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SUSTAINABLE MANUFACTURING PRACTICES AND ENVIRONMENTAL PERFORMANCE OF TABLE WATER COMPANIES

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ABSTRACT

The study examined how sustainable environmental performance is impacted by sustainable manufacturing practices in table water companies registered by National Agency for Food and Drug Administration and Control (NAFDAC). A random sample of 297 table water companies was used for the investigation, out of which 247 were validly completed. Using the Mahalanobis distance approach, three responses demonstrated the presence of outliers which were deleted from the dataset. Therefore, 244 responses were used for the study. Multiple regression analysis was used to establish the statistical significance and relationship between sustainable manufacturing practices and the environmental performance of the selected table water companies. The study found that the investigated sustainable manufacturing practices (sustainable product development, sustainable packaging, and sustainable waste management) have a positive and significant impact on the environmental performance of table water companies. The study recommends that table water companies invest more resources in state-of-the-art production technologies that could enhance manufacturing processes and reduce energy consumption.

Keywords: Environmental performance, packaging, sustainability, table water, waste management.

INTRODUCTION

It is difficult, if not impossible, to sustain life without water. Many people in developing countries, Nigeria inclusive, lack access to good drinking water supplies, which has prompted

people to look for alternatives. One of the alternative sources, as promoted by governments, large businesses, and small and medium-scale enterprises in Nigeria, to meet these shortfalls is table water. Table water is an umbrella name for drinkable water packaged in small sachets, disposable plastic bottles, and large refillable containers. The growth of table water factories in Nigeria and other Sub-Saharan African countries is caused by local water shortages, urbanization, poverty as well as governance failure at local, national, and global levels to provide good drinking water for the populace (Adekunle & Dakare, 2020; Stoler, 2013; Omole *et al.*, 2015). Stoler (2017, p. 1) observed that "local governments have failed to implement coherent urban planning strategies that enable measured financing and deployment of water and sanitation infrastructure. National or federal governments have been guilty of water resources mismanagement and neglect of existing infrastructure. In contrast, international organisations and institutions have not always implemented metrics that truly measure water access and capture the dynamism of local waterscapes.".

Government failure to provide portable and hygienic drinking water for the populace has created opportunities for profit-oriented business enterprises to produce and market table water to bridge the unmet need for drinking water in most parts of Nigeria. The production and distribution of table water in the Nigerian markets, as argued by Ikon *et al.* (2017), is considered a more economical way of accessing drinking water in the country. The table water industry in Africa has experienced some growth due to the development of water purification and packaging technology. According to Vedachalam *et al.* (2017:1), "no place is as intimately tied to the birth and proliferation of sachet water industry as West Africa, most notably Nigeria and Ghana." As found by Micah and Alabi (2017) and Stoler (2013), table water has become a product that is popularly accepted among consumers.

The practices adopted in producing, distributing, and consuming table water, especially in Nigeria, call for an empirical evaluation to establish sustainability. To the best of the researchers' knowledge, there needs to be more empirical studies on sustainable manufacturing practices in the table water industry in Nigeria. Related studies focused on the environmental implications of producing and consuming sachet water in Nigeria (Dada, 2009; Chendo, 2013; Ezeokpube *et al.*, 2014; Meeta, 2015; Micah & Alabi, 2017). Similarly, most studies on table water in Nigeria predominantly scrutinized the microbiological and physic-chemical qualities of the products (Alli *et al.*, 2011; Edema *et al.*, 2011; Adesiji, 2012; Muaz *et al.*, 2012; Onilude *et al.*, 2013; Aji *et al.*, 2015; Bukar *et al.*, 2015; Ikon *et al.*, 2017). However, the need to holistically and robustly analyze the manufacturing practices of the table water industry in Nigeria in pursuit of achieving the Sustainable Development Goals (SDGs) of ensuring the availability and sustainable management of water and sanitation for all serves as the gap this study seeks to fill. This study, therefore, examines the extent to which relevant manufacturing practices adopted by table water firms could promote the environmental sustainability performance of the industry.

LITERATURE REVIEW

Overview of the Nigerian Table Water Industry

Historically, "sachet water was launched into the Nigerian markets in the 1990s, but its regulation started in 2000 by the NAFDAC (Meeta, 2015). To guarantee effective industry regulation, NAFDAC outlined conditions and quality criteria to satisfy before registering a table water firm. The Agency registered 134 different sachet and bottled water-producing companies that met the criteria in 2000 (Onemano & Otun, 2013). Since then, there has been an incredible upsurge in the number of table water companies

registered in the country. The Agency registered 436 and 998 in 2001 and 2002, respectively (Akunyili, 2003). The number of table water companies increased from 134 in 2000 to 18,750 in 2014 (Nature Cares Resource Center, 2014). The industry is contributing to the Nigerian economy in various ways. These include the provision of safe and inexpensive access to drinking water; generation of employment opportunities for members of the society; source of revenue for business owners and government in the form of profit and tax, respectively among others (Adekunle & Dakare, 2020; Bello *et al.,* 2017).

The endorsement of quality by NAFDAC enhanced public confidence and demand for the product (Akunyili, 2003; Babatunde & Biala, 2010). An increase in demand for the products made the industry very attractive to potential investors that require comparatively low start-up capital (Omole *et al.,* 2015). Importantly also, the industry employs people in the downstream sector via packing, vending, and distribution (Ikpe, 2014).” According to Akunyili (2003, p. 85), “the inability of the government to provide persistently adequate potable water for the growing population tremendously contributed to the proliferation of table water producers in Nigeria." This is because the product fills the gap created by the scarcity of potable drinking water.

Despite the industry's growing contribution to the Nigerian economy, the table water industry is still battling several challenges. Omole *et al.* (2015) observed that Nigeria's challenges confronting the table water industry are more related to human behavioural patterns than the product itself. They suggested that efforts should be intensified to address the behavioural challenges by enhancing the operational effort of the regulatory Agency. Omole *et al.* (2015) also suggested the expansion of NAFDAC operations by engaging more professionals and well-trained workforces to combat the menace of profiteering perpetrated by some table water producers, which is detrimental to public health. Other suggestions include increasing budgetary allocation and providing a formidable legal framework.

Sustainable environmental performance

Environmental sustainability entails efficiently utilizing resources to preserve the environment for the coming generations (Salwa et al., 2017). According to Townsend (2008), “environmental sustainability focuses on the quality and quantity of natural resources, the environment, global warming, ecological concerns, waste management, reductions in energy and resource use, alternative energy production, and improved pollution and emissions management." As Zubir et al. (2012) posited, achieving environmental sustainability by companies involves adopting green practices like environmental management systems, green SCM, and green balanced scorecard strategies. Azevedo et al. (2012) found that environmental sustainability reduces economic costs.

Environmental performance focuses on measuring the impact of a company's activities on the environment and its components, such as ecosystems, land, air, and water (Rehman *et al.,* 2021). Nguyen *et al.* (2021) described environmental performance as the efficient management of environmental aspects of a company's activities, products, and services. These environmental aspects focus on material utilization, energy consumption, water usage, waste management, and handling industrial emissions. From a sustainability perspective, companies' environmental practices should lead to minimal waste generation and energy consumption as well as optimal compliance with the regulatory framework. Salwa et al. (2017) opined that environmental performance substantially depends on efficiently using clean and sustainable energy resources to minimize CO_2 emissions. CO_2

emissions harm the environment by causing global warming, acid rain formation, and polluting the air, negatively affecting human health and causing natural balance disruption to the ecosystem. Therefore, table water production should be done in a manner that reduces energy consumption and the emission of CO_2.

Sustainable manufacturing practices adoption among table water firms

As described by International Trade Administration (2007), sustainable manufacturing practices entail the "creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers, and are economically sound." Engaging in sustainable manufacturing practices has enormous benefits for firms. These benefits include enhancement in the quality of products, waste reduction, efficiency increase, market share growth, new market creation, high delivery speed, and innovation, among others (Millar & Russell, 2011).

NAFDAC, an Agency of the Federal Government of Nigeria, is responsible for registering and regulating table water firms in Nigeria. The Agency was established to control and regulate the manufacturing, importing, exporting, distributing, advertising, sales, and use of food, drugs, cosmetics, chemicals/detergents, medical devices, and all drinks (Akunyili, 2003). As part of NAFDAC's responsibility of regulating food and drug-producing organisations, the Agency has a good manufacturing practices (GMP) guideline that manufacturing companies must comply with before registering and approving operations. In the field of operations management, such guideline is called sustainable manufacturing practices.

For table water firms, the evidence of satisfying the requirements stipulated in good (sustainable) manufacturing practices is when NAFDAC issues a registration number to show that the needed conditions have been met. Issuance of the NAFDAC registration number to a table water firm is proof that the company has met all the stipulated conditions for sustainable operation as stipulated by the Agency. Some of the issues in NAFDAC guidelines for establishing table water firms in Nigeria in line with the selected sustainable manufacturing practices for this study are sustainable product development, sustainable packaging, and sustainable waste management.

Sustainable product development: NAFDAC prescribes minimum GMP requirements for personnel and product design in table water companies. The Agency prescribes that there should be adequate personnel to perform and supervise the production and packaging of table water. A production manager with a minimum of Ordinary National Diploma in a science-based course obtained from a recognized tertiary institution must supervise table water production. The production manager can carry out in-house and in-process quality control. At the same time, comprehensive product analysis should be performed by a public analyst registered by the Institute of Public Analysts of Nigeria (IPAN). In Nigeria, table water is mainly designed and packaged in small sachets, disposable plastic bottles, and large refillable containers. The process for developing table water products should be sustainably done to promote the environmental performance of the companies in the industry.

Sustainable packaging: Sustainable packaging is the use of packaging materials and designs to improve sustainability or attain sustainable development (Friedrich, 2022). As part of NAFDAC GMP requirements, the floor of the packaging materials store should be easily cleaned and disinfected, non-shedding durable material, and have a smooth surface. If present

in the store, windows should be screened with insect-proof nets and constructed so as not to trap dust.

Sustainable waste management: Sustainable approaches are required to manage the waste generated during the production and consumption of table water. As part of NAFDAC minimum GMP requirements, any building used in the manufacture, processing, and packaging of potable water should be maintained in a hygienic condition. The building should be regularly fumigated with approved fumigants following the Food and Drug Act and the pesticide registration regulation of NAFDAC. Adequate, clean washing and toilet facilities should be provided for personnel. Washing facilities should be equipped with soap, detergent, air driers, or single-service towels. Materials prescribed for cleaning and sanitation include bottle washer brush, long-handle stiff brush (for cleaning the storage tanks), food-grade liquid detergent, cleaning mop, dust brush/sweeping brush, cobweb brush, disposable wipes, waste bin, and plastic pallets." Waste generated in the factory must be promptly and properly disposed of.

METHODOLOGY

Research design, population, and sample

A cross-sectional survey research design was adopted in the study by collecting data from owners or managers of the table water companies at a particular point in time. The study population comprises all 1141 NAFDAC-certified table water companies operating in Delta and Edo States. A random sample of 297 table water companies was used for the investigation. Out of the 297 questionnaires administered, 247 were validly completed. Using the Mahalanobis distance approach, three responses demonstrated the presence of outliers. The responses were deleted from the dataset. The Mahalanobis distance approach is used in determining the presence or otherwise of an outlier in a sample. The presence of an outlier in a dataset is capable of changing statistical results. The Mahalanobis distance approach was used in this study as a preliminary analytical technique to delete the three responses capable of changing the study's statistical results. Therefore, 244 responses were used for the study. The questionnaires were completed by owners or managers of the table water companies selected. For companies where the owners or managers were too busy to complete the questionnaire, the responsibility for completing the questionnaire was assigned to other competent individuals in the firms.

Instrumentation, model specification, and operational measures of variables

The scale used for the study was adopted from previous but related studies. The scale for sustainable product development was adopted from Salwa *et al.* (2017) with a reliability score of 0.921. The reliability scores for sustainable packaging and waste management are 0.870 and 0.841 adopted from Garcia-Area *et al.* (2014) and Zhang *et al.* (2011), respectively. The scale for sustainable environmental performance was adopted from Adekunle and Dakare (2020) with a reliability score of 0.763. All the items are in Likert-scale format.

The research model was adapted and modified based on the models formulated by Salwa et al. (2017) and Adekunle and Dakare (2020), which contain the fundamental constructs of SMP constructs and sustainability performance. The functional relationships among the variables are shown as follows:

$$EPERF = f(PDEV, SPACK, WMGT) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The model is mathematically expressed as:

$EPERF_i = \beta_0 + \beta_1 PDEV_i + \beta_2 SPACK_i + \beta_3 WMGT_i + \varepsilon_i$ ……..(2)

The A priori expectation is $\beta_1 \ldots \beta_3 > 0$; a positive relationship is expected between the SMP constructs and sustainable environmental performance.

Sustainable product development (PDEV) is measured as a design that incorporates the environmental impact of table water products throughout their life cycle by paying attention to quality (Payner & Simon, 1995; Adekunle & Dakare, 2020). Sustainable packaging (SPACK) is measured as table water products' packaging using energy-efficient material and design to minimize environmental impact throughout its lifecycle (Adekunle & Dakare, 2020). Sustainable waste management (WMGT) is measured as collecting, transporting, processing, treating, and disposing table water waste (Adekunle & Dakare, 2020). Sustainable environmental performance (EPERF) is operationally defined and measured as activities that promote reducing energy consumption to preserve the environment for future generations (Adekunle & Dakare, 2020).

Estimation technique

Data were descriptively analyzed using percentage, mean, standard deviation, skewness, and kurtosis. Correlation and regression analyses were used to estimate the relationship between sustainable manufacturing practices and the environmental performance of the companies. Statistical Package for Social Sciences (SPSS version 24) was used to conduct all analyses at a 5% significance level.

RESULTS AND DISCUSSIONS

Description of respondents' demographics

This section contains the respondents' different background information, including gender, age, educational qualification, and work experience. The results are presented in Table 1 as follows:

Table 1

Respondents' demographics

Variable	Category	Frequency	Percent (%)
Gender of respondents	Male	167	68.4
	Female	77	31.6
	Total	244	100
Age of respondents	20years and below	11	4.5
	21-30years	79	32.4
	31-40years	108	44.3
	41-50years	32	13.1
	Above 50years	14	5.7
	Total	244	100
Education qualification of respondents	SSCE/GCE	10	4.1
	NCE/Diploma/OND	74	30.3
	HND/First Degree	87	35.7
	Postgraduate	73	29.9
	Total	244	100
Work experience of respondents	Below 1year	3	1.2
	1-3years	24	9.8
	4-6years	51	20.9

Variable	Category	Frequency	Percent (%)
	7-10years	109	44.7
	Above 10years	57	23.4
	Total	244	100.0

Table 1 showed that male and female respondents accounted for 68.4% and 31.6%, respectively, implying that most owners or highly placed employees in table water firms are male. In terms of respondents' age, 11 (4.5%) of them are 20 years and below, 79 (32.4%) are 21 – 30 years old, 108 (44.3%) are 31 – 40years old, 32 (13.1%) are 41 – 50years old while 14 (5.7%) showing that the majority of the respondents are between 21 and 50 years old. Table 1 further showed that respondents with SSCE/GCE, NCE/Diploma/OND, HND/First degree, and Postgraduate qualifications accounted for 4.1%, 30.3%, 35.7%, and 29.90%, respectively. Finally, Table 1 revealed that 44.7% of the respondents have worked for seven to ten years, while 23.5% have worked for more than ten years in the table water business. Other respondents that jointly accounted for 31.9% have worked below seven years in table water companies.

Table 2.

Descriptive statistics of research variables

S/N	Variables	Mean	Standard Deviation	Normality Test	
				Skewness	Kurtosis
1	Sustainable product development (PDEV)	3.75	0.542	-0.241	0.205
2	Sustainable packaging (SPACK)	3.74	0.659	-0.700	1.432
3	Sustainable waste management (WMGT)	3.70	0.624	-0.542	0.234
4	Sustainable environmental performance (EPERF)	3.61	0.641	-0.382	-0.377

The mean and standard deviation scores for sustainable environmental performance are 3.61 and 0.641. The mean scores for PDEV, SPACK, and WMGT are 3.75, 3.74, and 3.70 respectively. Normality test on the dataset was conducted using skewness and kurtosis. At the item level, the range of skewness values is 0.456 to 1.213 while kurtosis values ranged from 0.288 to 2.524. The absolute values of skewness and kurtosis at the construct level ranged from 0.241 to 0.700, and 0.377 to 1.432 respectively. The reported values are less than 3.0 and 8.0 for skewness and kurtosis respectively based on Kline's (2011) benchmark.

Correlation analysis

Table 3

Correlation coefficients of the constructs

Variables	EPERF	PDEV	SPACK	WMGT
Sustainable environmental performance (EPERF)	1			
Sustainable product development (PDEV)	0.411**	1		
Sustainable packaging (SPACK)	0.577**	0.377**	1	

Variables	EPERF	PDEV	SPACK	WMGT
Sustainable waste management (WMGT)	0.709**	0.431**	0.637**	1

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson's correlation coefficients in Table 3 revealed that sustainable environmental performance is positively and significantly related to PDEV ($r = 0.411$, $p < 0.05$), SPACK ($r = 0.577$, $p < 0.05$), and WMGT ($r = 0.709$, $p < 0.05$). The results show that all the constructs' correlation coefficients are less than 0.80. In line with Bryman and Cramer's (1997) benchmark of having a score of not more than 0.80, the results rule out the presence of multicollinearity in the model.

Estimated model using regression analysis

The research model was estimated using multiple regression analysis. The results are shown in Table 4:

Table 4

Estimated sustainable environmental performance model

Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	0.386	0.223	-	1.736	0.084	-	-
PDEV	0.125	0.058	0.106	2.150	0.033	0.797	1.255
SPACK	0.187	0.056	0.192	3.335	0.001	0.581	1.720
WMGT	0.556	0.061	0.541	9.161	0.000	0.552	1.813

$R^2 = 0.538$; Adj $R^2 = 0.532$; F-Statistic = 93.134; F-Statistic (Prob) = 0.000;
Durbin-Watson = 2.201; Number of Observation = 244
Dependent Variable: Sustainable environmental performance

Table 4 reveals that sustainable environmental performance is positively and significantly related to all the SMP constructs [PDEV ($\beta = 0.125$; $p<0.05$); SPACK ($\beta = 0.187$; $p<0.05$); and WMGT ($\beta = 0.556$; $p<0.05$)] investigated. The coefficient of determination (R^2) value of 0.538 shows that the SMP constructs jointly explain 53.8% of the variation in the sustainable environmental performance of table water companies. The F-statistic of 93.134 is significant at $p<0.05$, implying a statistically significant relationship between the dependent and the independent variables as a group. The results in Table 4 show that the tolerance values ranged from 0.552 to 0.797, demonstrating evidence of substantial scores above the minimum threshold of 0.10 (Hair *et al.,* 2010). The variance inflation factors (VIFs) scores ranged from 1.255 to 1.813, below the maximum acceptability limit of 5 (Hair *et al.,* 2010). The Durbin-Watson statistic is 2.201. The result validates the collinearity statistics (tolerance and VIF) thereby ruling out multicollinearity in the model.

DISCUSSIONS

This study found that sustainable environmental performance is positively and significantly impacted by sustainable product development. This finding corroborates Salwa et al. (2017), which found that environmental performance is positively perceived and influenced by sustainable product development. Similarly, the work of Eltayeb *et al.* (2011) shows a positive impact of eco-design (sustainable product design and development) on the performance of firms in forms of intangible outcomes such as the product's image and brand value, company's goodwill and favourable publicity. The outcome of the study of Adekunle and Dakare (2020) and Green et al. (2012) found that SMP and eco-design do not have a significant influence on sustainable performance. In a similar vein, Chen and Chai (2010, p.27) observed that "even though there is a tendency to increase awareness for sustainable products, the market opportunities for it are not highly attractive, and therefore, manufacturers are rather reluctant to invest in developing such products." Tseng et al. (2013) observed that companies could only embark on sustainable product development if customers demand such products and demonstrate a willingness to pay for them. Salwa *et al.* (2017) emphasized that price remains the topmost priority for customers when buying a product. Because of this, the government needs to encourage manufacturers by giving them incentives to invest in products that will promote environmental sustainability and consumer well-being.

The study also found that sustainable environmental performance is positively and significantly impacted by sustainable packaging. Manufacturers use packaging to differentiate their products from that of competitors. Thus, packaging is a critical strategic element for brand differentiation and identity. Lindh *et al. (*2016) observed that "packaging has a fundamental role in ensuring safe delivery of goods throughout the supply chain to the end consumer in good condition." Similarly, Nordin and Selke (2010) opined that the essence of packaging is to protect the content of a product which must be done in a manner that promotes environmental sustainability. Therefore, packaging must protect the content of a product so that it can save investment and create an avoidable environmental burden (Adekunle & Dakare, 2020; Lindh *et al.,* 2016).

Finally, sustainable waste management positively and significantly impact sustainable environmental performance. The finding of Adekunle and Dakare (2020) supported this outcome. Discourse on waste management has become germane due to the depletion of natural resources and climate change concerns partially caused by the indiscriminate disposal of waste (Shankar & Khandelwal, 2017). Meeta (2015) found that Nigeria's indiscriminate disposal of table water waste is causing severe environmental problems. Environmental sustainability can be enhanced when table water waste generated during production and after consumption is effectively managed.

CONCLUSION AND RECOMMENDATIONS

Several studies conducted on different aspects of table water production and consumption in Nigeria show that the industry's continuous growth calls for more studies on emerging issues relating to manufacturing practices in the industry to promote sustainability. This serves as the basis for empirically investigating sustainable manufacturing practices and their impact on the environmental performance of the Nigerian table water industry. Two hundred and forty-four (244) questionnaires were retrieved from managers and/or well-experienced representatives of selected table water firms in Delta and Edo states. They were analyzed using both descriptive and inferential statistics. The study concludes that sustainable manufacturing practices (sustainable product development, sustainable packaging, and

sustainable waste management) are essential drivers of the industry's environmental sustainability.

This study contributes to knowledge by providing a comprehensive analysis of the table water industry in Nigeria by examining three sustainable manufacturing practices: sustainable product development, sustainable manufacturing process, sustainable packaging, and waste management, which play a significant role in environmental sustainability. The following recommendations are made to guide table water managers and regulatory agencies. Firstly, based on the significant role of sustainable product development in promoting environmental performance, the study recommends that table water companies invest more resources in state-of-the-art production technologies that could enhance manufacturing processes and reduce energy consumption. Secondly, the packaging of table water products should comply with relevant regulations to checkmate every table water producer's tendency to engage in unwholesome practices that can negatively affect consumers' health. Finally, the study recommends that table water companies collaborate with the government and distributors to continuously sensitise the populace on keeping the environment clean and safe by properly disposing of table water waste.

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