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SUPPLY CHAIN INNOVATION AND PERFORMANCE OF MANUFACTURING COMPANIES

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ABSTRACT: *Challenges emerging from globalization, rising cost, and the need to be responsive to customers are confronting todays supply chain. As such empirical studies on supply chain innovation are crucial for theory and practice. However, literature on supply chain innovation is quite scarce. The aim of this study is to examine the impact of supply chain innovation on supply chain performance of manufacturing companies. The study was based on cross-sectional survey of 286 manufacturing companies in Nigeria. Cluster and stratified random sampling were employed and self-administered to the selected companies. Data was analyzed using structural equation modeling (Amos). Results suggest that supply chain innovation has significant relationship with supply chain performance. Theoretically, the study is the first to conceptualize technologies, collaborative processes, top management support, and innovation capability as indicators of supply chain innovation. Practically, the study provides guidelines for managers on manufacturing companies on strategies to pursue innovation in the supply chain. Limitations and suggestions for further studies were subsequently provided.*

KEYWORDS: Supply Chain Innovation, Supply Chain Technology, Supply Chain Collaboration, Innovation Capability, Top Management Support, Supply Chain Performance.

INTRODUCTION

Supply chain management is one of the important corporate strategies for competitive advantage and performance. Today, firm success relies on the "interactions between the flows of information, materials, money, manpower, and capital equipment" (Soni & Kodali, 2012). Despite the benefits of supply chain performance, it is confronted by many challenges which continuously affect its performance impact. These challenges include globalization, increasing cost, heightened customer expectations, price pressure, and shortened product life cycles (Rimiene & Bernatonyte, 2013). Therefore, traditional supply chain management models need improvement in order to build new models and also encourage managers to relinquish old supply chain configuration to reconfigure innovative ones (Arlbjørn, de Haas, & Munksgaard, 2011; Ageron, Lavastre, & Spalanzani, 2013; Melnyk, Lummus, Vokurka, Burns, & Sandor, 2009; Storer & Hyland, 2009). As such innovation in supply chain becomes a topical issue.

Despite the importance of innovation in supply chain toward cost reduction (Stank, Dittmann, & Autry, 2011), customer responsiveness (Butner, 2010), bullwhip effects (Barros, Barbosa-Póvoa, & Blanco, 2013), competitive advantage, supply chain performance (Tan, Zhan, Ji, Ye, & Chang, 2015) and market performance (Stank, Dittmann, & Autry, 2011); its theoretical and empirical boundaries is still not matured, and literature is not only quite scarce but also not integrative. Based on these, researchers question why the supply chain management have ignored innovation or why innovation have ignored the supply chain (Arlbjørn et al., 2011;

Lavastre, Ageron, & Alain, 2014). On top of that, the few literature on supply chain innovation are from the perspectives of developed countries and among multinational companies (Li, 2012). The 5 percent of the research in developing countries were done in Asia and South America (Soni & Kodali, 2012). Thus, creating vacuum in other developing economies, especially in Africa.

Furthermore, although few studies exist on supply chain innovation, concept were not integrated. Types of innovation includes technological, organizational, marketing, process, and product. However, past studies fail to integrate these types of innovation in single study. For example, Lee, Lee, & Schniederjans (2011) investigated supplier cooperation, supply chain efficiency, and quality management practices as supply chain innovation. Tan, Zhan, Ji, Ye, & Chang (2015) evaluated big data and supply chain innovation capability to measure supply chain performance. Kim, Thomas, Paul, & Brown (2015) suggested that collaboration and knowledge/competence acquisition are indicators of supply chain innovation. Seo, Dinwoodie, & Kwak (2014) conceptualized supply chain trusts, innovativeness, and supply chain integration as indicators of supply chain innovation. The need to integrate types of innovation as indicators and examine how they influence supply chain innovation and performance has been suggested (Ageron et al., 2013). In order to cover the gaps in previous researches, the study designed a theoretical integration of technological, process, product, and marketing capabilities to examine the impact of supply chain innovation on supply chain performance.

Supply chain innovation is "the system by which companies reconfigure and integrate their internal and external structures/processes and infrastructure/humanware with the aim of sensing and seizing new opportunities that facilitate information management, sourcing, production, and delivery of products in a responsive, cost efficient and timely manner to the end-consumer" (Singhry, Abd Rahman, & Imm, 2014). In this study, supply chain innovation is conceptualized as technology, collaboration, innovation capability, and managerial role (top management support). Although, past studies linked supply chain innovation with supply chain performance (Panayides & Lun, 2009; Tan et al., 2015), the empirical integration and examination of technology, collaborative processes, innovation capability, and top management support remain unknown in the academic literature.

Supply chain technology is defined as the "technologies that can be applied in isolation or in combination with other technologies or the supply chain business processes and supply chain network structure to create supply chain innovation" (Arlbjørn et al., 2011). In this study, supply chain technology consists of advanced manufacturing technology (AMT) and information technology (IT). AMT is defined as "a group of computer-based technologies, which includes computer-aided design, computer-aided manufacturing, manufacturing resources planning, robotics, group technology, flexible manufacturing systems, automated materials handling systems, computer numerically controlled (CNC) machine tools, and bar-coding or other automated identification techniques and any technology, which is new or advanced to a company when compared to its previous or current manufacturing technology" (Abd Rahman & Bennett, 2009).

AMT is essential in supply chain management because it improves the process of transforming raw materials into finished goods; it fosters close collaboration between the upstream and downstream supply chain (Meybodi, 2013); it helps the supply chain to increase production capacity, reduce production costs, lead time, wastages and rework and thus improves product availability and quality (Das & Nair, 2010). On the other hand, information technology is

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defined as "computer and communication technology which facilitates the creation, storage, transformation, and transmission of information between two or more companies" (Youn, Yang, Kim, & Hong, 2014). Information technology helps the supply chain achieve alignment, agility, and lean (Rajaguru & Matanda, 2013). It facilitates communication and real-time information sharing, as well as reduces inventory, communication, and transaction costs (Prajogo & Olhager, 2012).

Supply chain collaboration is defined as a "partnership process where two or more autonomous firms work closely to plan and execute SC operations toward common goals and mutual benefits" (Cao & Zhang, 2011). Collaboration allow partners to share knowledge and capabilities, which eventually influences organizational innovation capability and performance (Zheng, Zhang, Wu, & Du, 2011). In this study, supply chain collaboration consists of processes as concurrent engineering of product design (CEPD), collaborative planning, forecasting, & replenishment (CPFR), and collaborative marketing (CM). Concurrent engineering is a manufacturing philosophy where designers, manufacturers, suppliers, marketers, and customers work simultaneously right from the design of a product to its market success (Liang, 2009; Nategh, 2009). Concurrent engineering enables partners to jointly share product design information which subsequently reduce manufacturing costs, improves product quality, increase time-to-market, and reduce costs of scrap and rework (Kowang & Rasli, 2011).

CPFR is "a business practice that combines the intelligence of multiple supply chain partners and synchronize them into joint forecasting, and planning with the aim of improving demand visibility and supply chain efficiency (Danese, 2007, 2011). CPFR helps the supply chain to develop a mutual plan, forecast and replenishment and therefore improves supply chain efficiency and supply chain performance (Småros, 2007). Collaborative marketing is defines as the ability of seller and buyer to aligned their pricing, promotion and distribution activities, in order to achieve supply chain and organizational performance (Le Meunier-FitzHugh & Lane, 2009). Collaborative marketing helps to redesign the level of major customer involvement with marketing strategy and thus influences supply chain performance (Green, Whitten, & Inman, 2012). Innovation capability is a 'learning-to-learn type' (Collis, 1994), the "cultural readiness and appreciation of innovation' (Hult, Hurley, & Knight, 2004), and the engine forces that boost performance (Amabile, 1998). 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, performance, (Schweitzer, 2014), and firm growth (Yang, 2013).

Background of the Study

In this study, the theoretical lenses of the dynamic capabilities theory (DCT) (Teece, 2007), social exchange theory (SET) (Blau, 1964), and the upper echelon theory (UET) (Hambrick, 2007) were employed to explain the relationship between supply chain innovation and supply chain performance. DCT explained the relationship between supply chain technology, innovation capability, and supply chain performance. Technology is the dynamic capability that firms modify to create new knowledge and increase the supply chain performance. SET was used to explain the relationships among supply chain partners. Through mutual collaboration, partners develop collaborative capabilities and subsequently improve the supply chain performance. UET was used to explain the relationship between top management support and supply chain performance. Hambrick (2007) shows that the biases and dispositions of chief

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executives help explain the strategic behaviour and performance of organization. Furthermore, Maccurtain, Flood, Ramamoorthy, West, & Dawson (2010) and Flood, Fong, Ken, Regan, & Moore (1997) suggested that the decision and actions of top management teams influence innovation and new product performance. Thus, the research framework of this study is presented in Figure 1.

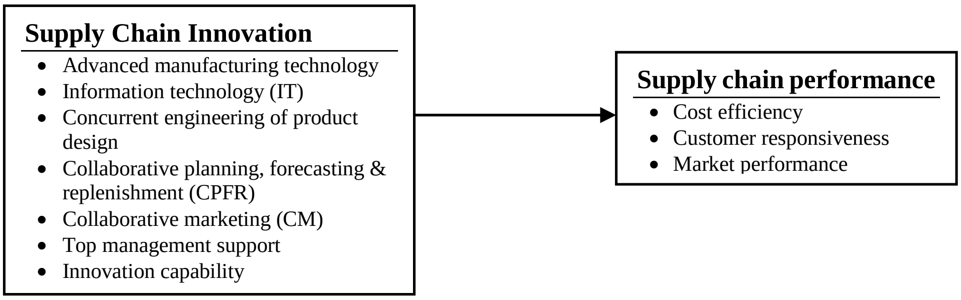

Figure 1. Research framework of supply chain innovation and supply chain performance

HYPOTHESIS DEVELOPMENT

Relationship between supply chain innovation and supply chain performance

Innovation is essential for both short-term and long-term business success (Bessant & Tidd, 2007; Smart & Bessant, 2007). Buyer-seller collaboration and capabilities have been suggested as instrumental toward supply chain innovation (Bello, Lohtia, & Sangtani, 2004; Golgeci & Ponomarov, 2013; Soosay, Hyland, & Ferrer, 2008; Storer & Hyland, 2011). However, previous studies examine the concept from a narrow perspective which indicate that empirical studies on supply chain innovation require further investigation (Flint, Larsson, Gammelgaard, & Mentzer, 2005). Ageron et al. (2013) argue that operational processes, information system/information technology, and managerial processes improve supply chain management performance. Golgeci & Ponomarov (2013) found a positive association between "innovativeness and innovation magnitude with SC resilience". Oke & Prajogo (2013) found supply chain partner innovativeness to influence product innovation strategy. They also show that the impact of supply chain partner innovativeness on innovation strategy is improved with stronger strategic relationship with key partners. Chong, Chan, Ooi, & Sim (2011) found that supply chain practices of Malaysian firms improve firms' innovation and organizational performance. Lee, Lee, & Schniederjans (2011) found that supply chain innovation reduces operational cost, lead time, create superior operational strategies, enhance quality, and provide visibility and flexibility for dealing with rapid changes in customer demand. Despite these findings, these studies have some integrative limitations. In view of this, the study argues that the integration of technology, collaboration, top management support, and innovation capability might enhance the supply chain performance of manufacturing companies. Therefore, it is hypothesized that:

H1: There is a significant relationship between SCI and SCP.

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METHOD AND MEASUREMENT

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. MAN is an organized body that represents the interest of Nigerian manufacturing companies. With 1574 companies on its database, 1035 companies were targeted and 323 companies were randomly selected from 8 clusters. Therefore, the study employed both cluster and systematic random sampling. Questionnaire was self-administered with help of 8 research assistants who were also staff of MAN in the 8 branches. 292 questionnaire were returned and 286 were found usable. Even though face-to-face questionnaire administration is expensive in terms of time, money, and efforts, it performs better than mail and telephone surveys (Szolnoki & Hoffmann 2013). The response rate of the study was 90.4% and higher than suggestion mage by Sudman et al. (1965) who point that self-administered questionnaires have a completion rate of about 76% and rejection rate of 24%.

The entire scales in this study had been validated in previous literature. However, while all scales were adopted, they 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 agree. AMT measurements was selected from Bülbül et al. (2013), Dıaz et al., (2003), Koc & Bozdag (2009), and Mora-Monge et al. (2008). Information technology was extracted from Chen & Paulraj (2004), McCarthy-Byrne & Mentzer (2011), and Wu et al.(2006). Concurrent engineering of product design was choosen from Chen & Paulraj (2004) and Feng & Wang (2013). CPFR were extracted from Maltz & Kohli (1996), McAllister (1995), and McCarthy-Byrne & Mentzer (2011). Collaborative marketing was extracted from Acur et al. (2012), Doney & Cannon (1997), Ganesan (1994), Green et al. (2012), McCarthy-Byrne & Mentzer (2011). Top management support was adopted from Chen & Paulraj (2004) and (Carr & Pearson, 1999). Innovation capability was adopted and modified from Storer & Hyland (2009) and Zacharia et al. (2011). SCP was adopted from Cirtita & Glaser-Segura (2012), Rajaguru & Matanda (2013), Stank et al. (1999), and Ye & Wang (2013).

RESULT

Table 1. Descriptive statistics of organizational profiles

Company data		Frequency	Per cent
Sector	Food, beverages & 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	9.4
	Pulp, paper & paper products, printing & publishing	28	9.8
	Electrical & electronics	17	5.9
	Textile, wearing apparel, carpet, leather/leather footwear	25	8.7

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	Wood and wood products including furniture	17	5.9
	Non-metallic mineral products	10	3.5
	Motor vehicle & miscellaneous assembly	11	3.8
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	0.3
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

Common Method Bias

Common method bias occurs when questionnaires were administered to a single respondent in a sample firm. Common method bias was assessed based on Harman's single factor test. By considering all the 5 latent variables together in exploratory factor analysis, it was clear that all variables have sufficient explanatory power as shown by the total variances explained. The test showed that initial eigenvalues % of variance and sums of squared was 25.650 less than 30%. This suggests that common method bias was not a major issue in this study (Podsakoff et al., 2003).

Validating the measurement model

Table 2 shows that the measurement models of the seven variables have satisfied the minimum recommended fit threshold and therefore acceptable for structural modeling. Furthermore, normality tests were performed on the measurement models as a precondition for regression analysis. The univariate and multivariate normality were measure using by Mardia's test of

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normality (Ghasemi & Zahediasl, 2012). The results of skewness ranges between -0.137 and -1.421. Thus, it could be suggested that all the measurement items are within the normality (skewness) threshold of -1.96 and +1.96 (Field, 2009). Furthermore, Table 3 shows that the factor loading of all items ranges between .54 and .93. The reliability values of all variables and items ranges between .71 and .91. All are above the 0.7 Cronbach's threshold and therefore satisfied the requirement for reliability (Nunnally, 1978).

Table 2. Results of Confirmatory Factor Analysis (CFA) of Latent Variables and Endogenous Construct(s)

Variable	No. of items/ dimensions	Validity (CFA)
Advanced manufacturing technology	7/1	RMR = .066, GFI = 0.981, AGFI = 0.946, CFI = 0.992, TLI = 0.984, NFI = 0.984, RMSEA = 0.057, PCLOSE = 0.334, ChiSq/df = 1.934, P-Value = 0.036
Information technology	5/2	RMR = .037, GFI = 0.993, AGFI = 0.975, CFI = 0.999, TLI = 0.997, NFI = 0.993, RMSEA = 0.026, PCLOSE = 0.623, ChiSq/df = 1.193, P-Value = 0.312
Concurrent engineering of product design	4/1	RMR = .009, GFI = 0.998, AGFI = 0.978, CFI = 0.999, TLI = 0.997, NFI = 0.998, RMSEA = 0.030, PCLOSE = 0.416, ChiSq/df = 1.256, P-Value = 0.262
Collaborative planning, forecasting, & replenishment	7/3	RMR = .044, GFI = 0.965, AGFI = 0.910, CFI = 0.937, TLI = 0.879, NFI = 0.916, RMSEA = 0.094, PCLOSE = 0.013, ChiSq/df = 3.497, P-Value = 0.000
Collaborative marketing	8/3	RMR = .036, GFI = 0.985, AGFI = 0.965, CFI = 0.997, TLI = 0.995, NFI = 0.979, RMSEA = 0.023, PCLOSE = 0.839, ChiSq/df = 1.155, P-Value = 0.299
Innovation capability	5/2	RMR = .030, GFI = 0.985, AGFI = 0.942, CFI = 0.984, TLI = 0.961, NFI = 0.976, RMSEA = 0.077, PCLOSE = 0.171, ChiSq/df = 2.685, P-Value = 0.030
Top management support	6/2	RMR = .022, GFI = 0.988, AGFI = 0.960, CFI = 0.990, TLI = 0.975, NFI = 0.977, RMSEA = 0.051, PCLOSE = 0.418, ChiSq/df = 1.752, P-Value = 0.105
Supply Chain Performance	8/3	RMR = .020, GFI = 0.973, AGFI = 0.939, CFI = 0.981, TLI = 0.967, NFI = 0.963, RMSEA = 0.058, PCLOSE = 0.307, ChiSq/df = 1.945, P-Value = 0.013

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Table 3. Results of Construct Reliability, Item Reliability, Factor Analysis

Variable/item		Factor loading	Cronbach's Alpha
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 (IT)			**.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			**.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	

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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	
Supply Chain 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	

Validity of the Measurement Models

Three approaches were used to evaluate the construct validity of this study. The first was the four conditions suggested by Mokkink et al. (2010). Secondly, the Pearson correlation coefficients was used to evaluate the construct validity (Farag et al., 2012; Rod et al., 2013). The output of this process suggested bivariate correlation with positive coefficients between 0.144 and 0.602 (see Table 4). There are no variables that correlated above 0.85 and therefore multicollinearity was not an issue in this study. The third techniques used in evaluating

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construct validity was to examined the fitness indices (Bagozzi, 1993). All the latent exogenous constructs have satisfactorily fit indices which also signal construct validity (Table 2).

Convergent validity was evaluated based on recommendations by Fornell & Larcker (1981) and Hair Jr, et al. (2013). First, item loading should be more than 0.70 and significance. Second, composite reliability of construct must be greater than 0.80. Third, average variance extracted (AVE) of all construct must be greater 0.50 (Fornell & Larcker, 1981). However, on the first condition, Hair et al. (2012) argue that items with factor loading above 0.4 should be retained if their deletion would affect content/construct validity and composite reliability. Results from Table 3 shows that item loading of all construct ranges between 0.57 – 0.92. Table 4 shows that composite reliability of all construct ranges between 0.81 – 0.93; average variance extracted (AVE) of all construct were between 0.52 – 0.68. AVE greater than 0.50 indicates that the seven variables have items total variance explained of more than 50 per cent. It can therefore be concluded that evidence of convergent validity exist (Anderson & Gerbing, 1988)

Discriminant validity was assessed based on the criterion recommended by Fornell & Larcker (1981). The criterion states that "the square root of AVE for each construct must be greater than its correlations with all other constructs". In other words, "AVE should exceed the squared correlation with any other construct" (Hair Jr et al., 2013). The bold values represented on diagonal in Table 4 shows that the square root of AVE for each construct is greater than its correlation with all other constructs (Fornell & Larcker 1981). Furthermore, values above the bold diagonal are the squared correlation of all constructs and are smaller than AVE (Hair Jr et al., 2013). The values in Table 4 indicate that each construct is empirically and statistically distinct from other constructs in the study (Chin, 1988). Therefore, it can be concluded that evidence of discriminant validity exist (Anderson & Gerbing 1988).

Table 4: Convergent and Discriminant Validity

Variable	Mean	SD	AMT	IT	CEPD	CPFR	CM	IC	TMS	SCP	CR	AVE
AMT	33.038	8.801	**.738**	.362	.081	.056	.099	.133	.021	.026	.893	.546
IT	26.543	4.923	.602**	**.822**	.148	.138	.110	.308	.042	.099	.911	.676
CEPD	31.794	5.235	.284**	.384**	**.726**	.226	.176	.154	.118	.075	.809	.527
CPFR	38.271	4.355	.237**	.371**	.475**	**.725**	.260	.192	.234	.150	.883	.525
CM	42.636	5.831	.315**	.332**	.419**	.510**	**.787**	.145	.129	.125	.928	.620
IC	28.895	3.074	.365**	.555**	.392**	.438**	.381**	**.749**	.283	.181	.864	.561
TMS	34.143	3.705	.144*	.206**	.344**	.484**	.359**	.532**	**.720**	.228	.862	.517
SCP	47.595	3.968	.162**	.316**	.273**	.387**	.354**	.425**	.477**	**.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

After analyzing measurement model for normality, reliability and validity, the structural model was assessed. Overall the validation of the structural model indicates a satisfactorily fitness

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indices: RMR = .141, GFI = .935, AGFI = .904, CFI = .959, TLI = .947, NFI = .913, RMSEA = .053, PCLOSE = .368, ChiSq/df. = 1.786. Figure 2 provides the validated structural model of the research framework.

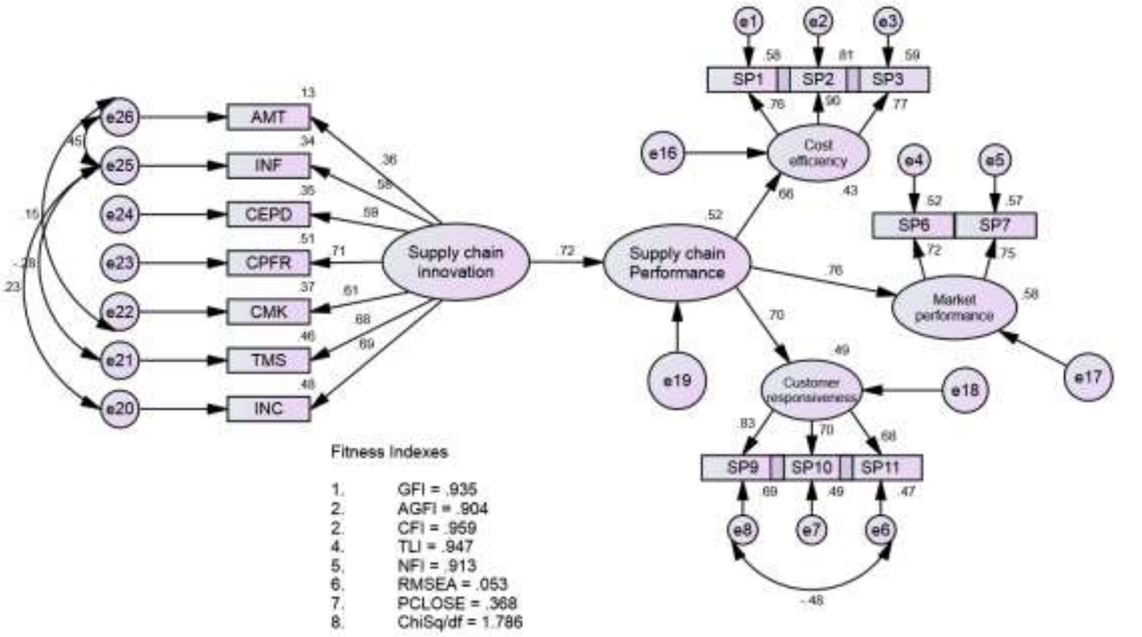

Figure 2. Regression estimate of supply chain innovation and supply chain performance

Table 5. Result of standardized and unstandardized regression estimate of the model

Relationships of construct and variables	Std. Beta	R^2	Actual Beta	S.E.	C.R.	P	Result
Supply chain innovation and supply chain performance	.719	.518	.114	.016	5.938	***	Significant/ supported
Advanced manufacturing technology and supply chain innovation	.363	.132	1.377	.255	5.402	***	
Information technology and supply chain innovation	.585	.342	1.214	.127	9.550	***	
Concurrent engineering of product design and supply chain innovation	.590	.348	.933	.108	8.606	***	
Collaborative planning, forecasting, & replenishment and supply chain innovation	.712	.507	1.333	.132	10.060	***	
Collaborative marketing and supply chain innovation	.612	.374	1.532	.173	8.881	***	
Top management support and supply chain innovation	.680	.463	1.083	.112	9.629	***	

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Innovation capability and supply chain innovation	.691	.477	.824	.086	9.550	***	
Cost efficiency and supply chain performance	.658	.433	1.006	.161	6.241	***	
Customer responsiveness and supply chain performance	.701	.578	.874	.143	6.134	***	
Market performance and supply chain performance	.760	.491	.994	.159	6.241	***	

Results of standardized and unstandardized regression weights from Table 5 suggest a positive and significant relationship between supply chain innovation (SCI) and supply chain performance (SCP) (β = 0.72, P < 0.001). The table shows that when SCI goes up by 1 standard deviation, SCP goes up by 0.719 standard deviations. When SCI goes up by 1, SCP goes up by 0.093 but with a standard error of about .016. The probability of getting a critical ratio as large as 5.938 is 0.001. In other words, the regression weight for SCI in the prediction of SCP is significantly different from zero at the 0.001 level (two-tailed). It is estimated that the antecedents of supply chain innovation account for 52 percent of the variance of supply chain performance. In other words, 48 percent of variance of supply chain performance could be explained by variables not included in this research framework. Among the antecedents of supply chain innovation, collaborative planning, forecasting, & replenishment has more influence on innovation (β = 0.712, p < 0.001) and is followed by innovation capability (β = .691, p < 0.001). The third most importance antecedent of supply chain innovation is top management support (β = .680, p < 0.001). The fourth factor is collaborative marketing (β = .612, p < 0.001). The least are concurrent engineering of product design (β = .590, p < 0.001), information technology (β = .585, p < 0.001), and advanced manufacturing technology (β = .363, p < 0.001). Furthermore, market performance has greater influence on supply chain performance (β = .760, p < 0.001) and is followed by customer responsiveness (β = .701, p < 0.001) and cost efficiency (β = 658, p < 0.001).

Discussion of Findings

The positive and significant relationship between supply chain innovation and supply chain performance is consistent with previous studies in supply chain context (Oke & Prajogo, 2013; Panayides & Lun, 2009; Seo et al., 2014). Lee, Lee, & Schniederjans (2011) found that SCI influences organizational performance through cost reduce operational cost, lead time, superior operational strategies, enhance quality, visibility and flexibility. Through a blended theoretical lens, Oke & Prajogo (2013)found that partner innovativeness influences the innovation performance of Australian manufacturing companies. Panayides & Lun (2009) investigated 980 manufacturers of electronic equipment in the United Kingdom and found that supply chain innovativeness influence SCP. Furthermore, Seo et al. (2014) found a significant relationship between innovation in supply chain and SCP of manufacturing companies in South Korea. Agus (2008) found that innovation in supply chain processes such product and process design, product development, and production line significantly enhance product quality and firm performance.

This finding also supports the DCT, SET, and UET. DCT shows that new capabilities such as manufacturing and information technologies improve competitive advantage and supply chain performance. Through the modification and restructuring of manufacturing and information

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technologies, companies stand a better chance of reducing operational costs, distributing the right products and subsequently increase their sales, marker share and market performance. Therefore, the findings suggest that enhancement of SCP could be explained by proper implementation of manufacturing technologies such as computer aided engineering, design, numerically control machine, inspection guided vehicles, storage, handling systems, alignment of computers, electronic transaction, and connectivity of IT systems. Furthermore, collaboration within organization functions, suppliers, and customers enhances innovation performance. Similarly, top management support for the supply chain and innovation capability are also major determinants of supply chain innovation. Therefore, supply chain innovation is an important strategy that could help manufacturing companies reduce manufacturing cost, inventory cost, and total cost. It improves on-time delivery of product from suppliers to manufacturers and manufacturers to customers' customers. It helps to reduce out of stocks, increase sales and market share and subsequently enhance partners' profits. Innovative supply chain could thus, change a traditional supply chain that was characterized by uncertainties, high cost into one that is adaptable to globalization and competition.

CONCLUSION

The aim of the studies is to investigate the effect of supply chain innovation on supply chain performance of manufacturing companies in Nigeria. As challenges within and outside the industry is changing supply chain, companies do not have to wait and react but be proactive and innovate. The study yielded important results that extend the theoretical and practical boundaries of supply chain innovation. It demonstrates the importance of integrating technology, collaboration, innovation capability, and top management support to reduce supply chain cost, improve customer responsiveness, and market performance. Thus, this paper has both theoretical and managerial implications.

Theoretical Implication

This study emphasizes the importance of fit in theory through blended theory of upper echelon, dynamic capabilities, and social exchange to explain supply chain innovation. It shows that supply chain innovation studies can be underpin in different theoretical lenses. Previous studies in supply chain innovation have ignored the role of upper echelon theory. This study has made it explicit that the theory fits in in explaining supply chain innovation. The theory explains that the top executive mental model and focus determines the direction of strategy in an organization. This study also enriched the literature of supply chain innovation by being the first to integrate constructs such as supply chain technology (AMT, information technology), supply chain collaboration (CEPD, CPFR, collaborative marketing), managerial roles and innovation capability in a single framework.

Managerial Implications

The findings could guide Nigerian manufacturers on strategies to renew technologies and collaboration to reduce these challenges such as poor transportation and distribution networks, less advanced production and information technologies, low level of manufacturing skills lack of customer agility, weak collaboration, and competitive pressures. Thus manufacturing companies could use the findings to resolves issues regarding increase inventory costs, manufacturing costs, bullwhip effect, lead times and late delivery, The implication for Nigerian

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manufacturers is that supply chain innovation could be better if they take proactive measures to developed more ability to apply technologies for continuous improvement and customer focus concepts, work effectively with individuals within and outside our organization and internationally, recognize and resolve conflicts as they arise in collaboration efforts, take advantage of new knowledge, select partners to successfully collaborate with, and learn from prior collaboration experiences.

By employing the indicators of SCI (AMT, IT, CEPD, CPFR, CM), companies and their managers are encouraged to improve the degree of their firms' innovativeness and activities. Thus the study could encourage managers to develop innovative behaviours and cultures toward adopting and using new technologies as well as seek for new collaborative opportunities (Škerlavaj, Song, & Lee, 2010). Innovation in technology without corresponding increase in employees skilled usually has negative consequences (Soosay and Hyland, 2005). As such training of employees is pre-requisite for success. When firm develops plans to enhance supply chain performance, they need to consider the role of innovation capability across the supply chain. Besides, companies with lower innovation capability may not adequately achieve supply chain performance.

LIMITATIONS AND RECOMMENDATION FOR FUTURE RESEARCH

Despite the findings of this study, it is not without some limitations. First, a single respondent in each firm was asked to fill a questionnaire on different sections of the questionnaire. Although, most of the respondents were top managers who have adequate information about their companies, it is very difficult for a single manager to supervise the whole supply chain. Therefore, there is tendency of common method bias. Even though statistical analysis suggested that common method bias was not an issue in this study, the study suggested collection of data from multiple information-rich respondents in the future. Second, data was collected from focal companies only and the supply chain involves many partners such as suppliers, logistic service providers, retailers, and customers. Therefore, future researchers should collect data from dyadic, tripartite, or multiple supply chain partners.

Second, the study did not control the result with factors such as firm size, ownership structure, and manufacturing sector. Future research should examine the model by controlling for these variables. Because, the manufacturing industry may have different sectors and sectors may vary regarding supply chain activities. For example, companies in different sectors may not have the same levels of technology, collaboration, and innovation capability. Therefore, responses may not reveal predominant realities for all companies in the manufacturing industry. As such, there could be tendency of hetrogedasticity. Thus, the study suggests for collection of data from homogenous manufacturing sectors in the future.

Third, cross-sectional survey was used and it only allows data to be collected at one point in time and assume that the environment is same across time and space. Therefore, a longitudinal study is suggested in future studies because innovation occurs largely due to dynamism of the business environment. Fourth, although the psychometric study was based on response of top manager who are information-rich, there is need to use secondary data to compare with the results of this study. Fifth, although innovation capability was suggested as a mediator, variables such as absorptive capacity, supply chain competences can be introduced. Furthermore; some variables such as environmental uncertainties, supply chain trust,

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sustainable sourcing and reverse logistics can be added to the model in future study. Future studies could also examine mediating or moderating relationships in the model. Finally, the findings of the study should be interpreted with caution despite the good PCLOSE fit indices. This is because the data came from Nigerian manufacturing companies which operated in an unstable environment with infrastructural disadvantages and poor manufacturing supports characterized by heavy importation and smuggling of industrial goods. Therefore, future studies can be conducted in other economies such Malaysia, Brazil, South Africa, and Egypt for comparison and more robustness of the model.

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