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Effect of Supply Chain Technology, Supply Chain Collaboration and Innovation Capability on Supply Chain Performance of Manufacturing Companies

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Abstract

The dynamic business environment requires constant upgrade of firms' capabilities and processes to influence the innovation capability. The purpose of this study is twofold. First, to investigate the mediating effect of innovation capability on the relationships between supply chain technology and supply chain performance. Second, to determine the intervening role of innovation capability on the relationship between supply chain collaboration and supply chain performance. The study was based on the epistemology of post-positivism worldview and the methodology of cross-sectional survey of top managers at a firm level. Cluster and stratified random sampling were employed utilized. Questionnaires were distributed and collected through self-administered (face-to-face) method. Structural equation modeling with Amos graphic was used for analysis. The finding that innovation capability is a full mediator on the relationship between supply chain technology and supply chain performance as well as on supply chain collaboration and supply chain performance. The study improves the literature of the supply chain management through the incorporation of supply chain technology (advanced manufacturing technologies and information technology), supply chain collaboration (concurrent engineering of product design, collaborative planning, forecasting, & replenishment, and collaborative marketing), and innovation capability. For practice, the study provides guidance for managers to improve firms' supply chain performance.

Keywords: Supply chain technology, supply chain collaboration, innovation capability, and supply chain performance
JEL Classification: O3, C8, D2, D3, L1, L6, M1, M3, Y1,

Introduction

Supply chain management (SCM) is a dynamic strategy for firms' competitiveness and performance. Despite the advances in supply chain management literature, several issues continue to challenge firms' abilities to deliver quality products at the right cost, place and time. First, factors such as weak corporate technological culture, technological paradox, lack of technological expertise, under-utilization of technology, and incompatible technological system continue to affect the implementation of supply chain technology (Adegbie & Adeniji, 2013). Similarly, supply chain collaboration has proven more challenging and vague to implement. Difficulties such as breakdown of trust, different goals and priorities, and lack of compatible communication structure affect the development of collaborative culture (Nagashima, Wehrle, Kerbache, & Lassagne, 2015; Ramesh, Banwet, & Shankar, 2010).

Second, mixed findings on the relationship between supply chain technology and supply chain performance as well as between supply chain collaboration and supply chain performance suggest the need for further research to resolve the inconsistency. For example, Davis-Sramek, Germain, & Iyer (2010) and Richey, Adams, & Dalela (2012) suggest significant relationship between supply chain technology and supply chain performance. However, Omar, et al. (2006) concluded that supply chain technology is not significantly related to manufacturing performance. Furthermore, Kumar and Nath (2014) and Ramanathan and Gunasekaran (2014) found significant relationship between supply chain collaboration and supply chain performance. However, Hadaya and Cassivi (2007) show that collaborative planning does not influence supply chain performance. Similarly,Valle & Vázquez-Bustelo (2009) suggest that in a period of uncertainties and for companies pursuing radical innovation, collaborative engineering does not influence product development time and quality. On top of these mixed findings, the integration of advanced manufacturing technology and information technology as supply chain technology is not clear in the literature. Equally, the combination of concurrent engineering of product design, collaborative planning, forecasting, & replenishment, and collaborative marketing as supply chain collaborative processes remain fuzzy in the literature.

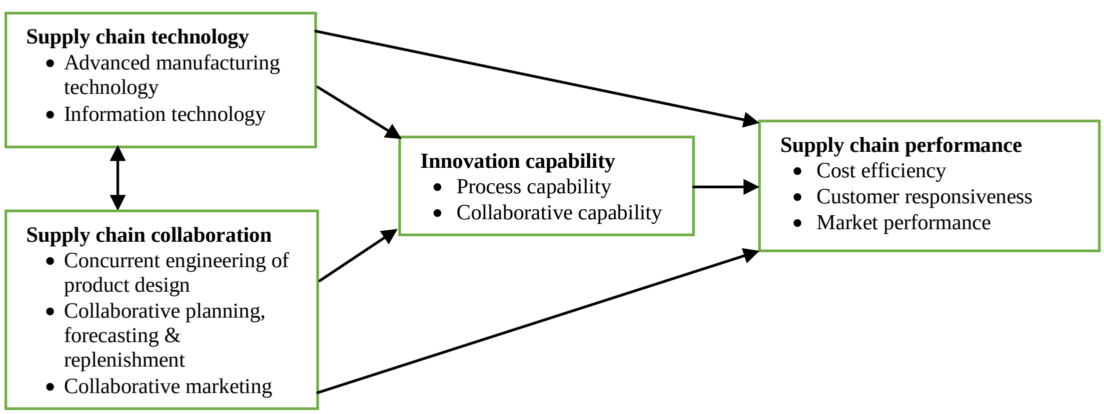
Third, although the performances of Nigerian manufacturing companies has improved from 6.13 per cent to 7.71 per cent (Alao & Amoo, 2014; Schwab, 2013), the industry is challenged by less advanced production and information technologies, dearth of qualified middle managers, and breakable collaboration. The effects cause high operating cost, poor product quality, late delivery, and dissatisfied customers (Aniki, Mbohwa, & Akinlabi, 2014; Onuoha, 2013). As a result many Nigerian manufacturing companies have closed down (Ebhota & Ugwu, 2014). Thus, the need for country-specific and firm specific studies to reposition the competitiveness of Nigerian manufacturing companies in a globalized world (Singhry, 2015). In order to cover the gaps and resolve the emerging issues, the paper investigates the role of innovation capability on the combined effect of supply chain technology, supply chain collaboration and supply chain performance.

Supply chain technology is a dynamic capability that firms must build, integrate, and reconfigure to enhance performance (Teece, 2010). This technology influences the transformation and distribution of materials and goods (Meybodi, 2013). It helps the supply chain reduce cost of transaction and communication. It improves product quality and on-time delivery (Das and Nair, 2010), facilitates real-time information sharing (Prajogo and Olhager, 2012), which subsequently enhances firm performance (Prasad and Heales, 2010). Supply chain collaboration (SCC) is a dynamic process for partners to 'move as one' (Bolstorff & Rosenbaum 2012). Collaboration improves information visibility and sharing, development of mutual plan, forecast and replenishment, sense of responsibilities, end-customer satisfaction (Sandberg, 2007), and ultimately supply chain performance (Liao and Kuo, 2014). Furthermore, as a 'learning-to-learn type' (Collis, 1994), the "cultural readiness and appreciation of innovation' (Hult et al., 2004), innovation capability builds knowledge and propel innovation orientation (Börjesson, et al., 2014; Pavlou & El Sawy, 2011) which also stimulate supply chain performance (Panayides and Lun, 2009).

Theoretical Background

The research framework extends the recommendation for future studies by Ageron et al. (2013) through the theoretical lens of the dynamic capabilities theory (DCT) (Teece, 2007). In this paper, technology is a dynamic capability while collaboration is a dynamic process. Technology and collaboration must be modified for mutual benefits to enhance supply chain performance. The upper echelon managers of Nigerian manufacturing companies play important role toward technology implementation and facilitations of collaboration with major partners. It is thus, suggested that firms with greater dynamic resources compete better than those with less (Teece, 2007). Therefore, the research framework of this study is developed and presented in Figure 1.

Figure 1. Research framework of supply chain innovation and supply chain performance



Hypothesis development

Supply chain technology and supply chain performance in the presence of innovation capability

Firms implement new technologies to build competences across the supply chain (Wu, 2014). The goal is to develop innovation orientation and achieve competitive advantage (Teece, 2007). Firms with strong technological competences achieve higher level of gains than those with lower (Garcia, Avella, and Farnandez 2012; Singhry, Abd Rahman, and Ng, 2014). Although significant relationship between advanced manufacturing technology (AMT) and SCP have been suggested (Roh et al., 2014; Sha et al., 2008), Small and Yasin (1997) concluded that not all AMT influence performance. Additionally, Gunasekaran (1999) suggested that AMT alone does not guarantee customer and market success. Similarly, despite the benefits of information technology in the supply chain, many organizations were disappointed with the outcomes of their IT investment due to productivity paradox (Ye and Wang, 2013). Although previous studies have found significant relationship SCT and SCP, SCC and SCP, and SCT and IC, Hortinha et al. (2011) found that innovation capability mediates the relationship between technology orientation and performance of manufacturing companies. However, the role of innovation capability on the

relationship between supply chain technology and supply chain performance is not clear. Based on the argument above and the DCT which demonstrates the need to modify and implement new technologies for knowledge creation and supply chain performance, it is proposed that:
H1: Innovation capability mediates the relationship between supply chain technology and supply chain performance.

Supply chain collaboration and supply chain performance in the presence of innovation capability
The knowledge-based view of the dynamic capabilities theory shows that acquiring, combining, and sharing knowledge is critical to innovation and competitive advantage (Zahra et al., 2007). Accordingly, Petti and Zhang (2013) found significant influence of collaboration on knowledge exploration, exploitation and firm performance. Likewise, Koufteros and Vonderembse (2005) found a significant relationship between concurrent engineering of new product development and innovation performance. However, Valle and V'azquez-Bustelo (2009) suggest that in a period of uncertainties and for companies pursuing radical innovation, concurrent engineering does not influence product development time and quality. Furthermore, Hadaya and Cassivi (2007) did not find significant relationship between collaborative planning and SCP. Although, Seo et al. (2014) found an indirect effect of innovativeness on the relationship between integration and supply chain performance, the intervening role of innovation capability on the relationship between supply chain collaboration and supply chain performance remains unclear. Based on the knowledge-based view of the dynamic capabilities theory and the preceding arguments, it is postulated that:

H2: Innovation capability mediates the relationship between supply chain collaboration and supply chain performance.

Method and Measurement
This study used quantitative research methodology based on cross-sectional survey. Data was collected from members of Manufacturers' Association of Nigeria (MAN). 323 companies were randomly selected from a population of 1574. Cluster and systematic sampling techniques were used to select the respondents. The companies were selected based on location (Branches) and sectors. Subsequently, a systematic sampling was conducted to select the companies that participated in this survey. Self-administered (face-to-face) questionnaire with the help of 8 research assistants were employed for data collection. The research assistants have experience in administering questionnaires. The sample size was computed from the table of sample size determination as suggested by Krejcie and Morgan (1970). 292 questionnaire were filled and returned and 286 were found usable. The response rate was 90.4% and greater than 76% (Sudman, Greeley, & Pjnto, 1965) and more effective than mail and telephone surveys (Szolnoki and Hoffmann 2013).

The research instruments in this study have been validated in previous literature. They were directly adapted in some while adopted and modified in others to suit the context of this study. All items have been measured on 7 point Likert-type scale from 1 = strongly disagree to 7 = strongly agree. AMT measurement was extracted from Bülbül et al. (2013), Dıaz et al., (2003), Koc and Bozdag (2009), and Mora-Monge et al. (2008). Information technology was picked from Chen and Paulraj (2004), McCarthy-Byrne and Mentzer (2011), and Wu et al.(2006). Concurrent engineering of product design was mined from Chen and Paulraj (2004) and Feng and Wang (2013). CPFR was chosen from Maltz and Kohli (1996), McAllister (1995), and

McCarthy-Byrne and Mentzer (2011). Collaborative marketing was selected from Acur et al. (2012), Doney and Cannon (1997), Ganesan (1994), Green et al. (2012), McCarthy-Byrne and Mentzer (2011). Innovation capability was adopted and modified from Storer and Hyland (2009) and Zacharia et al. (2011). Supply chain performance was adopted from Cirtita and Glaser-Segura (2012), Rajaguru and Matanda (2013), Stank et al. (1999) and Ye and Wang (2013).

Result

First, Cronbach's reliability and factor loading were assessed to classify the dimensions of the constructs. The items reliability ranges between .54 and .93 (Nunnally, 1978) while the factor loading between .71 and .91. Next, the common method bias was assessed based on Harman's single factor test. Exploratory factor analysis show that all constructs' have % of variance and sums of squared of 25.650 less than 30%. This suggests that common method bias was not a major issue in this study (Podsakoff et al., 2003). Table 1 represents the item reliability and constructs' factor loadings.

Table 1: Exploratory factor analysis

Constructs and Items		**Reliability Cronbach's (α)**	**Factor loading**
Advanced manufacturing technology			**.905**
MT1	We use computer-aided engineering (CAE)	.71	
MT2	We use computer-aided design	.63	
MT3	We use computer numerically controlled machine tools	.72	
MT4	We use computer-aided inspection (CAI)	.87	
MT5	We use automated guided vehicles (AGV)	.85	
MT6	We use automated materials handling systems	.68	
MT7	We use automated storage	.68	
Information technology			**.813**
FT1	There are direct computer-to-computer links with our key supply chain partners	.59	
FT2	Our IT system is compatible with those of our supply chain partner	.90	
FT3	Our IT system can be seamlessly connected with those of supply chain partners	.83	
FT4	We transmit information to our major customers electronically	.90	
FT5	We receive information from our customers electronically	.83	
Concurrent engineering of product design			**.825**
CE1	There is a strong consensus in our firm that major supplier involvement is needed in product design/development	.57	
CE2	We involve major suppliers at product design and development stage	.59	
CE3	We have joint planning committees on key issues with major suppliers	.90	
CE4	Major customer was an integral part of the design effort for new product	.73	
Collaborative planning, forecasting, & replenishment (CPFR)			**.710**
CP1	We often adjust our production system to meet the requirement of our customers.	.92	

CP2	We often work with major customers to determine the delivery schedules that will best meet their needs.	.58	
CP3	We try to incorporate our suppliers' and customers' forecast into our forecast	.54	
CP4	We work with major suppliers and customers to help them improve their forecast accuracy	.68	
CP5	We work with supply chain partners to develop joint sales forecast for replenishment	.80	
CP6	We can depend on our suppliers to provide us with good market forecast and planning information	.76	
CP7	If we request forecasting data from our customers, they would respond constructively and caringly	.69	
Collaborative marketing			**.815**
CM1	Future markets are explicitly addressed in our interactions with major customers	.60	
CM2	We often participate in our customer's decisions regarding retail pricing	.93	
CM3	We often consult with this customer to help design promotional activities that are exclusive to this relationship	.86	
CM4	We work with major customers to plan and execute a pricing strategy for the sale of products	.73	
CM5	We work with major customers to plan and execute a promotion strategy for the sale of products	.76	
CM6	We work with major customers to plan and execute a distribution strategy for the sale of products	.74	
CM7	Our major customers are always frank and truthful with us	.72	
CM8	We believe the marketing information major customers provides us	.91	
Innovation capability			**.782**
NC1	We have developed more ability to select partners to collaborate with	.86	
NC2	We have developed more ability to learn from prior collaboration experience	.77	
NC3	We have developed more ability to apply continuous improvement and customer focus concepts.	.69	
NC4	We have developed more ability to understand the interconnection of supply chain management with other disciplines.	.73	
NC5	We have developed more ability to manage incremental improvements and changes to products, processes and systems.	.68	
Supply chain performance			**.818**
SP1	Supply chain helps us reduce manufacturing cost	.75	
SP2	Supply chain helps us reduce total cost	.91	
SP3	Supply chain helps us reduce inventory cost	.76	
SP4	Supply chain helps us increase customer responsiveness/service	.72	
SP5	Supply chain helps us deliver product on time	.76	
SP6	Supply chain helps us reduce out of stock rate	.83	
SP7	Supply chain helps us improve market share	.70	

SP8	Supply chain helps us improve sales growth	.68	

Confirmatory factor analysis – validity

Construct, convergent, and discriminant validities were assessed in this study. Two approaches were used to evaluate the construct validity of this study. The four conditions proposed by Mokkink et al. (2010). Next is the Pearson correlation coefficients as underlined by Farag et al. (2012) and Rod et al. (2013). The result showed correlations coefficients between 0.144 and 0.602 (refer to Table 3). No variables correlated above 0.85 and therefore multicollinearity was not a problem in this study (Awang, 2014).

Convergent validity was evaluated based on recommendations by Fornell and Larcker (1981) and Hair Jr, et al. (2013). First, item loading should be > .70 and significance. Second, composite reliability of each construct must be > .80. Third, average variance extracted (AVE) of all construct must be > .50 (Fornell and Larcker, 1981). Furthermore, Hair et al. (2012) contend that factor loading above .4 be taken if deletion affect construct validity or composite reliability. Table 2 demonstrates that item loading range between .71 and .91. The composite reliability between .81 and .93; AVE between .53 and .68. Therefore, proof of convergent validity exist (Anderson and Gerbing, 1988)

Discriminant validity was evaluated on the criterion validated by Fornell and Larcker (1981). The benchmark states that "the square root of AVE for each construct must be greater than its correlations with all other constructs". This means that "AVE should exceed the squared correlation with any other construct" (Hair Jr et al., 2013). The bold figures in Table 2 show that the square root of AVE for each construct is greater than its correlation with all other constructs (Fornell and Larcker 1981). Furthermore, figures above the bold values are smaller than AVE (Hair Jr et al., 2013). Thus results indicate that each construct is statistically discrete from another (Chin, 1988) and therefore suggest the presence of discriminant validity (Anderson and Gerbing 1988).

Table 2. Construct, convergent and discriminant validities

Variable	Mean	SD	AMT	IT	CEPD	CPFR	CM	IC	SCP	CR	AVE
AMT	33.038	8.801	**.738**	.362	.081	.056	.099	.133	.026	.893	.546
IT	26.543	4.923	.602**	**.822**	.148	.138	.110	.308	.099	.911	.676
CEPD	31.794	5.235	.284**	.384**	**.726**	.226	.176	.154	.075	.809	.527
CPFR	38.271	4.355	.237**	.371**	.475**	**.725**	.260	.192	.150	.883	.525
CM	42.636	5.831	.315**	.332**	.419**	.510**	**.787**	.145	.125	.928	.620
IC	28.895	3.074	.365**	.555**	.392**	.438**	.381**	**.749**	.181	.864	.561
SCP	47.595	3.968	.162**	.316**	.273**	.387**	.354**	.425**	**.762**	.917	.581

AMT = advanced manufacturing technology, IT = information technology, CEPD = concurrent engineering of product design, CPFR = collaborative planning, forecasting, & replenishment, CM = collaborative marketing, SCIC = innovation capability, TMS = top management support, SCP = SCP

1. **. Correlation coefficient is significant at the 0.01 level (2-tailed).
2. *. Correlation coefficient is significant at the 0.05 level (2-tailed).
3. Bold diagonal values are the squared root of average variance extracted (AVE)
4. Values above the diagonal are the squared correlation of variables.

Validating the structural model

The model is a mediation beyond Baron & Kenny (1986) as suggested by Hayes (2009). Four conditions must be satisfied for mediation to occur: "(a) the total effect of X on Y (t) must be significant; (b) the effect of X on M (α) must be significant; (c) the effect of M on Y (β) must be significant; (d) the direct effect of X on Y adjusted for M (t') must be smaller than the total effect of X on Y" (Baron and Kenny, 1986; Mathieu and Taylor, 2006). Prior to the analysis of the structural model in Figure 2, the first three steps of the mediation analysis were evaluated and result is presented in Table 3.

Figure 2. Model of supply chain innovation and supply chain performance

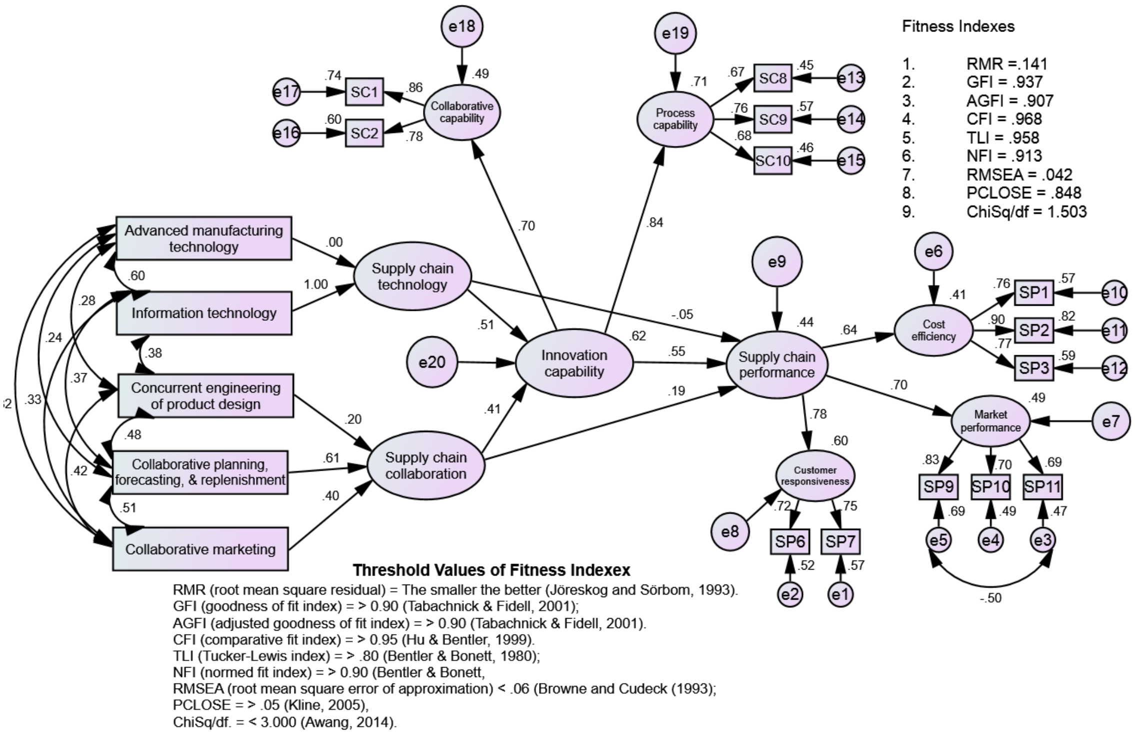


Table 3. Result of standardized and unstandardized regression estimate of the mode

Stages of mediation analysis	**Relationship**	**Std. Beta**	**R^2**	**Actual Beta**	**S.E.**	**C.R.**	**P**
Stage one X→Y	Supply chain technology and supply chain performance	.254		.022	.007	3.305	***
	Supply chain collaboration and supply chain performance	.428	.333	.022	.007	3.118	.002
Stage two X→M	Supply chain technology and innovation capability	.512		.051	.009	5.948	***
	Supply chain collaboration and innovation capability	.415		.028	.007	3.843	***
Stage three M→Y	Innovation capability and supply chain performance	.553		.403	.148	2.718	.007
Stage four	Supply chain technology and supply chain performance	-.06		-.003	.009	-.383	.702 **(ns)**
	Supply chain collaboration and supply chain performance	.191		.010	.006	1.664	.096 **(ns)**
Coefficient of	Innovation capability		.618				

determination	SCP		.437				
Interpretation	*ns = not significant and not supported						

The first criteria shows that the relationship between supply chain technology and supply chain performance is significant (β = 0.254; P < 0.001). Similarly, supply chain collaboration influences supply chain performance (β = .43, P < 0.01). The test for the second condition revealed that supply chain technology is significantly related with innovation capability (β = .51, P < 0.01). Correspondingly, supply chain collaboration influences innovation capability (β = .42, P < 0.01). Furthermore, the third condition indicated that innovation capability is positively and significantly related with supply chain performance (β = .65, P < 0.01).

Test of hypotheses

Data from Figure 2 and Table 3 are used to compute the mediation effects. Table 4 shows a full intervening effect of innovation capability on its relationship with supply chain technology and supply chain performance [(β for X→M = 0.512; M→Y = 0.553; and X→Y = -0.046)]. Accordingly, Table 5 demonstrates that innovation capability is a full mediator on the relationship between supply chain collaboration and supply chain performance [(β for X→M = 0.415; M→Y = 0.553; and X→Y = 0.191)].

Table 4. Supply chain technology and supply chain performance in the presence of innovation capability

Test of Hypothesis 1	**Path estimate**	**Actual estimate**	**P-Value**	**Results**
SCT and Innovation capability	0.512	.051	0.000	Significant
Innovation capability and SCP	0.553	.403	0.007	Significant
SCT and SCP	-0.046	-.003	0.702	Not significant

1. The indirect path effect (standardized path estimate) = 0.512 x 0.553 = 0.2831
2. The direct part (standardized path estimate) = -0.046
3. Both the indirect path (standardized path estimate) of X → M and M → Y are positive and significant and greater than (β = 0.051, P > 0.001) respectively.
4. Since the product of indirect effects (.512 x .553 = 0.2831) is greater than direct effect (-0.046), full mediation occurs
5. The type of mediation is full mediation since the direct effect is no longer significant (P > 0.05) after innovation capability enters the model.

Table 5. Supply chain collaboration and supply chain performance in the presence of innovation capability

Test of Hypothesis 2	**Path estimate**	**Actual estimate**	**P-Value**	**Results**
SCC and innovation capability	.415	.028	***	Supported
Innovation capability and SCP	.553	.403	.007	Supported
SCC and SCP	.191	.010	.096	Not supported

1. The indirect path effect (standardized path estimate) = .415 x .553 = 0.2295
2. The direct path (standardized path estimate) = .0191
3. Both the indirect path (standardized path estimate) of X → M and M → Y are positive and significant (β= 0.415, P < 0.01).
4. Since the product of indirect effects (.415 x .553 = 0.2295) is greater than direct effect

(0.191), mediation occurs

5. The type of mediation is full mediation since the direct effect is no longer significant (P >) after IC enters the mode

Discussion

The first stage of the mediation results show a positive relationship between supply chain technology and supply chain performance. This finding is consistent with Richey et al. (2012) who suggested that technological complementarity influence logistics quality. Agus (2008) suggested that the adoption and use of new technology in supply chain has statistical relationship with product quality and business performance. Henderson et al. (2004) observed that the integration of AMT and information technology influence firm performance. Likewise, there is a significant relationship between supply chain collaboration and supply chain performance. This finding is similar to Nix and Zacharia (2014) suggest that collaborative engagement directly influences operational and relational outcomes. van Hoof and Thiell (2014) found that SCC influences cleaner production and sustainable competitive advantages. Ramanathan and Gunasekaran (2014) found that collaborative alliances improve supply chain performance. Additionally, the relationship between innovation capability and supply chain performance (M→Y) is positive. This finding is consistent with Panayides & Lun (2009) and Seo et al. (2014) who found that innovativeness influences supply chain performance. Similarly, Singhry (2015) found that innovation capability relates with supply chain innovation which afterward influences supply chain performance.

The introduction of innovation capability into the model changed the relationship between supply chain technology and supply chain performance to negative and non-significant (Stage 4 – Table 3). Therefore, innovation capability has a fully mediates the relationship between supply chain technology and supply chain performance (H1). This finding means that Nigerian manufacturing companies could integrate AMT and IT to increase their process and collaborative capabilities for supply chain performance. Thus, the companies could enhance cost efficiency, customer patronage, and market performance by designing a strategy that include the integration of computer-aided manufacturing, computer-aided engineering, computer-aided design, computer-numerically controlled machine, computer-aided inspection, and automated guided vehicles. Other technological competences include automated materials handling systems, automated storage, and compatible IT to connect and transmit real-time information. Although this finding is unique, it is similar even though not directly related with Hortinha et al. (2011) who found that innovation capability (exploitative and explorative) mediates the relationship between technology orientation and performance. Additionally, Chang et al. (2015) found that joint dynamic capabilities mediate between information technology investments and collaborative value.

Similarly, the introduction of innovation capability between supply chain collaboration and supply chain performance changed the positive relationship into non-significant. Thus, innovation capability is a full mediator between supply chain collaboration and supply chain performance (H2). This shows that relationship with suppliers, customers, and among organizational functional units enhance knowledge creation, innovation orientation and consequently improve the supply chain performance. This finding is similar but not directly related with Chen et al. (2013) who found an indirect effect of marketing capability on the relationship between collaborative communication and customer performance. Equally, Shin and Damon (2012) found an indirect effect of marketing capability on customer orientation and firm performance. Nigerian manufacturing companies should nurture the culture of supply chain collaborative practices to improve innovation capability.

Conclusion

This paper shows how innovation capability depends on supply chain technology and supply chain collaboration to propel firm performance. The study reveals that the relationship between supply chain technology and supply chain performance, as well as supply chain collaboration and supply chain performance is more complex than what has been suggested in the isolated literature of operation and strategic management. The three issues raised and objective of the paper have been achieved. The mediation effects indicate that innovation is an action-based concept that cannot measure supply chain performance directly (Rhee, Park, and Lee, 2010). Therefore, innovation capability is the mechanism through which technology and collaboration enhances better cost reduction, customer agility, and market performance. The findings of this paper yield some interesting theoretical and practical contributions.

Theoretically, the paper is the first to introduce innovation capability as a mediator variable between supply chain technology, supply chain collaboration and supply chain performance. The intervening effects of innovation capability explain the mixed results in previous studies. The introduction of innovation capability into the model alters the direct relationship of supply chain technology and collaboration with SCP, and therefore caused full mediation effects. The mediation effect indicates that higher SCP depends on enhancement of process and collaborative capabilities. This demonstrates that higher SCP depends on development of process and collaborative capabilities. Thus the paper contributes toward resolving the inconsistent findings of SCT and SCP and SCC and SCP.

Practically, the findings provide insights and guidelines to chief executive officers, supply chain, and production managers of manufacturing companies on strategies to integrate technologies and collaboration to lessen challenges associated with poor distribution networks, less advanced production and information technologies, breakable collaboration, and low manufacturing skills. The objective is to reduce inventory costs, manufacturing costs, bullwhip effect, lead times, late delivery, and weak collaboration. Nigerian manufacturers are thus encouraged to take proactive measures to developed ability to apply technologies for continuous improvement and customer focus concepts, work effectively with individuals within and outside our organization and internationally, take advantages of new knowledge, select partners for effective collaboration, and learn from prior collaboration experiences. The study will also guide managers on how to develop innovative behaviours and cultures toward adopting and using new technologies as well as seek for new collaborative opportunities (Škerlavaj et al., 2010). Innovation in technology without corresponding increase in employees skilled usually has negative consequences (Soosay et al., 2008). As such upgrades of innovation capability is pre-requisite for supply chain success.

Limitations and recommendations for further Study

Despite the important findings of this study, it was not without some limitations. First, a case-based approach as well as longitudinal could help overcome some of the limitations of the cross-sectional study. Second, some variables could add interesting value in this study which have not been observed. Thus, future research should investigates how organizational culture interact with supply chain technology, collaboration, and performance. Organizational culture generally refers to the organizational values communicated through norms, artifacts, and observed behavioral patterns (Hogan & Coote, 2014). Accordingly, this study recommends the investigation of

Schein's model of organizational culture. Despite the value of Schein's model, empirical studies in relation to the supply chain is scarce. Third, the underlying risks of supply chain technology and collaboration should be investigated. Disruption in sourcing, production, and distribution can cause immediate shortages and lack of capacity utilization. These could increase the susceptibility of the supply chain. Fourth, the effect of quality management in supply chain technology and collaboration need investigation. Quality management is important for maintain technological capabilities (Zu & Kaynak, 2012). It has been suggested that quality management could influence customer satisfaction and profit (Kuei, Madu, Lin, & Chow, 2002). Finally, the current findings should be interpreted with cautions and within the cultural context of Nigerian manufacturing industry. This is because Nigerian manufacturing companies operates in an unstable environment with infrastructural disadvantages and poor manufacturing supports. Therefore, future studies can be conducted in other economies such as Malaysia, Brazil, South Africa, and Egypt to compare the findings of this study.

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