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Effects of Technological Innovation in Relationship between Green Supply Chain Management Practices and Green Performance

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ABSTRACT

Although scholars have conceptualised on green supply chain management practices (GSCMPs) and green performance (GP), evidence to validate the conceptualisation was lacking, albeit in the context of small and medium enterprises. In addition, effect of technological innovation on supply chain practices and GP was largely unexplored by researchers. Therefore this study validates and provides empirical evidence on the relationship between GSCMPs, technological innovation and GP, in the context of manufacturing small and medium enterprises in Nigeria. A well-structured questionnaire was administered on conveniently selected manufacturing small and medium enterprises in Yola, Adamawa State of Nigeria. Both descriptive and inferential statistical tools such as frequencies, means, standard deviation, Pearson correlation, multiple regression, independent samples t-test and analysis of variance were used in analyzing data and reporting results. Findings revealed that positive significant relationship exist between GSCMPs and GP in small and medium enterprises. Also, technological innovation was found to have influenced the GP of small and medium enterprises, thereby exhibiting partial mediating effect in the conceptualised relationship. This study has succeeded in validating the aforementioned conceptualization as well as advancing the GSCM theory in emerging economies. Practical implications on how to enhance supply chain practices within the context of manufacturing small and medium enterprises in Nigeria were discussed. Recommendations for future research were stated accordingly.

Keywords: Green Supply Chain Management Practices, Technological Innovation, Green Performance, Adamawa, Nigeria
JEL Classifications: M30, M31

1. INTRODUCTION

Sustainability is a broad area with few researches focusing on the integration of green supply chain management practices (GSCMP), technology innovation (TECIN) and green performance (GP) (Subramanian and Gunasekaran, 2015). GSCM can be defined as "integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life" (Srivastava, 2007. p. 54-55). Accordingly GSCM is often classified into; internal practices within the firm and external practices with supply chain value partners (practices with supply chain partners (De Giovanni and Vinzi, 2012; Yang et al., 2013). Interestingly, green integration is based on transaction, cooperation, coordination and collaboration (Spekman et al., 1988).

Specifically, an internal GSCMP reflects on environmentally friendly perceptions of firms within (Azevedo et al., 2011). While external GSCMP encompasses integration and collaboration between a firms, suppliers, customers and stakeholders (Zhu et al., 2013). Even though, a methodological advancement is required to increase the robustness of the causal relationship between GSCM and GP of firms (Yang et al., 2013). Furthermore several authors have called for research on GSCM, collaboration, environmental issues and performance (Yang et al., 2013).

Few studies have articulated the benefits of GSCM collaboration (Azevedo et al., 2011) in terms of waste reduction, reducing pollutant emission using renewable energy. Whereas, editorial findings of transport research journal part E, 2015 revealed that only few studies reported the burden to upstream suppliers. Similarly, examining how to improve packaging, reduce hazardous emissions, reverse philosophy and promote cleaner practices are widely challenged (Subramanian and Gunasekaran, 2015). However, it is important to note that IT is a valuable tool for measuring, controlling and improving energy efficiency in production management (Bunse et al., 2011). However, the unanswered questions still remains that; how can companies design incentive structures and reward system in GSCM relationships?

There are five sections in this study. The introduction is followed by exhaustive elaboration of theoretical background and hypotheses development. Section 3 described the methodology with emphasis on the research orientation, measures, sampling techniques, normality checks and data analysis. Section 4 presents the empirical results and Section 5 discussion, theoretical and practical implications and as well as recommendation for further research.

2. THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

GSCM has emerged as an important new archetype for enterprise to achieve profit and market share objectives by lowering their environmental risk and impacts and while raising their ecological efficiency" (Zhu et al., 2005. p. 450). Globalization has led to firms to be more responsive to environmental and social performance of their suppliers of materials, components and services (Seuring and Müller, 2008).

However, this study was, viewed from the paradigm of institutional isomorphism theory. Firms tend to adopt GSCM in response to government regulations and other external pressures (DiMaggio and Powell, 1983; Deephouse, 1996; Dacin, 1997; Glover et al., 2014). The theory propound that organisations which are related and depend on each other usually tends to perform mutually supplementary functions. On the other hand, system theory is the key theoretical linkage in this study in understanding the structure of GSCM, IT and performance. A congruence of a "set of biological, social, material or technological partners" to achieve a common goal is referred to as a system (Hjørland and Nicolaisen, 2005). Interestingly it is further defined as "a system that is made up of entities and the linkages between the entities" (Ho and Sculli, 1995. p. 506). Therefore, to this effect systems theory is viewed as an integral part of this research work that foster and facilitate the relationship and collaboration between the food supply chain and externalities. The entire value chain is been looked at as a system with the presence of some objects and their attributes related to each other and to their environment comprising of input, process and output to form a whole system (Schoderbek et al., 1990).

2.1. GSCMPs and TECINs

TECIN has been articulated as a tool of monitoring environmental practices and results (Esty and Winston, 2006). As a result green innovation has been emphasized based on four premise; product, process, managerial and marketing innovations (Porter and Linde, 1995; Reid and Miedzinski, 2008). GSCM was demonstrated on the academic front to represent environmentally friendly image of products, process, systems, and technologies for sustained firm's survival (Vachon and Klassen, 2006). Ultimately such innovation was found to have been instrumental in environmental performance and compliance to environmental regulations (Chen et al., 2006). GSCM is becoming more acceptable in practice as a measure of eliminating direct and indirect firms waste (Lee and Kim, 1995). Substantial amount of research has investigated the effect of technology on GSCM performance (Tyogi et al., 2015), the result revealed a close association between web-based technology and GSCM performance. Studies have demonstrated the relevance of TECINs to GSCMP (Zhang et al., 2013; Akman and Mishra, 2015). Where by improving technology uninterruptedly may lessen the consequences of industrial waste and climate change (Sikdar and Howell, 1998). As such, we posit:

H1: There is a significant relationship between GSCMPs and GP.

2.2. TECINs and GP

Technological relationships have been perceived to be an emerging expanse of concern for most intellectuals (Orlikowski, 2000) due to its influence on organizational structure, processes and outcomes. It thus has a dramatic effect on how firms should be responsive to products and delivery services and sustained competition in global environment (Garcı´a Morales et al., 2007). Therefore, firms need to be uninterruptedly innovative to guarantee their survival (Hurley and Hult, 1998). Firm's survival largely depends on how they have defined their business area in relation to technological distinctiveness, in the event of disruptions or turbulent environment (Decarolis, 2003) to achieve optimal performance. For instance, it has been proved that technical competence influenced performance in Italian high technology firms (Malerba and Marengo, 1995). Inconsistently, there is a conflict in results of the relationship between environment sustainability and financial performance (Clarkson et al., 2011; Clarkson et al., 2011). Therefore, we hypothesized:

H2: There is a significant relationship between TECIN and GP.

2.3. GSCMPs and GP

Articulation was however made on further confirmation of the influential effect of green supply chain collaboration on GP as well as on competitiveness of a firm (Yang et al., 2013). However, how green collaboration intermittently influenced GP for sustained competitiveness is still unclear and subject to further investigation (Yang et al., 2013). It is also suggested that, GSCMP may promote efficiency and synergy, minimize waste and cost savings as well as ensures environmental performance (Rao and Holt, 2005). Thus further arguments accentuated that, environmental collaboration and suppliers adequate monitoring enhance environmental performance (Green et al., 2012; Gimenez and Sierra, 2013). Similarly, adoption of GSCMP may ultimately improve performance, even though recent trends confirmed that it might not necessarily encompasses financial performance and profitability (Green et al., 2012). Thus, we posit:

H3:There is a significant relationship between GSCMPs and GP.
H4: TECIN will mediate the relationship between GSCM and GP.

3. METHODOLOGY

For the purpose of this study explanatory survey design was adopted. This is because the study sought to explain the relationships between GSCM, TECIN and GP. Survey instrument were used to collect quantitative data over a period 4 months. Surveys are strong tools connecting academia and reality through concept testing of sampled data (Flynn et al., 1990).

3.1. Sample

This research draws the sample from the various manufacturers and suppliers of agrochemicals and pesticides in North-Eastern Nigeria using stratified sampling method. The reasons for choosing this sector are many increased investment in agricultural may as well increased threat to environmental damage (land degradation, pollution of ecosystem). Illiteracy of the major players could not allow integrating GSCMPs and impeding them from adopting new technologies for enhanced production. Stratified random sampling, involves a process of stratification or segregation, followed by random selection of subjects from each stratum Sekaran (2003). Stratified random sampling can either be proportionate or disproportionate to the number of elements in the stratum Sekaran (2003). This study used disproportionate stratified random sampling because some strata (departments) are too small (production, quality control, procurement and maintenance) and others are too large.

3.2. Survey Instrument

A structured self-administered questionnaire consisting of 57 closed ended multiple choice questions was used for this research. The questionnaire was divided in to four sections after grounding the variables through exhaustive literature to established content validity. The study employed five likert scales measuring the statements in the questionnaire.

3.3. Measurement Properties

We have reviewed the literature extensively and identified with valid measures and adapted related scales from previous researches as indicated in the preceding sections. However, we have categorized GSCMPs into internal and external and are consistent with studies of Jabbour et al. (2014), Zhu et al. (2007).

3.3.1. Measurement of ınternal green practices

3.3.1.1. Green policy

Clear environmental policy statement, managers commit themselves to support GSCM, cross-functional cooperation works well for green operations, provision of green education and training,

3.3.1.2. Green shipping practices

Adopts eco-friendly design of shipping, used environmentally friendly materials and equipment (Kirchoff and Koch, 2011; Ginsberg and Bloom, 2004; Kalafatis et al., 1999; Lampe and Gazdat, 1995).

3.3.1.3. Green marketing

Provide customers with environmentally friendly service information, more budget for green advertisement, promotion of resource and energy conservation, attracts customers with green initiatives and eco-service (Yang et al., 2013; Kirchoff and Koch, 2011; Ginsberg and Bloom, 2004; Kalafatis et al., 1999; Lampe and Gazdat, 1995).

3.4.1. Measurement of technology ınnovation

Our firm focuses on using alternate source of energy. Our firm has optimized process to reduce wastage. Our firm is using eco-friendly materials for packaging, Reduction of emission of green house gases in the environment by use of clean technology (Sikdar and Howell, 1998; Zhang et al., 2013; Bag and Anand, 2014; Nguene et al., 2011).

3.4.2. Measurement of external green practices

3.4.2.1. Collaboration with customers

Collaboration with customers for cleaner production, collaboration with customers for the development of ecological packaging, collaboration with customers for eco-design (Jabbour et al., 2014; Zhu et al., 2007).

3.4.3.2. Green purchasing

Measured with cooperation with suppliers, delivery of environmental guideline for each product purchased, selection of suppliers based on ISO 14001, evaluation of second-tier suppliers environment, environmental audit of supplier firms (Zhu et al., 2007; Jabbour et al., 2014).

3.4.3.3. Green environmental monitoring of supplier

We used environmental impacts as criterion for supplier selection, we asked suppliers for information about environmental compliance, we ensure our suppliers comply with environmentally friendly practices, we ensure that our supplier adopt ISO environmental management system (Ellinger et al., 2000; Bowen et al., 2001; Vachon and Klassen, 2008; Yang et al., 2013).

Green environmental monitoring by customer: Customers used environmental impacts as criteria in supplier selection, customers asked information about our environmental compliance, customers demanded us to be environmentally friendly practices of our suppliers, customers demanded to implement ISO environmental management system (Carter and Easton, 2011; Ellinger et al., 2000; Bowen et al., 2001; Vachon and Klassen, 2008; Yang et al., 2013).

3.5.1. Measurement of GP

Green practices decrease of cost of raw materials. Green practices reduce the inventory levels. Green practices reduce cost for energy consumption. Customer relationship management green practices improved customer satisfaction (Zhu et al., 2008).

4. RESULTS

Initially 250 agrochemical firms in North-Eastern Nigeria were examined out of which 156 was used in this study. Overall GSCM has a substantive and significant influence on TECIN (r = 0.392,

P > 0.01). It is also evident that GSCM has a positive significant relationship with GP (r = 0.335, P > 0.01). Thus, supporting the assertion in H1, H2, H3, H4 respective. The firms dimensional correlations (internal and external GSCM practices) showed significant positive relationship as demonstrated in Table 1 except for external green collaboration with customer (EGCC) and internal green policy (IGP) (r = 0.199, P < 0.055), EGP and TECIN (r = 0.134, P < 0.060), GEMS and IGM (r= 0.032, P < 0.148), GEMC and TECIN (r = 0.127, P < 0.059), GP and IGM (r = 0.181, P < 0.083). Dimensional item by item mean scores indicate the level of importance of the dimensional items in measuring each factor in the determination of the hypothesized relationship in this study. The mean scores testify the absolute agreement of the respondents that attached importance to GSCM, TECIN and GP.

This study further measured the effect sizes of both direct and indirect relationship between the variables. The regression results of the main hypothesis 1 posit a direct effect of internal GSCMPs (IGP, internal green shipping practices and internal green marketing) on TECIN (β = 0.615; t = 4.326; P < 0.001). This accounted for 33% variance in explaining TECIN. Whereas there was also a support for H2 effect of TECIN on GP (TECIN and GP) revealed (β = 0.305; t = 3.521; P < 0.001) which accounted for 27% in explaining GP. Similarly, the influence of overall GSCM on GP (GSCM AND GP) was (β = 0.561; t = 4.412; P < 0.001) and accounted for 34% predicting GP, thus supporting H3.

However, the dimensional direct and indirect effect of GSCM and TECIN revealed an interesting outcome of IGP has a significant positive impact on TECIN (β = 0.151; t = 2.881; P < 0.004), IGSP was also positively associated with TECIN (β = 0.224; t = 4.165; P < 0.000) as well as positive relations between IGM and TECIN (β = 0.320; t = 6.365; P < 0.039) all together explained by 58%. On the other hand, the main direct effect of EGCC (β = 0.329; t = 6.758; P < 0.001), EGP (β = 0.204; t = 4.075; P < 0.001), GEMS (β = 0.080; t = 0.1.598; P > 0.111) and GEMC (β = 0.066; t = 1.459; P < 0.145) explain by 58%. In addition all the variables had a significant positive impact on TECIN except for GEMS and GEMC with a negative influence. The possible explanation may that lack of awareness of the concept of GSCMPs in developing nations and Nigeria in particular. The results thus provide support for the three sub-hypotheses.

Furthermore, our findings suggest that TECIN had a significant influence on GP (β = 0.245; t = 3.521; P > 0.001). The relationship between antecedent EGCC (β = 0.008; t = 2.068; P > 0.875), EGP (β = 0.122; t = 1.209; P < 0.006), GEMS (β = 0.181; t = −158; P > 0.001), GEMC (β = 0.173; t = 2.741; P > 0.040) and GP were found to be all significant with statistical confidence of 35% except for EGCC that was found to be insignificant in the expected direction as demonstrated in Table 2.

4.1. Testing for Mediation

However, the study tested for mediation using Baron and Kenny, (1986) steps and assumptions. This method allows for testing of full and partial mediation (James et al., 2006). The result empirically document that for Model 1 was positively associated between GSCM and TECIN (β = 0.615; t = 4.326; P > 0.001) accounted for 33%, while Model 2 TECIN and GP (β = 0.245; t = 3.521; P > 0.001) showed a significant relationship with reduced coefficients. Nevertheless, Model 3 GSCM and GP (β = 0.561; t = 4.412; P > 0.001) and Block 1 β = 0.305; R = 273; R^2 = 0.075; $R^2\Delta$ = 0.075; P > 0.001. Block 2 β = 0.163; R = 0.377; R^2 = 0.142; $R^2\Delta$ = 0.142; P > 0.043. Therefore, it should be noted that the path

Table 1: Correlations and descriptive statistics

	1	2	3	4	5	6	7	8	9
IGP	1								
IGSP	0.792	1							
IGM	0.468	0.453	1						
TECIN	0.264	0.508	0.369	1					
EGCC	0.199	0.529	0.581	0.586	1				
EGP	0.387	0.447	0.526	0.134	0.168	1			
GEMS	0.349	0.441	0.032	0.486	0.451	0.376	1		
	0.376	0.495	0.462	0.127	0.614	0.422	0.561	1	
GP	0.589	0.742	0.181	0.574	0.416	0.335	0.432	0.260	1
Mean	4.85	5.06	4.95	4.87	5.01	3.78	3.66	3.80	4.26
SD	1.28	1.33	1.29	0.91	1.22	1.09	1.44	1.11	1.31

SD: Standard deviation, IGP: İnternal green policy, EGCC: External green collaboration with customer

Table 2: Hypothesized regression of GSCMPs, innovation and GP

Path	Standardized estimate	t value	Significant
Internal GSCM and TECIN (R=580)			
IGP→TECIN	0.151	2.881	0.004
IGSP→TECIN	0.224	4.165	0.000
IGM→TECIN	0.320	6.365	0.039
External GSCM and TECIN (R=582)			
EGCC→TECIN	0.329	6.758	0.001
EGP→TECIN	0.204	4.075	0.000
GEMS→TECIN	0.080	1.598	0.111
GEMC→TECIN	0.066	1.459	0.145
TECIN and GP (R=0.273)			
TECIN→GP	0.245	3.521	001
Internal GSCM and GP (R=648)			
IGP→GP	0.092	1.021	0.309
IGSP→GP	0.365	8.221	0.000
IGM→GP	0.271	3.355	0.000
External GSCM and GP (R=346)			
EGCC→GP	−0.008	2.068	0.875
EGP→GP	0.122	1.209−0.158	0.006
GEMS→GP	0.181	2.741	0.001
GEMC→GP	0.173		0.040

GSCMP: Green supply chain management practices, GP: Green performance, TECIN: Technology innovation, IGP: Internal green policy, EGCC: External green collaboration with customer

Table 3: Summary results of multiple regressions with hierarchical steps

Step	Model	B	R	R^2	$R^2\Delta$	P value
1.	OGSCM→TECIN	0.615	0.329	0.108		0.000
2.	TECIN→GP	0.245	0.273	0.075		0.001
3.	OGSCM→GP	0.561	0.335	0.112		0.000
4	Block 1	0.305	0.273	0.075	0.075	0.001>0.05
	Block 2	0.163	0.377	0.142	0.142	

GP: Green performance, TECIN: Technology innovation

of interaction between GSCM, TECIN predicting GP indicated a case of partial mediation and support H4 as shown in Table 3.

5. CONCLUSION

This study investigated and empirically tested the relationship between GSCM, TECIN and GP. Findings support and corroborate the linkage between GSCM and TECIN in terms of IGP, IGSP, IGM, EGCC and EGP in explaining its impact on TECIN. Concerted effort need to be made in extending green practices philosophy by applying various organizational theories (Subramanian and Gunasekaran, 2015). Specifically calls on the determination of the effect of socioeco-innovative technologies on clean supply chain management and how can technology use and power be increased at various levels of CSCMP (Subramanian and Gunasekaran, 2015), was extensively addressed.

From the practical point of view, this study revealed how TECIN predict GP. Suggesting that, embracing TECINs by Nigerian agrochemicals players may invariably enhance GP. This study further offered empirical evidence that GSCM internally and externally do predict GP, even though improvement is paramount in the area of collaboration with customers. More attention should be focused on adoption and implementation of GSCM in developing nations (Vachon and Klassen, 2006) due to little attention given to GSCM orientations (Rao, 2002). On the other hand, TECIN acts as a conduit in the interaction of GSCM and GP. The study was able to authenticate and further validate the fact that TECIN mediate GSCM and GP.

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