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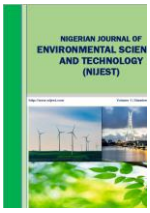

Level of Adoption of Green Supply Chain Management Technologies and Practices in Selected Pharmaceutical and Textile Firms in Southwestern Nigeria

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ABSTRACT

The study examined the level of adoption of green supply chain management (GSCM) technologies and practices in selected pharmaceutical and textile firms in Southwestern Nigeria. The study was carried out in 10 pharmaceutical and 10 textile firms in Lagos and Ogun States, because of the high concentration of industrial firms in these two states. Primary data were collected through two sets of structured questionnaires administered to 1 Production Manager; 2 Suppliers; 3 Distributors; 3 Retailers; and 3 Consumers in each firm, making a total of two hundred and forty (240) respondents. The harvested quantitative data were subjected to frequencies and mean analysis in SPSS. This study used five stages of adoption to measure the level of adoption of Green Supply Chain Management (GSCM) technologies and practices, which were Awareness, Interested, Evaluating, Trying, and Adoption stages. Out of the eighteen technologies and practices presented, none of the selected firms is in the adoption stage for any of the technologies or practices presented. However, the firms are already in Trying stage in acquiring green materials and sourcing ethically (Mean 3.5-4.4), while all other remaining technologies and practices were still being evaluated (Mean 2.5-3.44). The study concluded that the extent of adoption of green supply chain management technologies and practices in the pharmaceutical and textile firms is very low.

Keywords: Green Supply Chain, Green Supply Chain Management technologies, Green Supply Chain Management Practices, Pharmaceutical Firms, Textile Firms.

1.0. Introduction

The industrial sector is one of the major contributors to Nigeria's economic growth. For instance, recent information on financial output of the nation in 2019 indicated that the industrial sector contributed 27.38% to the country's GDP (Emachone, 2020). However, 10 metric tons of carbondioxide (CO_2) emanate from Nigeria's industrial sector annually, thus positioning the country as one of the highest CO_2 emission nations in Africa (Efobi *et al*., 2019). Carbondioxide emission in the industrial sector arises, for instance, as a result of burning of fossil fuels like coal gases and diesel during manufacturing processes or burning of industrial wastes (Nurdiawansyah and Lindrianasari, 2018).

Supply chain includes all processes employed by firms to convert natural resources in their raw states into consumer-goods, and transport them to the final consumers (Janvier-James, 2012). Supply Chain (SC) has direct effects on the quality of industrial products, as well as the entire profit structure of the industrial firms. For this reason, value mechanism in the SC is important in an attempt to sustain competitiveness in the market space, and reduce the cost of operations. Therefore, supply chain greatly impacts both promptness and effective distribution of goods in the industrial sector (Kleab, 2017). The stakeholders in supply chain of industrial organizations are shown in Figure 1.

Green supply chain management (GSCM) helps the supply chain of the industrial sector to effectively manage demand, carry out inventory, handle disruptions and minimize the cost of production, in order to meet customer demands in the most effective manner. Supply Chain Management (SCM) also enhances quality of human life through job creation via design and control of supply chains, managing of inventory, warehousing, packaging and logistics. The attainment of GSCM potentials involves integration of all the departments in the industrial sector, and that of the suppliers, distributors, transporters and customers (external partners).

Green supply chain management puts into consideration environmental concern as it relates to supply chain. Thus, GSCM involves all the stages of SCM starting with the designing of the product, to the end of its lifetime, to recycling stage or disposal stage, taking environmental concerns into consideration in every stage of the supply chain. According to Jayaram and Avittathur (2015), environmental concern is put into consideration before GSCM can be achieved through green supply chain policies, which at the long run, is desirable for mitigating environmental hazards, and tailoring productions towards sustainability. According to Tseng and Chiu (2013), GSCM expands its scope across the phase of designing a product and manufacturing procedures by spanning through all the design and manufacturing phases, at the same time, it involves sourcing for resources. GSCM focuses on having environmentally friendly technologies and processes, that the industry stakeholders are craving for.

Therefore, the major aim of GSCM is to reduce carbon dioxide (CO_2) emissions. Other benefits of GSCM are better efficiency of assets, reduction in waste production, introduction of environmental innovation, and the reduction of production costs in order to maximize profit. GSCM adaptation in industrial sector encompasses green selections, ecofriendly procuration, environmentally friendly design, environment-oriented packaging, eco-technologies, biodegradable supplies and greenmarket and minimization of wastes (Jayant and Azhar, 2014). Also, GSCM promotes effectiveness and efficiency of operations, thereby achieving profit satisfaction. GSCM is a very imperative strategy for industrial sector that wishes to save cost, position herself for stronger brand recognition, and strategic competitive advantage (Roehrich *et al*., 2017). GSCM thus involves the implementation of ecological monitoring ideologies to all activities of customer order cycle such as product design, procurement process, manufacturing, assembly of products, packaging, logistics, dissemination of information and communications technology (ICT), distribution of products, and evaluation of products at the end of its lifespan (Uygun and Dede, 2016).

Figure 1: Stakeholders in the Supply Chain of Industrial organizations (Hirota, 2015)

The contributions of pharmaceutical and textile companies to pollutions, especially water and air pollutions, cannot be overemphasized. For example, pharmaceutical industries, which involve 'researching, developing, producing, and marketing pharmaceutical drugs, vaccines, and treatments for common and rare diseases', according to Milanesi et al(2020), contributes greatly to environmental issues nationally and globally. For instance, Singh et al. (2016) noted the roles of improper pharmaceutical products' waste management in pollution, such as mismanagement of expired drugs and the water pollution caused by pharmaceutical products. Similarly, Cai and Choi (2020) noted that textile industry brings a serious pollution to the environment rising from the fact that the industry consumes a lot of energy (like electricity), resources (such as wool, cotton, linen etc), and water. For instance, they noted huge water pollution in the dyeing process of textiles, thus causing 'colourful rivers and streams'.

Table 1 presents eighteen (18) green supply chain management technologies and practices that were identified in the various literatures reviewed, and the purposes why each is considered to be green and therefore, different from what is conventional. The purpose is necessary because the present state of the supply chain in the pharmaceutical and textile industries in Nigeria, in terms of environmental sustainability, is critical, especially in terms of waste management and dyeing process respectively. Therefore, the use of GSCM could bring about environmental friendliness in resolving these challenges.

Table 1: Identified Green Supply Chain Management Technologies and Practices in the Pharmaceutical and Textile Industries

	PURPOSE/APPLICATION
	Technologies
Artificial-Intelligence (AI)- based technologies e.g. Xu et al., 2021, Pournader et al., 2021	IoT is used to collect data from various points AI for planning and control of GSCM Systems AI-based technological enablement can be a valuable tool to connect green customers, green suppliers and green supply chain collaborators through the exchange of information across the verticals of the supply chain AI-based technological enablement can influence the selection of appropriate strategies and action plans
Agent-based Systems e.g. Pourabdollahi, et al., 2017	Agent-based Systems can be extremely useful in relationship building with green customers, green suppliers and business patrons Agent-based Systems add great value in supply chain coordination and collaborative demand planning in green supply chains Agent-based Systems can solve many GSCM problems where traditional analytical models fail
Genetic Algorithms e.g. Pournader et al., 2021	Genetic algorithms can be used in green logistics management such as vehicle routing and scheduling, container loading and material handling problems in GSCM Genetic algorithm for green supply chain network design
Expert Systems e.g. Chai and Ngai, 2020, Ghadimi, 2015	Expert Systems for green logistics strategy formulation Expert Systems for green inventory planning and management Expert systems for green decision making
	Green Practices Expert Systems for green supplier selection
	Green Practices
Green Practices e.g. de Sousa Jabbour et al., 2015	Ethical Sourcing Acquisition of green materials Reverse Logistics Just-in-time Efficient Transportation

Owie (2019) evaluated the green management technologies in Nigeria, and also in the industrial sector, using fast-moving consumer goods firms. However, among others, Kumar et al. (2019) and Tumpa et al. (2019) investigated green supply chain technologies and practices in the pharmaceutical and textile industries in India and Bangladesh respectively, and not in Nigeria. Therefore, there is a dearth of information on the green supply chain technologies and practices in Nigerian pharmaceutical and textile industries, and their

level of adoption, which this study sought to address. Thus, the objective of the study is to identify and examine the level of adoption of green supply chain management (GSCM) technologies and practices in selected pharmaceutical and textile firms in Southwestern Nigeria.

2.0. Methodology

The study focused on the respondents from pharmaceutical and textile firms in Southwestern Nigeria. Although the Southwestern geopolitical zone of Nigeria includes six states, which are Ekiti, Lagos, Ogun, Ondo, Osun and Oyo. However, the study focused on two states among the six: Lagos and Ogun States, because of the high concentration of textile and pharmaceutical firms in the states.

Multi-stage sampling was used for the study. For instance, using purposive sampling, Lagos and Ogun states were selected from all the Southwestern states, because they have high concentration of pharmaceutical and textile firms. Purposive sampling was also used to select two industrial subsectors: pharmaceutical and textile firms, out of many firms in the selected states, because of their association with high levels of water and air pollutions. Likewise, purposive sampling was also used to select ten (10) pharmaceutical and ten (10) textile firms in the two states, based on their volumes of production. Primary data were collected through two sets of structured questionnaires administered to 1 Production Manager; 2 Suppliers; 3 Distributors; 3 Retailers; and 3 Consumers in each firm, making a total of two hundred and forty (240) respondents. The first set of questionnaires was given to the Production Managers, Suppliers and Distributors; while the second set was given to the Retailers and Consumers. The two different sets of questionnaire were necessary to cater for professional questions that were specific to the roles. Random sampling was however used in selecting these respondents from each of the firms, so that every participant had an equal chance of being chosen.

The presented GSCM technologies and practices under study were broadly grouped into five, as stated in Table 1. The study used Kotler (2005) five stages of adoption to measure the level of adoption of the green supply chain management (GSCM) technologies and practices in the study area, which according to Jayarathna (2016), are dynamic, and not stationary. The pyramidal five stages used were Awareness, Interested, Evaluating, Trying, and Adopting stages.

3.0 Results and Discussion

From the 240 copies of questionnaire distributed, 226 (94.2%) copies were retrieved, as shown in Table 2.

Table 2: Distribution and Retrieval of Questionnaires to the Selected Respondents in the Study Area

		Production Managers	Suppliers	Distributors	Retailers	Consumers	Total Retrieved	Total Distributed
Pharmaceutical	Lagos (60)	3	10	15	15	15	58	60
	Ogun (60)	2	10	15	14	15	56	60
	Total	**5**	**20**	**30**	**29**	**30**	**114**	**120**
Textile	Lagos (60)	4	10	15	15	15	59	60
	Ogun (60)	1	10	13	14	15	53	60
	Total	**5**	**20**	**28**	**29**	**30**	**112**	**120**

Table 2 also shows that ten (10) of the respondents were Production Managers, representing 4.4% of the respondents, while forty (40) were Suppliers which was about 17.7%, Distributors and retailers were 58 (25.7%) each, and sixty (60) of the respondents were Consumers, which represent 26.5% of the respondents. These stakeholders were considered for this study because they constitute members of the supply chain.
To establish the level of adoption of green supply chain management technologies and practices, the respondents were first asked if they or their organizations have started to adopt any green technology or

practice using Yes or No, and Table 3 presents their responses. Frequencies were run using Statistical Package for Social Sciences. For the analysis, out of the 114 responses from the selected pharmaceutical firms, 6 were incomplete/missing for the question, which might be because of inadequate knowledge of the subject matter (green technologies and practices) among the study participants. They were therefore, discarded.

Table 3: Adoption of Green Supply Chain Practices and Technologies in the Selected Pharmaceutical and Textile Industrial Firms of the Study area

Nature of Firm	Level of Adoption		Total
	Frequency (%) Yes	Frequency (%) No	
Pharmaceutical	38 (33.3)	76 (66.7)	114
Textile	24 (21.2)	88 (78.8)	112
Total	**62 (100)**	**164 (100)**	**226**

Thus, the study reveals that 33.3% of respondents in the selected pharmaceutical firms is in one level of adoption or the other (as in the identified adoption pyramidal stages). Similarly, 21.2% of respondents in the selected textile firms is also in one level of adoption or the other. Therefore, the result shows that the adoption of GSCM technologies and practices in these selected firms is low. This is in line with the findings of Solaja and Adetola (2020); and Alliyu and Solaja (2016), which stated that adoption of green supply chain management practices in emerging countries like Nigeria is low. This may be because most of the pharmaceutical and textile firms under study have little or no knowledge of the importance of these technologies and practices. These firms may as well lack the required expertise to start the adoption of GSCM technologies and practices.

Mean ranking was also run using Statistical Package for Social Sciences to evaluate the aforementioned five stages of adoption of green technologies and practices. Thus, Table 4 reveals the mean ranking of the level of adoption of green supply chain management technologies and practices among the selected firms in the study area. Eighteen (18) Green Supply Chain Management technologies and practices found in the reviewed literatures were presented, as shown in the table. Out of the eighteen technologies and practices presented, none of the selected firms is really in adoption stage (last stage in the pyramidal stages identified by Kotler, 2005) for any of the technology or practice presented. However, the firms are already in Trying stage in acquiring green materials and sourcing ethically (Mean 3.5-4.4). However, all other remaining technologies and practices were still being evaluated (Mean 2.5-3.44).

Table 4: Mean Ranking of the Level of Adoption of Green Practices and Technologies in the Industrial Sector of the Study Area

S/N	GSCM Technologies Indicators	Aware Freq(%)	Interested Freq(%)	Evaluating Freq(%)	Trying Freq(%)	Adopting Freq(%)	Mean
i.	Acquisition of green materials	26 (11.5)	35 (15.5)	36 (15.9)	51 (22.6)	78 (34.5)	3.53
ii.	Ethical Sourcing	31 (13.7)	33 (14.6)	33 (14.6)	48 (21.3)	81 (35.8)	3.51
iii.	Expert system for green decision-making	29 (12.8)	35 (15.5)	35 (15.5)	51 (22.6)	76 (33.6)	3.49
iv.	Expert system for green supplier selection	36 (15.9)	31 (13.7)	31 (13.7)	47 (20.8)	81(35.9)	3.47
v.	Reverse Logistics	43 (19.0)	35 (15.5)	38 (16.7)	44 (19.5)	66(29.3)	3.46
vi.	Efficient Transportation	34 (15.0)	31 (13.7)	32 (14.2)	54 (23.9)	75 (33.2)	3.46
vii.	Expert Systems for green inventory planning and management	34 (15.0)	35 (15.5)	31 (13.7)	54 (23.9)	72 (31.9)	3.42
viii.	Green certification	36 (15.9)	34 (15.0)	38 (16.8)	37 (16.4)	81 (35.9)	3.41
ix.	Just-in-time	34 (15.0)	35 (15.5)	36 (15.9)	48 (21.3)	73 (32.3)	3.40
x.	Agent-based Systems to solve GSCM problems	36 (15.9)	33 (14.6)	34 (15.0)	52 (23.0)	71 (31.5)	3.39

xi.	Agent-based Systems in SC coordination and collaborative	53 (23.6)	20 (8.8)	35 (15.5)	48 (21.2)	70 (30.9)	3.27
xii.	Expert System for green logistics strategic design	33 (14.6)	34 (15.0)	35 (15.5)	55 (24.3)	69 (30.6)	3.26
xiii.	AI for planning and control of GSCM Systems	38 (16.8)	38 (16.8)	39 (17.3)	51 (22.6)	60 (26.5)	3.25
xiv.	Genetic algorithms in green logistics management	43(19.0)	35 (15.5)	40 (17.7)	44 (19.5)	64 (28.3)	3.23
xv.	AI-based technological enablement for GSCM collaboration	39 (17.3)	39 (17.3)	38 (16.7)	51 (22.6)	59 (26.1)	3.23
xvi.	AI-based technological enablement strategic action and plans	36 (15.9)	47 (20.8)	33 (14.6)	54 (23.9)	56 (24.8)	3.21
xvii.	Agent-based Systems for relationship building	53 (23.5)	34 (15.0)	40 (17.7)	41 (18.1)	58 (25.7)	3.08
xviii.	IoT for collection of data	44(19.5)	54 (23.9)	35 (15.5)	40 (17.6)	53 (23.5)	3.02

Key: Aware: 0.0-1.44; Interested: 1.5-2.44; Evaluating 2.5-3.44; Trying 3.5-4.44; Adopting 4.45-5.0

The result reveals that the mean ranking for 'Acquisition of green materials' with a mean score of 3.53; and 'Ethical Sourcing' with a mean value of 3.51; are the highest, being in the Trying stage range. This may be that the firms adopting these high mean technologies and practices know their importance. Moreover, the adopting level for some other technologies and practices was low, especially 'Internet of things (IoT) for collection of data', which has mean value of 3.02. The reasons for the low level of adoption may be that most of the selected firms do not have an adequate knowledge of its importance, or the needed organizational structure is not in place. The study result agrees with Baig *et al*. (2020) research findings, which stated that the level of adoption of GSCM practices in developing countries like Nigeria is low, due to social and environmental challenges.

Furthermore, Laosirihongthong *et al*. (2013) stated that there is a low-level adoption of reverse logistics because it had no significant impact on green supply chain management, which is against the findings of this study. There is the likelihood that his sampled manufacturing firms do not require reverse logistics for their day-to-day activities, or may lack the awareness and knowledge needed to adopt reverse logistics practice.

4.0 Conclusion

Despite the benefits of green supply chain management technologies and practices, it is concluded that the level of adoption of GSCM technologies and practices in the selected pharmaceutical and textile firms in Southwestern Nigeria is low. Therefore, the study recommends to the National Environmental Standards Regulation Agency (NESREA) to formulate appropriate environmental sustainability laws and policies to boost the level of adoption of green supply chain management and practices in Nigerian pharmaceutical and textile firms. For further studies, the study was only conducted in two Southwestern states (Lagos and Ogun States). Similar studies could be carried out in other states and other regions of the country. Also, the study only focused on pharmaceutical and textile firms, other firms in the industrial sector, and even other sectors of the national economy, are suggested for further studies.

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