The study was psychometric which follows a post-positivism epistemology based on cross-sectional survey. Data was collected from members of Manufacturers' Association of Nigeria (MAN) between August 2014 and November 2014. Manufacturers association of Nigeria is an organized body that represent the interest of Nigerian manufacturing companies. With 1574 companies on its database, 1035 qualified to participate in the survey because of cluster and 323 companies were randomly targeted from 8 clusters. Thus, the study employed both cluster and systematic sampling techniques. The sample size was computed based on table suggested by Krejcie and Morgan (1970). Questionnaire was self-administered with support from the 8 research assistants who were staff of MAN in the respectiveclusters. Even though, face-to-face administered questionnaire is expensive in terms of time, money and efforts, it performs better than mail and telephone surveys (Szolnoki and Hoffmann, 2013). The response rate of the study is 90.4%. This is higher than the suggestion of Sudman *et al.* (1965) who point that self-administered questionnaires have a completion rate of about 76% and rejection rate of 24%.

The research survey instruments were adopted from the previous validated measures and were modified to suit the context of this study. All variables have been measured on seven-point Likert-type scale from 1 = strongly disagree to 7 = strongly. Instruments were adopted, extracted and integratedfrom many sources. Operationalization ofIT was selected from Chen and Paulraj (2004), Mccarthy-byrne and Mentzer (2011) and Prajogo and Olhager (2011), innovation capabilitywas adopted and modified from Cohen and Levinthal (1990), Lavastre *et al.* (2014); Sohal (2013) and Storer and Hyland (2009) while supply chain performance was extracted and modified from Cirtita and Glaser-Segura (2012), Rajesh and Margaret (2012), Stank *et al.* (1999) and Ye and Wang (2013).

This study was conducted based on four-stage mediation effect (Baron and Kenny, 1986). The first is the significant relationship between independent and dependent variables or criterion (X→Y). Second, the relationship between mediating and dependent variables (M→Y) must be positive and significant. Third, the relationship between the mediator and the criterion (M→Y) must also be positive and significant. Fourth, a hypothesis of full mediation is supported when the presence of a mediator turn an already significant relationship of X→Y into non-significant. Furthermore, a hypothesis of partial mediation is supported if the introduction of a mediator maintains a significant and positive relationships of all the 3 paths: X →Y, X→M and M→Y but the product of multiplying X→M and M→Y standardized coefficients (r) is greater than the new standardized coefficient of X→Y. However, if either one or both path (s) of X→M and M→Y is/are not significant, then one settles for hypothesis of direct relationship (Mathieu and Taylor, 2006).

RESULTS AND DISCUSSION

The organizational profiles comprises of business sector, job title, ownership structure, firm age, number of employees, annual revenue and costs due to supply chain activities. Table 1 provides frequency and percentage of the organizational profile. Table 1 shows that the

Table 1: Descriptive statistics of company profile

Company data	Description	Frequency	Percent
Sector	Food, beverages and tobacco	51	17.8
	Chemicals and pharmaceuticals	63	22.0
	Domestic and industrial plastic, rubber and foam	37	12.9
	Basic metal, iron and steel and fabricated metal products	27	09.4
	Pulp, paper and paper products, printing and publishing	28	09.8
	Electrical and electronics	17	05.9
	Textile, wearing apparel, carpet, leather/leather footwear	25	08.7
	Wood and wood products including furniture	17	05.9
	Non-metallic mineral products	10	03.5

Table 1: Continue

Company data	Description	Frequency	Percent
	Motor vehicle and miscellaneous assembly	11	03.8
Job title	Vice president and above	73	25.5
	Director/assistant director	59	20.6
	Manager/assistant manager	154	53.8
Ownership structure	Foreign-owned company	81	28.3
	Local firm	158	55.2
	Foreign-local firm	47	16.4
Firm age	1-5 years	31	10.8
	6-10 years	50	17.5
	11-20 years	50	17.5
	21-30 years	66	23.1
	31 years or more	88	30.8
	Missing value	1	00.3
Number of employees	100 or less	64	22.4
	101-200	52	18.2
	201-500	72	25.2
	501 or more	98	34.2
Annual revenue	10 or less million	67	23.4
	11-100 million	39	13.6
	101-999 million	48	16.8
	1-30 billion	86	30.1
	31 or more billion	46	16.1
Annual cost	10 or less million	68	24.1
	11-100 million	42	14.7
	101-999 million	58	20.3
	1-30 billion	78	27.3
	31 or more billion	39	13.6

companies in the sample covers all the sectors of the Nigerian manufacturing industry. Chemical and pharmaceutical has the highest number of companies in the manufacturing sector 63 (22.2%). This is followed by the food, beverage and tobacco sector with 51 (17.8%) while domestic and industrial plastic, rubber, and foam has 37 (12.9%). Electrical and electronics has 17 (5.9%); wood and wood products including furniture has 17 (5.9%); motor vehicles has 11 (3.8) while non-metallic mineral products is the lowest with 10 (3.5%). The respondents were the top managers of their companies. The 73 (25.5%) of the respondents were vice presidents and above, 59 (20.6%) were directors/assistant directors and 154 (53.8%) were functional managers from the purchasing or supply chain department. In terms of ownership structure, 81 (28.3%) of the companies are Foreign-owned. About 158 (55.3%) are domestic companies while 47 (16.4%) have mix ownership of both foreign and domestic. Local firms made up more than half (55.5%) of the sample.

Table 1 equally indicates that 31 (10.8%) of the companies had been in business between 1-5 years, 50 (17.5%) between 6-10 years, 50 (17.5%) between 11-20 years, 66 (23.1%) between 21-30 years and 88 (30.8%) above 31 year. Furthermore, 64 (22.4%) employ less than 100 staff, 52 (18.2) employ 101-200, 72 (25.2%) employ 201-500 while 98 (34.3) companies have more than 501 staff on their payroll. It should be noted that the Nigerian manufacturing industry is the third largest employer of labour after the public service and the agricultural sector.

Validating the measurement model: Confirmatory Factor Analysis (CFA) was perform based on the maximum likelihood command. The amalgamated measurement model of the three constructs have the following fitness indexes: RMR = 0.034, GFI = 0.942, AGFI = 0.918, CFI = 0.972, TLI = 0.965, NFI = 0.916, RMSEA = 0.039, PCLOSE = 0.904, Chi Sq/df = 1.442, p = 0.002. These indexes have satisfied their respective recommended threshold values and therefore, adequate to proceed with structural modeling. Reliability was assessed based on Cronbach's alpha (α) above 0.7 (Nunnally, 1978). Composite Reliability (CR) was computed as shown in Table 2. Composite reliability for IT, SCIC and SCP are 0.893. 0.833 and 0.920, respectively. Table 2 shows that the composite values of all constructs are above 0.70. Construct validity was assessed based on three approaches. First the four conditions suggested by Mokkink *et al*. (2010) was followed. Second, bivariate Pearson correlation coefficients yielded positive and significant correlation at $p<0.001$ (Farag *et al*., 2012). Lastly, acceptable fitness indexes was used and the measurement models had good fitness indices (Bagozzi, 1993). Convergent and discriminant validities were evaluated based on recommendations by Fornell and Larcker (1981). Average Variance Extracted (AVE) of the three constructs are 0.543, 0.501 and 0.592 and all above the threshold value of 0.50.

Table 2: Descriptive statistics, bivariate correlation coefficients, composite reliability and Average Variance Extracted (AVE) variable

Variables	No. of items/dimensions	Mean	SD	IT	SCIC	SCP	CR	AVE
IT	4/2	21.401	3.710	**0.737**	0.185	0.098	0.893	0.543
IC	5/2	28.895	3.074	0.430	**0.708**	0.203	0.833	0.501
SCP	8/3	47.595	3.968	0.313	0.451	**0.769**	0.920	0.592

IT = Information Technology, IC = Innovation Capability, SCP = Supply Chain Performance, CR = Composite Reliability, AVE = Average Variance Extracted

Table 3: Standardized and unstandardized regression weights estimate of information technology and supply chain performance

	Standardized estimates		Unstandardized estimates				
Relationship	Std. β	R^2	Actual β	SE	CR	p	Remark
Information technology and supply chain performance	0.510	0.26	0.205	0.058	3.563	***	Significant

Std β = Standardized β, R^2 = Coefficient of determination, actual β = Unstandardized β, SE = Standard Error, CR = Critical Ration, *** = Probability value and significant at p<0.001

Table 4: Standardized and unstandardized regression weights estimate of mediated hypothesis of chain innovation capability between information technology and supply chain performance

	Standardized estimates		Unstandardized estimates				
Relationship	Std. β	R^2	Actual β	SE	CR	p	Remark
Information technology and innovation capability (X→M)	0.734	0.502	0.502	0.105	4.756	0.000	Significant
Innovation capability and supply chain performance (M→Y)	0.731		0.542	0.166	3.264	0.001	Significant
Information technology and supply chain performance (X→Y)	-0.014		-0.007	0.096	-0.074	0.941	Non-significant

Std β = Standardized β, R^2 = Coefficient of determination, actual β = Unstandardized β, SE = Standard Error, CR = Critical Ration, *** = Probability value

The bold values in the diagonal of Table 2 show that square root of AVE are greater than correlation coefficient of one construct with other constructs (Hair *et al*., 2013). Values above the bold diagonal are the square of all correlation coefficient and less than AVE. The values provide evidence that each construct is empirically and statistically distinct from another construct and thus support convergent and discriminant validities. All factor loadings are above 0.60 which indicate unidimensionality (Chin, 1998).

Validating the structural model: The first stage of the mediation precondition in Table 3 shows that the relationship between information technology and supply chain performance is positive and significant (r = 0.51, p<0.001). Table 3 shows that when information technology goes up by 1 standard deviation, supply chain performance goes up by 0.51 standard deviations. When IT goes up by 1, supply chain performance goes up by 21.

The regression weight estimate of 0.21 has a standard error of about 0.058. It is estimated that the IT explains 26 % of the variance of supply chain performance. In other words, the error variance of supply chain performance is approximately 74% of the variance of supply chain performance itself. The probability of getting a critical ratio as large as 3.563 in absolute value is<0.001. In other words, the regression weight for IT in the prediction of supply chain performance is significantly different from zero at the 0.001 level (two-tailed).

Result of the mediation effect is presented in Fig. 2 and Appendix. The results show that innovation capability is a full mediator between IT and SCP. This is because, the introduction of mediator into model 2 changed the relationship between (X→Y) to non-significant (r = -0.001, p>0.005). However, X→M and M→Y paths remain positive and significant at (r = 0.73, p<0.001) and (r = 0.73, p<0.001), respectively.

Result from Table 4 indicates that when information technology goes up by 1 standard deviation, innovation capability goes up by 0.734 standard deviations. When information technology goes up by 1, innovation capability goes up by 0.502. The regression weight estimate 0.502 has a standard error of about 0.105. The probability of getting a critical ratio as large as 4.756 in absolute value is<0.001. In other words, the regression weight for information technology in the prediction of innovation capability is significantly different from zero at the 0.001 level (two-tailed).When innovation capability goes up by 1 standard deviation, supply chain performance goes up by 0.731 standard deviations. When innovation capability goes up by 1, supply chain performance goes up by 0.542. The regression weight estimate, 0.542 has a standard error of about 0.166. The probability of getting a critical ratio as large as 3.264 in absolute value is 0.001. In other words, the regression weight for innovation capability in the prediction of supply chain performance is significantly different from zero at the 0.001 level (two-tailed).When information technology goes up by 1 standard deviation, SCP goes down by 0.014 standard deviations. When information technology goes up by 1, SCP goes down by 0.007. The regression weight estimate, -0.007 has a standard error of

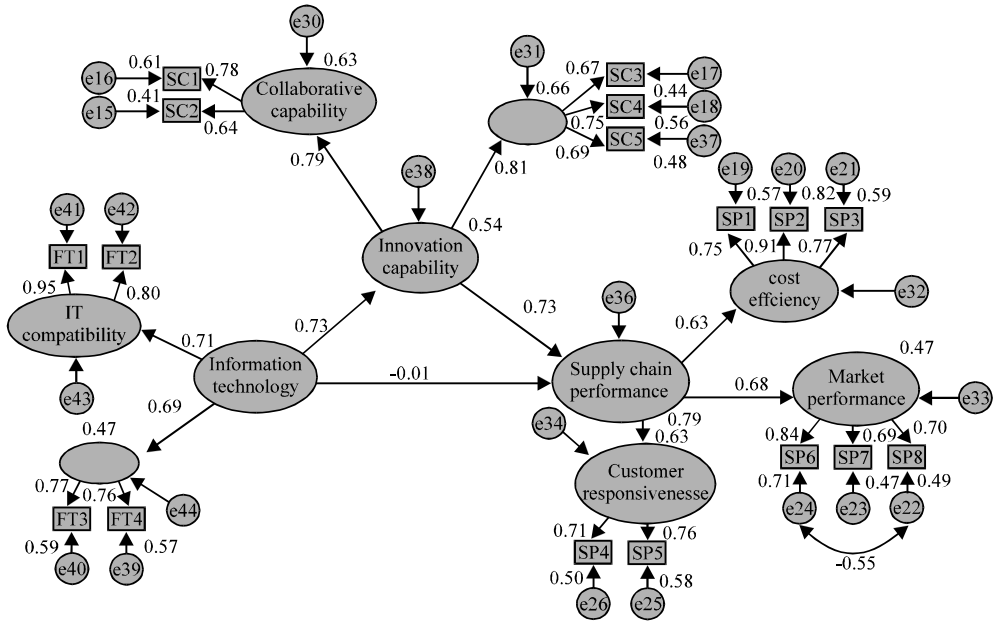

Fig. 2: Covariance regression weights of the mediated effect of information technology for supply chain performance: fitness indexes; RMR = 0.034, GFI = 0.942, AGFI = 0.918, CFI = 0.972, TLI = 0.965, NFI = 0.916, RMSEA = 0.039, PCLOSE = 0.904, χ^2/df = 1.442, p = 0.002

about 0.096. The probability of getting a critical ratio as large as 0.074 in absolute value is 0.941. In other words, the regression weight for information technology in the prediction of supply chain performance is not significantly different from zero at the 0.05 level (two-tailed).

The aim of this study is to test the mediating role of innovation capability on information technology and supply chain performance. A four-stage regression procedure was used to test the hypothesized mediation (Baron and Kenny, 1986; Mathieu and Taylor, 2006). Based on these steps, two structural models were analyzed and tested. The results for H_1 in model 1 showsthat 'information technology has significant relationship with supply chain performance'. The relationship was positive and significant (β = 0.205, p<0.001). The results indicates that companies with greater compatibility and alignment of information technologies achieve higher level of supply chain performance. Furthermore, it demonstrates that IT compatibility (β = 0.81) has greater influence of information technology than IT alignment (β = 0.62). This validates the theory that supply chain partners achieve greaterresult with compatible and aligned information technology infrastructure. Further analysis reveals that the explanatory power of information technology is greater on customer responsiveness (β = 0.78) than the other two measures of supply chain performance (market performance (β = 0.69) and cost efficiency (β = 0.65)). On top of these discussions, our finding is consistent with previous studies in the supply chaincontext. For example, Ye and Wang (2013) found direct relationship between information technology alignment and supply chain performance (cost and customer responsiveness). Furthermore, Kim *et al*. (2006) who suggested that a well compatible and aligned information system fosters both inter and intra-firm coordination and subsequently reduce costs of transaction and communication. Additionally, Cheng *et al*. (2014) found that flexibility in information technologyinfrastructure has significant influence onperformance.

Hypothesis 2 shows that 'information technology has significant relationship with innovation capability' (β = 0.73, p<0.001). This finding is similar with Rai *et al*. (2006) who concludes that information technology infrastructure influences supply chain process capability as well as demand planning, delivery process and financial performance. Hypothesis 3 shows that innovation capability has significant relationship with supply chain performance (β = 0.741, p<0.001). This finding is similar to Prajogo and Olhager (2011) who suggested that information technology capabilities enhances logistics integration. Liao and Kuo (2014) found a positive relationship between collaboration capability

and firm performance. Furthermore, Green *et al.* (2014) found that SC competency improves firm performance. Additionally, Kortmann *et al.* (2014) found that operational capabilities influences both cost-based and time-based efficiencies in a SC context.

Since, the X→M and M→Y paths and hypotheses are positive and significant, we proceeded to assess the mediating effect. The results in Fig. 2 and Table 4 show that innovation capability is a full mediator between information technology and supply chain performance. It could be observed from Table 3 that the prediction power of information technology on supply chain performance was 26%. However, with introduction of the mediating effect of innovation capability, the prediction power double to 52%. Although, the mediating effect of innovation capability on information technology and supply chain performance has not been tested, the result is closely similar with Kortmann *et al.* (2014) who found that operational and innovative capabilities have full mediating influence on strategic flexibility and operational efficiency in India and the United States of America. Similarly, Kristal *et al.* (2010) found an indirect effect of combinative competitive capabilities on supply chain strategies in advanced information technology and performance. However, the results contradict Chang *et al.* (2015) who did not find a mediation effect of dynamic capabilities onthe relationship between IT infrastructure and innovation performance. Equally, Liao and Kuo (2014) did not find a mediating effect of supply chain capabilities on collaborative innovation and organizational performance.

CONCLUSION

As a 'learning-to-learn type' and the "cultural readiness and appreciation of innovation' (Hult *et al.*, 2004), innovation capability is the mechanism through which partners translate technology into performance. Through innovation capability partners develop expertize and create new knowledge from implementation of information technology. This study reveals that the relationship between information technology and supply chain performance is more complex than what has been suggested in the isolated literature of operation management. The study postulated that innovation capability could play an intervening role between the information technology and supply chain performance of manufacturing companies in Nigeria. As competition is no longer between businesses but between the supply chains, firms have acknowledged that innovation is essential for competitive advantage and performance. The results of this study show that innovation capability through collaborative and process capabilities could resolve the conflicting findings of the relationship between information technology and supply chain performance. It shows that improvement in process and collaborative capabilities could resolve the problems of lack of compatibility and connectivity of IT systems, strategic uncertainties (Queen *et al.*, 2000), high costs of networking, and labour-intensive workforce (Ketty, 1994; Wendling *et al.*, 2013) in the supply chain. The study has both theoretical and managerial contributions.

This study has four theoretical implications. First, the research framework is the first to introduce innovation capability as a mediator variable between information technology and supply chain performance. The introduction of innovation capability into the model alters the direct relationship of information technology and supply chain performance and therefore, leads to full mediating effect. The mediation effect indicates two inferences. One, higher SCP depends on enhancement of process and collaborative capabilities. Two, information technology cannot measure supply chain performance directly. The inferences indicate that performance will be stagnated if large amount of money is spent at purchasing information technology without corresponding improvement innovation orientation and culture. Second, the study accentuate the importance of fit by integrating concepts. The results validate the argument that fit between information technology and innovation capability could enhance supply chain performance. Third, the study shows that innovation capability could explain the issue of information technology productivity paradox. Lastly, the findings extend the application of the dynamic capabilities theory into supply chain innovation research. The study reveals that the structural and knowledge aspect of dynamic capabilities are complementary to one another. In this perspective, companies build, reconfigure and integrate IT to renew their knowledge and competency and achieve supply chain cost efficiency, customer responsiveness and market performance. Therefore, companies have to relinquish their unfit information technology and knowledge and reconfigure innovatively. Improving knowledge is an important strategic resource and process which must be continuously renewed through learning.

Similarly, from a managerial perspective, the findings provides suggestion on ways to resolve the supply chain

problems of manufacturing companies. The findings suggest that information technology through innovation capability could help the manufacturing companies' resolves issues of poor visibility, poor quality, late delivery, high costs of communication and transaction, poor customer responsiveness and patronage. Nigerian manufacturers are thus encouraged to take proactive measures and developed more ability to apply technologies for continuous improvement and customer focus concepts, work effectively with individuals within and outside the organization and internationally, recognize and resolve conflicts as they arise in collaboration efforts, take advantage of new knowledge, select partners to successfully collaborate with as well as learn from prior collaboration experiences. Practitioners such as chief executive officers, chief operating officers and supply chain managerscould use the findings of this study to implement information technologyfor enhanced supply chain performance.

RECOMMENDATIONS

Limitations and recommendations for further research Despite the findings of the study, it was not without some limitations. First, innovation capability was suggested as a mediator between information technology and supply chain performance. However, other variables such as trust and absorptive capacity can be introduced as mediators into the model. Furthermore, some variables such as environmental uncertainties can also be employed as moderator in future study. Furthermore, the study did not investigates the underlying risks of information technology and innovation capability fit.

There is also a need to understand the cultural implication of why some top management fail to show adequate commitment toward innovation in the supply chain. The study suggests further studies of how knowledge management influence innovation capability since great deal of firms lack supply chain expertise (Gonzalez-Loureiro *et al*., 2014).

Finally, the current findings should be interpreted with cautions and within the cultural context of Nigerian manufacturing industry. This is because, the data comes from Nigerian manufacturing companies which operate under infrastructural disadvantages and poor government commitment to manufacturing companies. Therefore, future studies can be conducted in other developing economies so as to compare the homogeneity and heterogeneity of culture regarding the research framework of this study.

APPENDIX

Reliability and factor loading

S/no.	Construct's items	M	Std.	IR	C α	FL
Information technology					0.76	
FT1	We transmit information to our major customers electronically	5.4	1.2	0.75		0.95
FT2	We receive information from our customers electronically	5.4	1.2	0.65		0.80
FT3	We use information technology-enabled transaction processing	5.3	1.4	0.65		0.77
FT4	Inter-organizational coordination is achieved using electronic links	5.5	1.1	0.77		0.76
Innovation capability					0.74	
IC1	We have ability to take advantage of new knowledge.	5.8	0.81	0.72		0.78
IC2	We have ability to work effectively with individuals within and outside our organization and internationally.	5.9	0.83	0.69		0.64
IC3	We have ability to apply continuous improvement and customer focus concepts	5.9	0.83	0.69		0.67
IC4	We have ability to understand the interconnectedness of supply chain management with other disciplines.	5.9	0.87	0.69		0.75
IC3	We have ability to manage incremental improvements and changes to products, processes and systems	5.8	0.89	0.68		0.69
Supply chain performance					0.82	
SP1	Supply chain helps us reduce total cost	5.9	0.74	0.99		0.75
SP2	Supply chain helps us reduce inventory cost	5.9	0.81	0.79		0.91
SP3	Supply chain helps us reduce inventory build-up	5.9	0.89	0.79		0.77
SP4	Supply chain helps us increase customer responsiveness/service	6.1	0.67	0.80		0.71
SP5	Supply chain helps us deliver product on time	6.1	0.67	0.80		0.76
SP6	Supply chain helps us improve market share	5.9	0.84	0.79		0.84
SP7	Supply chain helps us improve sales growth	5.8	0.83	0.80		0.69
SP8	Supply chain helps us reduce out of stock rate	6.1	0.67	0.81		0.70

M = Mean, Std. = Standard deviation, IR = Item Reliability Cα = Cronbach's alpha and FL = Factor Loading; Cronbach's Alpha for the 17 items = 0.851 kaiser-meyer-olkin measure of sampling adequacy = 0.820, approx. χ^2 = 1720.34, Bartlett's test of sphericity = 135, Sig. = 0.000, total variance explained = 58.135%

REFERENCES

Abd Rahman, A. and D. Bennett, 2009. Advanced manufacturing technology adoption in developing countries: The role of buyer-supplier relationships. J. Manuf. Technol. Manage., 20: 1099-1118.

Ageron, B., O. Lavastre and A. Spalanzani, 2013. Innovative supply chain practices: The state of French companies. Supply Chain Manage. Intl. J., 18: 265-276.

Bagozzi, R.P., 1993. Assessing construct validity in personality research: Applications to measures of self-esteem. J. Res. Personality, 27: 49-87.

Baron, R.M. and D.A. Kenny, 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. J. Pers. Social Psychol., 51: 1173-1182.

Bolivar-Ramos, M.T. and V.J. Garcia-Morales, 2013. The effects of information technology on absorptive capacity and organisational performance. Technol. Anal. Strategic Manage., 25: 905-922.

Chang, K., Y. Chen and H. Huang, 2015. Information technology and partnership dynamic capabilities in international subcontracting relationships. Intl. Bus. Rev., 24: 276-286.

Chen, I.J. and A. Paulraj, 2004. Towards a theory of supply chain management: The constructs and measurements. J. Oper. Manage., 22: 119-150.

Cheng, J.H., M.C. Chen and C.M. Huang, 2014. Assessing inter-organizational innovation performance through relational governance and dynamic capabilities in supply chains. Supply Chain Manage. Int. J., 19: 173-186.

Chin, W.W., 1998. Commentary: Issues and opinion on structural equation modeling. MIS Q., 22: 7-16.

Cirtita, H. and D.A. Glaser-Segura, 2012. Measuring downstream supply chain performance. J. Manuf. Technol. Manage., 23: 299-314.

Cohen, W.M. and D.A. Levinthal, 1990. Absorptive capacity: A new perspective on learning and innovation. Admin. Sci. Q., 35: 128-152.

Durmusoglu, S.S.and G. Barczak, 2011. The use of information technology tools in new product development phases: Analysis of effects on new product innovativeness, quality and market performance. Ind. Marketing Manage., 40: 321-330.

Farag, I., C. Sherrington, S. Kamper, M. Ferreira and A. Moseley *et al*., 2012. Measures of physical functioning after hip fracture: Construct validity and responsiveness of performance-based and self-reported measures. Age Ageing, 41: 659-664.

Fornell, C. and D.F. Larcker, 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Market. Res., 18: 39-50.

Franks, J., 2000. Supply chain innovation. Work Study, 4: 152-155.

Gates, S. and P. Langevin, 2010. Human capital measures, strategy and performance: HR managers perceptions. Accounting Auditing Accountability J., 23: 111-132.

Gonzalez-Loureiro, M., M. Dabic and F. Puig, 2014. Global organizations and supply chain. Intl. J. Phys. Distrib. Logist. Manage., 44: 689-712.

Green, K.W., R.A. Inman, L.M. Birou and D. Whitten, 2014. Total JIT (T-JIT) and its impact on supply chain competency and organizational performance. Intl. J. Prod. Econ., 147: 125-135.

Hair, J.F., G.T.M. Hult, C.M. Ringle and M. Sarstedt, 2013. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). SAGE Publication, Thousand Oaks, CA., USA., ISBN-13: 978-1452217444, Pages: 328.

Hult, G.T.M., R.F. Hurley and G.A. Knight, 2004. Innovativeness: Its antecedents and impact on business performance. Ind. Market. Manage., 33: 429-438.

Jayaram, J., M. Dixit and J. Motwani, 2014. Supply chain management capability of small and medium sized family businesses in India: A multiple case study approach. Intl. J. Prod. Econ., 147: 472-485.

Jean, Jr. J., R.R. Sinkovics and S.T. Cavusgil, 2010. Enhancing international customer-supplier relationships through IT resources: A study of Taiwanese electronics suppliers. J. Intl. Bus. Stud., 41: 1003-1038.

Ketty, R., 1994. Barriers to information technology in Latin America and the Caribbean: Some options Ketty Rodriguez article. J. Commun., 15: 29-35.

Kim, D., S. Cavusgil and R.J. Calantone, 2006. Information system innovations and supply chain management: Channel relationships and firm performance. J. Acad. Market. Sci., 34: 40-54.

Knockaert, M., D. Ucbasaran, M. Wright and B. Clarysse, 2011. The relationship between knowledge transfer, top management team composition and performance: The case of Science-based entrepreneurial firms. Entrepr. Theory Pract., 35: 777-803.

Kortmann, S., C. Gelhard, C. Zimmermann and F.T. Piller, 2014. Linking strategic flexibility and operational efficiency: The mediating role of ambidextrous operational capabilities. J. Operat. Manage., 32: 475-490.

Kristal, M.M., X. Huang and A.V. Roth, 2010. The effect of an ambidextrous supply chain strategy on combinative competitive capabilities and business performance. J. Oper. Manage., 28: 415-429.

Kurnaz, S., A. Cohn and Y. Koren, 2005. A framework for evaluating production policies to improve customer responsiveness. CIRP. Ann. Manuf. Technol., 54: 401-406.

Lavastre, O., B. Ageron and L.C. Alain, 2014. Innovative Supply Chain Practices (ISCP) in supply chain management: Development and validation of a measurement scale. Manage., 17: 263-298.

Lee, R.P., J.L. Johnson and X. Tang, 2012. An investigation into the role of IT integration, relationship predictability and routinization in inter firm relationships: From the structuration perspective. Ind. Marketing Manage., 41: 368-377.

Liao, S. and F. Kuo, 2014. The study of relationships between the collaboration for supply chain, supply chain capabilities and fi rm performance: A case of the Taiwan's TFT-LCD industry. Intl. J. Prod. Econ., 156: 295-304.

Mathieu, J.E. and S.R. Taylor, 2006. Clarifying conditions and decision points for mediational type inferences in organizational behavior. J. Organ. Behav., 27: 1031-1056.

Mccarthy-Byrne, T.M. and J.T. Mentzer, 2011. Integrating supply chain infrastructure and process to create joint value. Intl. J. Phys. Distrib. Logist. Manage., 41: 135-161.

Melnyk, S.A., R.R. Lummus, R.J. Vokurka, L.J. Burns and J. Sandor, 2009. Mapping the future of supply chain management: A Delphi study. Int. J. Prod. Res., 47: 4629-4653.

Mokkink, L.B., C.B. Terwee, D.L. Patrick, J. Alonso and P.W. Stratford, *et al*., 2010. The COSMIN study reached international consensus on taxonomy, terminology and definitions of measurement properties for health-related patient-reported outcomes. J. Clin. Epidemiol., 63: 737-745.

Murray, P. and D. Blackman, 2006. Managing innovation through social architecture, learning and competencies: A new conceptual approach. Knowl. Proc. Manage., 13: 132-143.

Nonaka, I. and H. Takeuchi, 1995. The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press, New York, ISBN: 0195092694, Pages: 284.

Nunnally, J.C., 1978. Psychometric Theory. 2nd Edn., McGraw-Hill, New York, USA., ISBN-13: 9780070474659, Pages: 701.

Panayides, P., 2006. Enhancing innovation capability through relationship management and implications for performance. Eur. J. Innovation Manage., 9: 466-483.

Prajogo, D. and J. Olhager, 2011. Supply chain integration and performance: The effects of long-term relationships, information technology and sharing and logistics integration. Int. J. Prod. Econ., 135: 514-522.

Qrunfleh, S. and M. Tarafdar, 2013. Lean and agile supply chain strategies and supply chain responsiveness: The role of strategic supplier partnership and postponement. Supply Chain Manage. Int. J., 18: 571-582.

Queen, T., N. Ireland and P. Middleton, 2000. Barriers to the efficient and effective use of information technology. Intl. J. Pub. Sector Manage., 13: 85-99.

Rahman, A.A., N.J. Brookes and D.J. Bennett, 2009. The precursors and impacts of BSR on AMT acquisition and implementation. IEEE. Trans. Eng. Manage., 56: 285-297.

Rai, A., R. Patnayakuni and N. Seth, 2006. Firm performance impacts of digitally enabled supply chain integration capabilities. MIS Quarterly, 30: 225-246.

Rajesh, R. and J.M. Margaret, 2012. Effects of inter-organizational compatibility on supply chain capabilities: Exploring the mediating role of Inter-Organizational Information Systems (IOIS) integration. Ind. Market. Manage.,

Schweitzer, J., 2014. Leadership and innovation capability development in strategic alliances. Leadersh. Organiz. Dev. J., 35: 442-469.

Seggie, S.H. D. Kim and S.T. Cavusgil, 2006. Do supply chain IT alignment and supply chain interfirm system integration impact upon brand equity and firm performance?. J. Bus. Res., 59: 887-895.

Seo, Y.J., J. Dinwoodie and D.W. Kwak, 2014. The impact of innovativeness on supply chain performance: Is supply chain integration a missing link?. Supply Chain Manage. Intl. J., 19: 733-746.

Singhry, H.B., A.A. Rahman and S.I. Ng, 2014. The potential moderating role of supply chain capabilities on the relationship between supply chain technology and concurrent engineering in product design. Int. J. Sup. Chain. Mgt., 3: 132-139.

Sohal, A.S., 2013. Developing competencies of supply chain professionals in Australia: Collaboration between businesses, universities and industry associations. Supply Chain Manage. Intl. J., 18: 429-439.

Soni, G. and R. Kodali, 2012. A critical review of empirical research methodology in supply chain management. J. Manuf. Technol. Manage., 23: 753-779.

Stank, T.P., J. Dittmann and W. Autry, 2011. The new supply chain agenda: A synopsis and directions for future research. Intl. J. Phys. Distrib. Logist. Manage., 41: 940-955.

Stank, T.P., P.J. Daugherty and C.W. Autry, 1999. Collaborative planning: Supporting automatic replenishment programs. Supply Chain Manage. Int. J., 2: 75-85.

Storer, M. and P. Hyland, 2009. Dynamic capabilities and innovation in supply chains. CINet., 2009: 912-923.

Sudman, S., A. Greeley and L. Pinto, 1965. The effectiveness of self-administered questionnaires. J. Marketing Res., 1965: 293-297.

Szolnoki, G. and D. Hoffmann, 2013. Online, face-to-face and telephone surveys: Comparing different sampling methods in wine consumer research. Wine Econ. Policy, 2: 57-66.

Tan, K.H., Y.Z. Zhan, G. Ji, F. Ye C.and C. Chang, 2015. Harvesting big data to enhance supply chain innovation capabilities: An analytic infrastructure based on deduction graph. Intl. J. Prod. Econ., 165: 223-233.

Teece, D.J., 2007. Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. Strat. Manage. J., 28: 1319-1350.

Wade, M. and J. Hulland, 2004. Review: The resource-based view and information systems research: Review, extension and suggestions for future research. MIS Q., 28: 107-142.

Wendling, M., M. Oliveira and A.C.G. Macada, 2013. Knowledge sharing barriers in global teams. J. Syst. Inf. Technol., 15: 239-253.

Wu, I.L., C.H. Chuang and C.H. Hsu, 2014. Information sharing and collaborative behaviors in enabling supply chain performance: A social exchange perspective. Intl. J. Prod. Econ., 148: 122-132.

Yang, T., 2013. The impact of resumption of former top executives on stock prices: An event study approach. J. Bus. Econ. Manage., 14: 292-302.

Ye, F. and Z. Wang, 2013. Effects of information technology alignment and information sharing on supply chain operational performance. Comput. Ind. Eng., 65: 370-377.

Yul, S., and K. Kyu, 2015. Expert systems with applications the impact of knowledge complementarities on supply chain performance through knowledge exchange. Exp. Syst. Appl., 42: 3029-3040.