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LEVEL OF GREEN INNOVATION ADOPTION IN CHEMICAL MANUFACTURING FIRMS IN OGUN STATE, NIGERIA

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ABSTRACT

The quest to balance between an environmental sustainability and firm economic indices has generated a growing concern in the chemical industry. This is the basis for the emergent of green innovations to eliminate such notion. Nevertheless, studies have posited that regulation push from the government formed the main reason for this drive. Thus, if this push are substantial in the developing countries such as in Nigeria that remains scarcely documented, the resultant effect should be noticeable in their level of adoption. The focus of the article is to contribute to the debate by examining the status of green innovations in chemical firms in Ogun state, Nigeria. The study is descriptively set-up, with a quantitative data collection component in the form of a survey retrieving 223 questionnaire from staff of chemical companies as listed in the directory of Ministry of Commerce and Industry, Abeokuta, Ogun state. The results shows that to 'educate, train, and motivate employees in good housekeeping methods, operation, environmental training programs and maintenance of recovery technologies' is the utmost indicator towards the adoption of green innovation in the chemical firms. Furthermore, the industry is more committed to green managerial innovation, followed by the product and lastly is the process green innovation. The study concludes as well as offers implications as inferred from the obtained results.

KEYWORDS: Chemical industry, Green innovations, stakeholders, regulations, Nigeria.
JEL Classification: L65, O30.

1. INTRODUCTION

Chemical firms is the second largest manufacturing industry in the world. It experienced a double production capacity between 2000 and 2017 with their global network of 5.68 trillion dollar in 2017 (UNEP, 2019). The industry includes the industrial chemicals producers, pharmaceuticals, polymers, biocides, pesticides, food and feed additives, and cosmetics among others. It is a fact that any manmade materials comprise of one or more of the thousands of chemicals produced by the industry on a yearly basis (Schreiber, Ermel, Figueiredo and Zeni, 2016). The production has been projected to double from 2017 to 2030 with Asia-Pacific region, Africa and the Middle East expected to be the strongest almost every year until 2022 (UNEP, 2019). Therefore, Nigeria being the most populous black nation with over 200 million inhabitants requires close watch due to the state of evaluation and monitoring of manufacturing on environmental regulations.

Recently, international awareness on the environmental pollution vis-à-vis climate change have received global attention. Several countries including Nigeria agreed to the Kyoto protocol and the Paris Agreement (Ole, 2018). Because of the adverse impact of chemical industry to the environment has called for growing restrictive policies to punish environmentally harmful behaviors which has encouraged manufacturers to control the effects of their activities on the environment in order to avoid reputation risks and additional costs (Abdullah, Zailani, Iranmanesh and Jayaraman, 2015). Thus paving way for green innovation as one of the more important strategic tools to establish sustainable development in the manufacturing industries due to the increasing environmental pressure.

The adoption of green innovation entails implementation of new or improve processes, techniques and systems to reduce harms to the environment (Weng and Lin, 2011). Since the emergent of green innovation in the literature, the drives for manufacturing firms to adopt it as a strategy emanated because of stakeholders' involvement. A plethora of stakeholders involved usually includes customers, employees, suppliers, and local public agencies. Nevertheless, studies have emphasized the global importance of government environmental policies as the main push towards company's adoption of green innovations (Eiadat et al., 2008; Weng and Lin, 2011; Abdallah et al., 2015). This study benefits from the foregoing is such that if stringent regulations spur the introduction of green innovations in the Nigerian chemical firms and particularly, in Ogun state, which is endowed with the presence of these companies, then there should be a very high levels of adoption noticeable. Otherwise, the companies would have performed poorly and dissatisfied in their activities towards the adoption of green innovation types. Therefore, the focus of this paper is to examine the level of adoption of green innovations in the Nigerian chemical industry with the assumption that government environmental policies remains the only driver while all other determinants are constant. The remainder of this paper is organized as follows: next section introduces the theory, thereafter, the literature review on green innovations as well as the methodology. Then we present the results and discussion, and lastly, the conclusion and the implications inferred from the results.

2. LITERATURE REVIEW

This section combines the concept, theory and the empirical review of relevant studies in the area of green innovation and their relations with the chemical industry.

2.1 *Concept of green innovation*

Green innovation can be defined as the production or development of products or methods involved in energy conservation, pollution prevention, waste recycling, corporate environmental management that intends to restrict or lessen environmental influences and contribute to environmental sustainability, (Kong, Feng, and Ye, 2016) which extends beyond regulative compliance (Aragón-Correa, Martín-Tapia, and Hurtado-Torres, 2013). Green innovation is often categorized into green product and green process innovations (Conding, Habidin, Zubir, Hashim, and Jaya, 2012; Weng, Chen, and Chen, 2015). Meanwhile, green managerial innovation cannot be underestimated in the adoption of green innovation. Zhu and Sarkis (2004), in their research on the Chinese manufacturing industry, found that getting involvement from the top or middle-level managers has a significant influence on the adoption of successful internal environmental management. Therefore, this study classifies green innovation as green product innovation, green process innovation and green managerial innovation as stated by (Chiou *et al*., 2011; Sharif and Alhiyasat, 2016). Green product innovation is a versatile system in which three essential forms of environmental focus-materials, energy and pollution are highlighted based on their direct impact on the environment at various stages of the natural life cycle of the products, the manufacturing process, product use and disposal (Dangelico and Pujari, 2010). Chen (2011) defines green process innovation as the implementation of innovative ideas that leads to acceptance of manufacturing processes and procedures that produce less or no adverse environmental impacts. Green managerial innovation is the improvements in methods, guidelines and technologies of an organisation. New infrastructure and organisational system transformation are therefore the essential things needed to achieve the adoption of new green innovation technology, and it is also essential to change the values of employees and their lives in order to achieve sustainability in green innovation (Sharif and Alhiyasat, 2016). Green managerial innovation needs several reorganisations in the firm that can reduce any negative impact on the environment (Chiou *et al*., 2011).

2.2 ***Theoretical consideration***

The prominent of Stakeholders' theory in the field of green innovation has been widely accepted as the driver for the emergent of this type of innovation within the manufacturing industry. It has indeed become one of the most significant and frequently cited concepts in the literature since Freeman (1984) proposed the stakeholder theory. The stakeholders' theory implies that organizational stability and progress rely on achieving both its economic and non-economic objectives by meeting the needs of the various stakeholders of the company (Pirsch, Gupta, and Grau, 2007). According to this theory, it is essential for management to cultivate socially responsible conduct while paying attention to the interests and privileges of all stakeholders in a company (Maignan and Ferrell, 2004). A socially responsible company is one that figures prominently in managers ' decision-making responsibilities towards investors (Gibson, 2000; Weiss, 2003). Freeman (1984) describes stakeholders as an entity or person whose activity is either influenced by the product or influences how the company operates as staff, creditors or consumers. The theory explains how real issues with external stakeholders are included in organizational actions to meet the company's priorities and strategic direction (Donaldson and Preston, 1995). After reviewing many studies Huang, Ding and Kao (2009) found that the literature focuses on the impact of three stakeholder groups on corporate green innovation decision: regulatory, internal and market stakeholders. However, in the context of developing economies such Nigeria where stiff competition is minimal especially for any business that requires advance knowledge and technology to operate in addition to circumventing or sharp practices, regulatory push offers significant advantage for firms to adopt green innovation.

2.2 Green innovation

Green innovation is one of the strategic green solutions in manufacturing companies to achieve sustainable development due to growing concern on the environmental and economic pressures (Rizos, Behrens, and Taranic, 2015; Fernando, Wen, and Shaharudin, 2016). Javier and Natalia (2013) argue that innovative green firms are able to improve their products and internal processes without increasing their operating costs. In recent years, green innovation has gained prominence in literature and throughout the world not only because it is a crucial driver for environmental emission reduction (Carrion-Flores and Innes, 2010; Cai and Li, 2018). In addition, it has become a prominent option for businesses as it adds value to company profitability and shift to healthy economies in a growing environment (Carrillo-Hermosilla, Del Río, and Könnölä, 2010). Conding, Habidin, Zubir, Hashim, and Jaya (2012) and Weng, Chen, and Chen, (2015) classify green innovation into innovation in green products and green processes. However, in their research on the Chinese manufacturing industry, Zhu and Sarkis (2004) found that getting the commitment from the top or middle-level managers has a significant influence on the adoption of successful internal management of the environment, which means that green managerial innovation also plays a vital role in green innovation. Thus, Chiou et al. (2011) and Sharif and Alhiyasat (2016) stated that green innovation comprises of green product innovation, green process innovation and green managerial innovation.

However, it is clear that companies are now focusing on improving production processes to ensure optimal use of energy and reduced waste generation and emissions in their manufacturing processes (OECD, 2008). Thereby shifting the viewpoint of portraying the manufacturing company, most specifically chemical manufacturing activities, as having negative impacts on the environment. Therefore, Keshminder and Chandran (2017) observed that most innovations are adoptions rather than creations in chemical manufacturing firms. Green innovation adoption applies to a company's decision to use green innovations to tackle environmental issues. Green innovation involves consolidating shipping, sustainable waste disposal, purchasing environmentally friendly goods, reducing energy use, reducing waste and pollutants from solid or water waste, utilizing safer methods of production and using recyclable packaging or containers (Lin and Ho, 2011). Madu, Kuei, and Madu (2002) stated that there are so many aspects, which products and processes communicate with the environment and could have a chain reaction impact on environmental emissions. Product or process should therefore not be isolated in other terms the producer should follow ‘a cradle to grave approach,' in other words, complete control of material development phases.

In the past, interest was to look at the product on its own and design products that meet precise specifications and possibly environmental pollution laws, but the focus today is different. Therefore, for manufacturers to survive in today's competitive environment, they must take a product and process stewardship approach. When it comes to saving energy, using alternative energy such as using the machines and tools that work with the solar system, to minimize energy consumption protect the environment from using more chemicals (Anas and As'ad, 2014). Chemicals are inputs in most goods manufactured in nowadays. Also, they are found in the raw goods, and wide ranges of chemical products are used every day, from paint to cosmetics and pharmaceuticals. It is known that the chemical manufacturing firm has the most precise and measurable impact on the environment and whilst its relationship with all other manufacturing companies. As a result, chemical companies are the world's largest manufacturer Whitten, Davies, and Peck (2000), and it remains Nigerian manufacturing's backbone.

Activities in the manufacturing firms is consider to be the major contributor for environmental pollution from the process of using natural resources, making a product and producing waste and emission, contributed on the 61% of world energy consumption and 36% of global carbon dioxide (CO_2) emission respectively (Manufacturing, 2009). Hence, carbon dioxide (CO_2) emissions and other greenhouse gases have led to significant changes in the global climate system resulting in environmental, economic and social problems (Pachauri and Reisinger, 2007). Aja, Al-Kayiem, Zewge, and Joo (2016) noted that manufacturing firms are potential producers of pollutions, which make them critical contributors to anthropogenic emissions, and there is growing unfavorable environmental impacts of their operations.

Currently, the world is moving towards the stage at which human beings would have done the planet earth severe, irreversible damage. Current actions are dragging the planet into an atmospheric catastrophe that would merely make disaster likely if it were to occur. The world's natural resource availability is declining; demand for affordable and renewable raw materials is still increasing (Soni, 2015). United Nations Emissions Gap Reports (2018) show that global emissions of carbon dioxide (CO_2) from energy and industry increased in 2017 after three years of stabilization. Total annual greenhouse gas emissions, including manufacturing exhaust emissions, reached a record high of 53.5 gigatons in 2017, 0.7 increases from 2016. Chemical exposure has been estimated to play a significant role in 100 per cent of the cases of lead poisoning, 10 to 35 per cent of asthma cases, 2 to 10 per cent of certain cancers, and 5 to 20 per cent of neurological problems (Heintz and Pollin, 2011).

Thus, high concentration of manufacturing firms in Ogun State has contributed to the case of pollution, and industrial waste, constant smoke from factory chimneys, dust which is harmful to both the environment and human, untreated industrial effluent discharged directly into open drainage channels and some firms dump expired and hazardous waste haphazardly, thereby threatening air and water quality.

3. METHODOLOGY

This study is a descriptive research method. A preliminary local information on the population for chemical firms was retrieved from the 2018/2019 directory of the Ministry of Commerce and Industry, Abeokuta, Ogun State. There are 63 registered chemical firms in the study area out of which 54 companies were selected randomly after using the Yamane formula to select the sample population. The unit of analyses comprise of a representative from each cognate department of the chemical firms in Ogun state, which include: the operations, personnel, industrial engineering, material, maintenance, product design or research and development, and financial or marketing or accountants. In respect to this, any six (6) of the respondents were selected from each firm. Thus, we obtained 324 respondents from 54 chemical manufacturing firms. The twenty-three items used to measured adoption of green innovations were retrieved from previous studies (Chiou *et al*., 2011; Chen, 2011; and Keshminder and Chandran, 2017). However, the items of the constructs were rated from "Extremely Dissatisfied" to "Extremely Satisfied" on a ten-point scale. This study employed random selection of firms and respondents. The data collected were firstly; put through the measurement models (Hair et al. 2017) and thereafter the average for each of the items and constructs altogether calculated.

4. RESULTS AND DISCUSSION

The demographic characteristics of the respondents and their firm are considered in eight categories. These include gender, age of respondents, highest academic qualification of the respondents, unit/department of respondents, years of experience of the respondents, year of establishment of the firm, number of employees in the firm and question on how many times regulators has visited the firm in the past three years. The frequency distribution based on their gender indicates that 167 respondents are male representing 74.9% of the 223 retrieved questionnaire used in the study. The results also shows that 96.9% of the respondents were below 50 years of age while the rest are above 50 years of age. Furthermore, majority of the respondents 36.3% have obtained B.Sc. or B.Tech. degree as their highest academic qualification, followed by people with HND being 27.4% of the respondents. Respondents with PGD recorded 23.3% while others with Master and PhD academic qualification represents 12.1% and 0.9% respectively. This result indicates that the respondents are well educated with majority having first-degree qualification and above. The results prove that the industry requires high skilled and knowledgeable staff to have significant impact in their operations. It was also revealed that respondents with below 20 years of working experience represents 97.4% of the population, while 2.7% of respondents have more than 20 years working experience. In relation to firm establishment, 10.3% of the firms were established less than 5 years ago whereas 89.7 % of the firms have been in operations for more than 5 years. In addition, result shows that firm with less than 50 employees represents 13.5%, while 86.5% of respondents have above 50 employees in their companies. More importantly, frequency of regulators visitation to companies were divided into: less than 4 times, 4 to 6 times, 7 to 9 times and above 10 times and the results indicate 12.1%, 33.2%, 34.5%, and 18.8% respectively with only 0.9% of the staff having no knowledge of such visit. The next sub-sections examines the measurement model and ratings of the indicators of green innovations.

4.1 Measurement model

The composite reliability values shown in Table 1 ranges from 0.860 to 0.928, which are above the threshold of 0.70 and this indicates that all measures has good reliability despite there was no removal of any indicator from their constructs. It is expected that indicators with very low outer loadings (below 0.40) shouldbe eliminated from the construct (Hair et al., 2011). But Figure 1 shows that items on the constructs satisfy the requirement of reliability. A composite reliability of 0.70 or greater indicates adequate internal consistency (Gefen, Straub, and Boudreau, 2000). The measurements used within this study were within acceptable levels to support the reliability of the constructs. The average variance ranges from 0.534 to 0.764, and above the recommended level of 0.50 also shown on (Table 1). This indicates an adequate convergent validity for the items in each construct. The results show that the measurement model of this study provided adequate internal consistency and convergent validity.

Discriminant validity assessed the exceptionality of a construct, whether the phenomenon captured by the construct is not represented by the other constructs in the model (Hair et al., 2013). Table 2 and Table 3 present the discriminant validity of this study. The discriminant validity result shows that the square roots of AVE coefficients are greater than its highest correlation with any other. Fornell-Larcker criterion for discriminant validity assessment has found that neither approach reliably detects discriminant validity issues (Henseler, Ringle, & Sarstedt, 2015). Hence, HTMT inference test shows that none of the confidence interval contains the value one (1), so this result suggests that all the variables were empirically distinct (Henseler et al., 2015). At the end of the preliminary examination by conducting the measurement model, the study neither remove nor delete any manifest as revealed from the findings. Therefore, the study proceeds to conduct the level of green innovation adoption using the mean rating.

Table 1: Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Green Process	0.754	0.832	0.860	0.675
Green Product	0.897	0.912	0.928	0.764
Green managerial	0.891	0.893	0.911	0.534

Table 2: Fornell-Lacker Criterion

	GreenProc	GreenProd	Greenmanag
GreenProc	**0.822**		
GreenProd	0.775	**0.874**	
Greenmanag	0.518	0.538	**0.731**

Table 3: HeteroTrait-MonoTrait

	GreenProc	GreenProd	Greenmanag
GreenProc			
GreenProd	0.926		
Greenmanag	0.597	0.579	

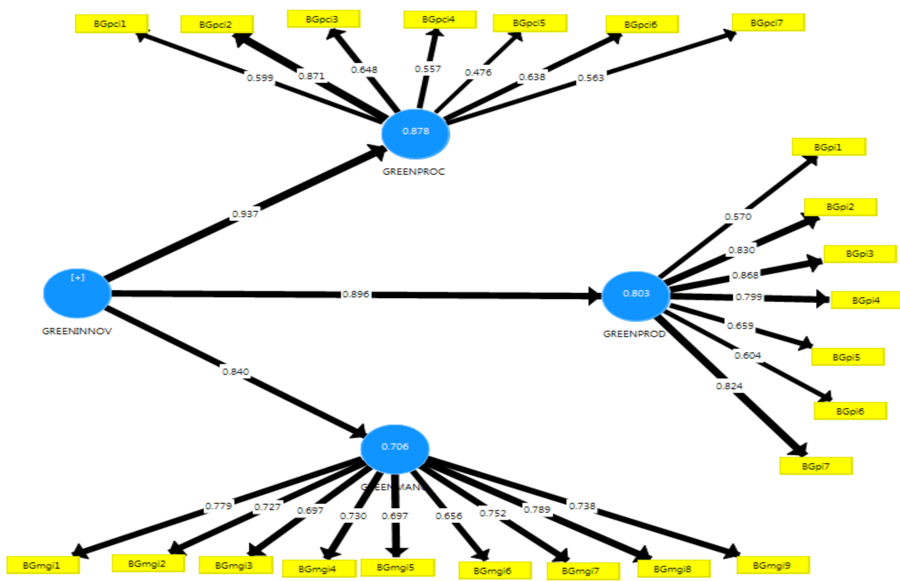

Figure 3: PLS Algorithm for Green Innovation Adoption Constructs

Key: GREENINNOV: Green Innovation; GREENPROD: Green Product Innovation; GREENPROC: Green Process Innovation; GREENMANG: Green Managerial Innovation

4.2 Ratings of Green Innovation Constructs

Based on the survey report as shown on the Table 4, green managerial innovation ranked first with a mean rating of 7.0752 and a standard deviation of 2.1228. It shows that there is high level of green managerial innovation in the chemical manufacturing firm. This affirms the opinion of Oltra and Saint Jean (2009) that green innovation is made up of new and changed methods, procedures, technologies and services that benefit the environment and thus lead to environmental sustainability and management has an important role to play in green innovation adoption. The results of green product innovation ranked second with a mean rating of 6.4471

and a standard deviation of 2.2540. This reveals that firms manufacture products that are sustainable and this will result to cost savings as noted by Klaus and Christian (2011), achievement of competitive advantage, increased market share Skarmeas and Leonidou (2013), increased sales Leenders and Chandra (2013), higher profits and higher productivity Antonietti and Cainelli (2011) and better reputation. However, more effort needs to be channel towards manufacturing of environmental friendly products. Huang and Wu (2010) noted that top management and a company commitment to considering environmental aspects from the start also contribute to achieving success in green product innovation. Meanwhile, green process innovation is ranked least with 6.3645 mean and standard deviation of 2.2834. It is an implication that green innovation in the chemical manufacturing firms are being circumvent because firms are mostly rigid to adopt process change. Especially when the change requires them to allocate part of their profit to improve processes or operations within the firm for nature protection. The result is not surprising because most firms are able to beat the government regulation authorities due to corruption as well as poor monitoring and evaluation procedure. It is important for the firms to recognize the positive impact of engaging in green innovation as a driver of business performance due to the inherent and advantage of technological capabilities development (Weng and Lin, 2011).
As stated in Table 5, the mean response rating for the seven (7) green product innovation items a maximum of 6.9462 (BGpi5; choice of materials that produces less pollution for conducting the product development and design) and a minimum of 5.7175 (BGPI7; modification of product design to substitute traditional materials with recycled ones). This reveals that the firm chooses materials that are less pollutant, but firm does not make use of recycled materials for their production. This implies that the management needs to be encouraged to make use of recycled product to minimise waste and in most cases reduce the energy requirement for heating or melting raw materials. This also confirmed in Arthur, Janine and José (2017) as regard the use of recycled materials.

Table 5 also presented the ratings of green innovation second latent construct. The mean response rating for the seven (7) green process innovation indicators ranges from 7.2242 (BGpci4; production planning and control during the manufacturing process focus on optimizing raw materials) to 4.8610 (BGpci5; installation of green energy technologies, solar/wind/bioenergy so as to increase energy efficiency). It implies that the management makes proper planning and control during the manufacturing process to focus on optimizing raw materials to be used, but in contrast, they do not make use of green technology to minimize energy consuming during the manufacturing process. Juxtaposing this assertion with the earlier results of green product innovation shows a confirmatory report.

The results of green managerial innovation with 9 indicators (Table 5) show the mean response rating for the items ranges from 8.0224 (BGmgi3; educate, train, and motivate employees e.g. in good housekeeping methods/operation, environmental training programs and maintenance of recovery technologies) to 5.9865 (BGmgi8; regular development of new strategy to adopt green innovation in supply chain management). It shows that learning and motivation strengthen the skills and knowledge of workers, making it easier for them to deal with the challenges of the processes and also to overcome the problems of green innovation but on the other side, management needs to develop new strategies to boost their competitive advantage.

Table 4: Description of Level of Green Innovation Adoption Constructs

Constructs	Mean	Standard Deviation	Rank
Green Managerial Innovation	7.07523	2.122805	1st
Green Product Innovation	6.44714	2.254041	2nd
Green Process Innovation	6.36451	2.283384	3rd

Table 5: Description of Green Innovation Adoption Indicators

Indicators		Mean	Standard Deviation	Rank
Green Product Innovation (Gpi)				
	BGpi1	6.57847	1.85314	3
	BGpi2	6.51569	2.32077	4
	BGpi3	6.42152	2.36374	5
	BGpi4	6.04932	2.63419	6
	BGpi5	6.94618	2.03278	1
	BGpi6	6.90134	1.96114	2
	BGpi7	5.71748	2.28114	7
Green Process Innovation (Gpci)				
	BGpci1	6.94618	2.09176	2
	BGpci2	6.43049	2.48298	4
	BGpci3	6.60986	2.14461	3
	BGpci4	7.22421	1.75374	1
	BGpci5	4.86098	2.31786	7
	BGpci6	6.30044	2.05648	5
	BGpci7	6.17937	2.31604	6
Green Managerial Innovation (Gmgi)				
	BGmgi1	7.82959	1.79780	2
	BGmgi2	6.79372	1.95962	6
	BGmgi3	8.02242	1.76921	1
	BGmgi4	7.08968	1.79615	5

BGmgi5	6.65470	1.87493	7
BGmgi6	7.56950	2.27270	4
BGmgi7	6.02690	2.31508	8
BGmgi8	5.98654	2.18817	9
BGmgi9	7.70403	1.94804	3

5. CONCLUSION AND IMPLICATIONS

This study examined the level of green innovation adoption in the chemical manufacturing firm in Ogun State, Nigeria. The findings of the study show that there is an evidence to assume the adoption of green innovations in chemical firms in the study area. As a result, the firm mostly adopts green managerial innovation and therefore, we recommend that the firms should also foster adoption of green process and green product innovations. Nevertheless, we can conclude in terms of innovative average aggregate rating that the government regulation authorities have not really driven the chemical firms. The results of the averages confirmed these as wide variations or dispersions are noticeable in the scores of standard deviations. There are other pointers to the fact that government regulations does not drive the chemical company adoption of green innovation in this study. Such as the low averages recorded in the following indicators: 'Choice of materials that produces less pollution for conducting the product development and design'; 'Installation of green energy technologies (solar/wind/bioenergy) so as to increase energy efficiency' and 'Regular development of new strategy to adopt green innovation in supply chain management'. Finally, the study justify its conclusion with the embarrassing number of times regulation agencies visit the companies to evaluate and monitor their environmental activities.

The implications of these results may either be that premium is placed on the commercial end of the firms' activities rather than the sustainability of the environment through innovation. As this is evident in the firms' choice of materials that consume least amount of energy for conducting product development or design, and the manufacturing of products which reduce resource consumption. The explanation while firms thinks this way centres on the inherent conflict between environmental protection and firms' business performance. Two school of thoughts exist, first is the neoclassical model in which stringent government environmental regulation is believed to make the polluting firm worse off. Because if firm invest and adopt a new efficient abatement technology that does not worth investing, its benefits will not be enough to raise the firm's profits. Secondly, the dynamic framework suggests that a non-static firm has the chance to sweep away inefficiencies out of the production process or encouraging innovation, then firms may experience fall in their costs of production. This leaves room for improvements in their business performance. Therefore, government regulators need to make sure that the focus of their policies is on environmental innovation rather than on mandated level of environmental performance to be achieved or technologies to be used. This indicates that unless environmental innovation strategies are triggered within firms, the final effect of any environmental policy on firms' business performance will be questionable in a developing context.

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Appendix A: LEVEL OF GREEN INNOVATION ADOPTION

Please rate **as appropriate.** Note; you can rate from 1-10: where 1= very dissatisfied and 10= extremely satisfied

S/N	Please rate the level of your firm's adoption in each of the following green innovation	Rating (1-10)
1.	**I. <u>Green Product Innovation (BGpi1-7)</u>** Choice of materials that consume least amount of energy for conducting product development or design	
2.	Choice of materials that are easy to reuse, recycle, and decompose for conducting product development or design	
3.	Manufacturing of products which reduces waste generation in product usage	

4.	Manufacturing of products which reduce resource consumption	
5.	Choice of materials that produces less pollution for conducting the product development and design	
6.	Designing/improving environmentally friendly packaging for existing and new products	
7.	Modification of product design to substitute traditional materials with recycled ones	
1.	**II. Green Process Innovation** (BGpci1-7) Effective reduction of the emission of hazardous substances/waste during the manufacturing process	
2.	Recycling of waste and emission that allow waste to be treated and re-used	
3.	Reduced consumption of resources	
4.	Production planning and control during the manufacturing process focus on optimizing raw materials	
5.	Installation of green energy technologies (solar/wind/bioenergy) so as to increase energy efficiency	
6.	Noise and vibration control technologies	
7.	Pollution control technologies that treat pollution released into the environment (air, water & soil (scrubbers/dust collection system/waste water treatment)	
1.	**III. Green Managerial Innovation (BGmgi1-9)** Voluntary codes/agreements for environmental good practice within the firm	
2.	Re-designing and improving product/service to obtain new environmental criteria or directives	
3.	Educate, train, and motivate employees (e.g., in good housekeeping methods/operation, environmental training programmes and maintenance of recovery technologies)	

4.	Pollution reduction/prevention schemes that address resources reduction, reuse and recycling, and energy consumption, which eliminates wasteful management practices	
5.	Cooperation with other firms so as to close material loops and to avoid environmental damage across the value chain (from cradle to grave)	
6.	Environmental certification such as ISO 9001	
7.	Regular development of new strategy to adopt green innovation in marketing and sales	
8.	Regular development of new strategy to adopt green innovation in supply chain management	
9.	New forms of management (e.g. total quality management)	