

Sustainable Manufacturing Practices in Selected Table Water Companies in Nigeria

ADEKUNLE Simon Ayo, PhD¹ & ELAHO Bernard O. PhD²

¹Department of Business Administration, Faculty of Management Sciences
University of Benin, Benin City, Edo State, Nigeria

²Department Human Resource Management and Organisational Behaviour,
Faculty of Business and Law, University of Northampton, NN1 5PA, United Kingdom

For correspondence, email: simon.adekunle@uniben.edu

Abstract

The study examined sustainable manufacturing practices in table water companies in Nigeria. A cross-sectional survey research design was employed in the study. The population of the study consists of all table water firms in Delta and Edo States, certified by NAFDAC. A sample of 297 companies was used for the investigation. Out of the 297 questionnaires administered, 247 were validly completed and therefore used for the study. Data collected were descriptively analyzed using mean and standard deviation while analysis of variance (ANOVA) was used to determine whether a significant difference exists among the selected sustainable manufacturing practices of the firms. The analysis was done using SPSS and hypotheses tested at 5% level of significance. The study found that the investigated sustainable manufacturing practices (sustainable product development, sustainable manufacturing process, sustainable packaging, and waste management) are adopted by all the table water firms. It was also found that a statistically significant difference exists in respondents' evaluation of the selected sustainable manufacturing practices. The study recommends that NAFDAC must be more aggressive in playing their surveillance role. There must also be a strategic and synergic collaboration among all the stakeholders in the industry such as National Agency for Food and Drug Administration and Control (NAFDAC), Association of Table Water Producers (ATWAP), and others. This will ensure that standards are continuously maintained and individuals or groups of individuals indulging in fake table water production are easily fished out and sanctioned accordingly.

Keywords: NAFDAC, Packaging, Production, Table water, Waste management

INTRODUCTION

Water is a universal liquid that sustains life and is needed by humans, animals, and plants (Adekunle & Dakare, 2020). However, the provision of safe drinking water especially for human beings is a challenge all over the world due to the presence of microorganisms or biological contaminants in drinking water which could give rise to waterborne infections such as typhoid fever, diarrhoea, hepatitis E, cholera among others which affect hundreds of thousands of people (Ozigis, 2015). Lack of access to direct pipe-borne water in Nigeria and other many developing countries has resulted in seeking for alternatives by residents (Bakker *et al.*, 2008; Vedachalam *et al.*, 2017). One of the alternative sources, as promoted by governments, large businesses, and small and medium-scale enterprises to meet these shortfalls, is table water. Table water in this context refers to the sachet, bottled, and refill water branded in sachets (popularly called pure water in Nigeria), disposable plastic bottles, and large refillable containers (Adekunle & Dakare, 2020; Vedachalam *et al.*, 2017).

The monumental growth and proliferation of table water factories in Nigeria and other Sub-Saharan African countries is proximally entrenched in local water shortages, urbanization, and poverty while the remote causes include governance failure at local, national and global levels (Stoler, 2013; Omole *et al.*, 2015). As observed by Stoler (2017), “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 while international organisations and institutions have not always implemented metrics that truly measure water access and capture the dynamism of local waterscapes.”.

As observed by Adekunle, Osunbor, Okere, Kokogho, Eyiario and Folorunsho (2023), government failure to provide portable and hygienic drinking water for the populace has created business 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 to be a more economical way of accessing drinking water in the country. The table water industry in Africa has experienced some level of growth due to development in technology for water purification and packaging. 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 by the populace

The practices adopted in producing, distributing, and consuming table water, especially in Nigeria call for an empirical evaluation to establish their sustainability. To the best of the researchers' knowledge, there is a paucity of 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

Adekunle & Elaho. SMPs in selected table water companies in Nigeria

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 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 sustainability of the industry.

LITERATURE REVIEW

Overview of the Nigerian Table Water Industry

Water is the most commonly distributed and useful liquid which makes it to be essential for life (Bello *et al.*, 2017). Nigeria is abundantly blessed with water and other resources. However, Nigerian governments (federal, state and local) have not been able to efficaciously utilize these resources to provide safe, adequate, improved, and inexpensive access to drinking water for the populace (Youdeowei *et al.*, 2019).

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 regulation of the industry, NAFDAC outlined conditions and quality criteria to be met 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). After 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 the year 2000 to approximately 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 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 (2003:85), “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 growing contribution of the industry to the Nigerian economy, the table water industry is still battling with a number of challenges. Omole *et al.* (2015) observed that the challenges confronting the table water industry in Nigeria 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, increasing budgetary allocation and providing a formidable legal framework to combat the menace of profiteering perpetrated by some table water producers which are detrimental to public health.

Sustainable manufacturing practices adoption among table water firms

Sustainable manufacturing is one of the components of sustainable development. The emergence of the concept of sustainable development can be traced to the 1970s and 1980s in response to increasing awareness and concern over the environmental impact of economic growth and global expansion of business trade (Sola *et al.*, 2013). World Commission on Environment and Development (2012:2) described sustainable development as:

“the one that does not compromise how the future generation gets satisfied with their needs. It contains two key concepts; the concept of needs, in particular the essential needs of the world’s poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment’s ability to meet present and future needs.”

United Nations Conference on Environment and Development (UNCED) Conference “held in Rio de Janeiro in 1992 gave birth to the concept of sustainable manufacturing and was adopted as one of the guiding principles for business and government in transitioning towards achieving sustainable development (Sola *et al.*, 2013). Different terminologies have been used to describe sustainable manufacturing practices. Some of these terminologies include best manufacturing practices (Ulusoy & Ikiz, 2001), cleaner production (Jackson, 2002), green manufacturing (Hu, 2012), sustainable production (Nabhani, McKie & Hodgson, 2013), sustainability of manufacturing and services (Gunasekaran & Spalanzani, 2012), and good manufacturing practice (NAFDAC, 2016), among others.”

Sustainable manufacturing practices as described by International Trade Administration (2007) 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 product, waste reduction, increase in efficiency, growth in market share, new markets creation, high delivery speed, innovation, among others (Millar & Russell, 2011).

NAFDAC, “an Agency of the Federal Government of Nigeria is charged with the responsibility of registering and regulating table water firms in Nigeria. The Agency was established to control and regulate activities relating to 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 guideline known as good manufacturing practices (GMP) that manufacturing companies must comply with before registration can be done and

approval issued for operations. In the field of operations management, such guideline is called sustainable manufacturing practices

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

Sustainable product development: In developing a product, the role of personnel is very critical. Therefore, NAFDAC prescribed minimum GMP requirements for personnel and product design. The Agency prescribes that there should be adequate personnel to perform and supervise the production and packaging of table water. Production of table water must be under the supervision of a production manager who must possess a minimum of Ordinary National Diploma in a science-based course obtained from a recognized tertiary institution. The production manager can carry out in-house and in-process quality control while comprehensive product analysis should be performed by a public analyst registered by the Institute of Public Analyst of Nigeria (IPAN). In Nigeria, table water is mostly designed and packaged in small sachets, disposable plastic bottles, and large refillable containers. The source of water which is one of the core raw materials should be from a borehole of minimum depths of 100ft – 150ft depending on the topography. The water source should be at least 30-50m away from the nearest septic tank which may or may not be situated within the premises.

Sustainable manufacturing process: NAFDAC prescribes minimum GMP requirements for equipment and environment to guarantee a sustainable manufacturing process. Equipment used in table water production can be categorized into raw water production equipment (PVC water tanks, submersible water pumping machine, surface pumping machine, aeration faucets, and PVC pipes and plumbing fittings); water treatment equipment (reverse osmosis module, industrial water filtration modules, ozone generator, ultraviolet sterilizer and lamps, and dosing pumps); fully automated water production line; automated sachet water filler; personnel protective equipment (disposable food handling gloves, hygiene face masks, head net/cap, laboratory coat, rubber boots and hand sanitizers); quality assurance equipment (pH meter, conductivity, weighing balance glass beakers, glass measuring cylinder, and water testing kit), among others. NAFDAC prescribes that the equipment should be designed or used to minimize man-material contact, be safe to use, easy to clean, and environmentally friendly. The water treatment process should be from borehole (100-150ft minimum) to raw water tank (should be PVC or stainless steel) to industrial modules to the treated water tank to microfilters to UV sterilizer and finally to the production line. The production room should be adequately illuminated and ventilated.

Sustainable packaging: As part of NAFDAC GMP requirements, the floor of the packaging materials store should be made of easily cleaned and disinfected non-shedding durable material

and should have a smooth surface. Windows if present in the store should be screened with insect-proof nets and be constructed in such a way as not to trap dust.

Waste management: 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 in accordance with the Food and Drug Act and the pesticides registration regulation of NAFDAC. Adequate, clean washing and toilet facilities should be provided for personnel. Washing facilities should be equipped with soap or detergent, air driers or single-service towels. Materials prescribed for cleaning and sanitation include bottle washer brush, long-handle hard 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

This study employed a cross-sectional survey research design. The population of the study consists of all table water firms in Delta and Edo States, certified by NAFDAC. A sample of 297 table water firms was used for the investigation. Out of the 297 questionnaires administered, 247 were validly completed and therefore used for the study. The copies of questionnaire were filled by the owner or managers of the table water firm. For firms where the owner or managers were too busy to complete the questionnaire, the responsibility for completing the questionnaire was assigned to other competent individuals in the firms. For reliability of the instrument, scales were 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 scale for sustainable manufacturing process was adopted from Habidin *et al.* (2017) with a reliability score of 0.810. 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. Data collected were descriptively analyzed using mean and standard deviation while analysis of variance (ANOVA) was used to determine whether a significant difference exists among the selected sustainable manufacturing practices of the firms. Statistical Package for Social Sciences (SPSS version 24) was used to conduct all analyses at a 5% level of significance.

RESULTS AND DISCUSSIONS

Description of respondents' demographics

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

Table 1: Respondents’ demographics and firms’ background information

Variable	Category	Frequency	Percent	Cumulative Percent
Gender of respondents	Male	169	68.4	68.4
	Female	78	31.6	100
	Total	247	100	
Age of respondents	20years and below	11	4.5	4.5
	21-30years	80	32.4	36.8
	31-40years	110	44.5	81.4
	41-50years	32	13.0	94.3
	Above 50years	14	5.7	100
	Total	247	100	
Education qualification of respondents	SSCE/GCE	10	4.0	4.0
	NCE/Diploma/OND	75	30.4	34.4
	HND/First Degree	88	35.6	70.0
	Postgraduate	74	30.0	100
	Total	247	100	
Work experience of respondents	Below 1year	3	1.2	1.2
	1-3years	24	9.7	10.9
	4-6years	52	21.1	32.0
	7-10years	110	44.5	76.5
	Above 10years	58	23.5	100
	Total	247	100	

Table 1 showed that male and female respondents accounted for 68.4% and 31.6% respectively. This implies that most owners or highly placed employees in table water firms are male. In terms of respondents' age, 11 (4.5%) of them are 20years and below, 80 (32.4%) are 21 – 30years old, 110 (44.5%) are 31 – 40years old, 32 (13%) are 41 – 50years old while 14 (5.7%). This shows that the majority of the respondents are between 21 and 50years old. Table 1 further showed that respondents with SSCE/GCE, NCE/Diploma/OND, HND/First degree and Postgraduate qualifications accounted for 4%, 30.4%, 35.6% and 30% respectively. Finally, Table 1 revealed that 44.5% of the respondents have worked for seven to ten years while 23.5% of them have worked for more than ten years in the table water business. Other respondents that jointly accounted for 32% have worked below 7% in table water companies

Description of Sustainable Manufacturing Practices

Tables 2 to 5 showed the descriptive statistics of the sustainable manufacturing practices investigated. The frequencies and percentages of strongly agree and agree were merged while that of strongly disagree and disagree were also merged to show the level of agreement and disagreement respectively. The calculated values are scored as follows: between 1.0 - 1.5 is

scored very low, 1.6 - 2.5 is low, 2.6 - 3.5 is moderate, 3.6 - 4.5 is high and 4.6 and above is very high. The results are shown as follows:

Table 2: Sustainable product development (SPD)

Code	Statement	Strongly (Agree)	Not Sure	Strongly (Disagree)	Mean	SD
SPD1	Materials used for the production of table water are largely free from hazardous substances	179 (72.6%)	50 (20%)	18 (7.4%)	3.85	0.846
SPD2	Materials used for the production of table water are durable enough to safeguard the content of the product	109 (44.2%)	52 (21.1%)	86 (34.7%)	3.10	1.200
SPD3	Little attention are paid to materials used for the production of table water	56 (22.8%)	66 (26.8%)	125 (50.4%)	2.57	1.304
SPD4	Table water is rarely designed to reduce energy consumption	51 (20.7%)	68 (27.3%)	128 (52%)	2.48	1.192
SPD5	Equipment used in producing table water supports easy maintenance	201 (81.5%)	37 (15%)	9 (3.5%)	4.04	0.810
Overall mean and standard deviation of sustainable product development					3.21	0.486

Table 2 shows that the majority of the respondents (72.7%) agreed that materials used for the production of table water are largely free from hazardous substances while only 7.4% disagreed with the statement. The mean score of 3.85 further confirms this outcome. The Table also shows that 44.2% of the respondents agreed that materials used for the production of table water are durable enough to safeguard the content of the product. The mean score of this statement is 3.10 which shows that majority of the respondents agreed with the statement.

However, the majority of the respondents disagreed with the statements that: little attention is paid to materials used for the production of table water, and table water is rarely designed to reduce energy consumption. This is shown by the mean scores of 2.57 and 2.48 respectively. Table 2 further shows that the majority of the respondents (81.5%) agreed that equipment used in producing table water supports easy maintenance. The mean score of 4.04 further confirms this outcome. The overall mean score for sustainable product development is 3.21. It can be concluded that respondents’ assessment of sustainable product development is moderate.

Table 3: Sustainable manufacturing process (SMPr)

Code	Statement	Strongly (Agree)	Not Sure	Strongly (Disagree)	Mean	SD
SMPr1	Table water firm invests in production equipment that promotes environmental friendliness	203 (82.3%)	36 (14.6%)	8 (3.1%)	4.06	0.755
SMPr2	Hazardous and non-hazardous waste creation is minimized during production	202 (81.8%)	39 (15.8%)	6 (2.4%)	4.03	0.751
SMPr3	Materials considered to be harmful but not illegal are used during the production of table water	6 (2.6%)	98 (39.4%)	143 (58%)	2.16	0.926
SMPr4	During production, little efforts are made to minimize air emissions and pollutions	44 (17.9%)	75 (30.4%)	128 (51.7%)	2.48	1.175
SMPr5	Equipment parts used for table water production are easily accessible and serviceable	141 (57.2%)	77 (31.2%)	29 (11.6%)	3.54	0.927
Overall mean and standard deviation of sustainable manufacturing process					3.25	0.495

Table 3 shows that the majority of the respondents (82.3%) agreed that firms invest in production equipment that promotes environmental friendliness while only 3.1% disagreed with the statement. The mean score of 4.06 further confirms this outcome. Table 3 also shows that the majority of the respondents (81.8%) agreed that hazardous and non-hazardous waste creations are minimized during production. The mean score of this statement is 4.03. This further shows that majority of the respondents agreed with the statement.

However, the majority of the respondents 58% and 51.7% disagreed with the statements that: materials considered to be harmful but not illegal are used during the production of table water; and during production, little efforts are made to minimize air emissions and pollution. This is shown by the mean scores of 2.16 and 2.48 respectively. Table 3 further shows that the majority of the respondents (57.2%) agreed that equipment parts used for table water production are easily accessible and serviceable. The mean score of 3.54 further confirms this outcome. The overall mean score for sustainable manufacturing process is 3.25. It can be concluded that respondents' assessment of the sustainable manufacturing process is moderate.

Table 4: Sustainable packaging (SP)

Code	Statement	Strongly (Agree)	Not Sure	Strongly (Disagree)	Mean	SD
SP1	Table water sachets and bottles contain basic information about the product	147 (59.6%)	73 (29.4%)	27 (11%)	3.58	0.911
SP2	Ability of packaging materials to be processed effectively in the production line	192 (77.8%)	38 (15.2%)	17 (7%)	3.92	0.898
SP3	The ways products are packaged facilitate easy handling and transport of the product	168 (68.1%)	64 (26%)	15 (5.9%)	3.79	0.842
SP4	Ability of packaging to effectively protect the product	153 (62%)	72 (29.2%)	22 (8.8%)	3.66	0.873
SP5	Easy to remove packaging materials from the product by consumers	176 (71.3%)	53 (21.5%)	18 (7.2%)	3.75	0.841
Overall mean and standard deviation of sustainable packaging					3.74	0.685

Table 4 shows that majority of the respondents (Over 59%) agreed with the statements measuring sustainable packaging in the following orders: ability of packaging materials to be processed effectively in the production line ($\bar{X} = 3.92, SD = 0.898$); the ways products are packaged facilitate easy handling and transport of the product ($\bar{X} = 3.79, SD = 0.842$); easy to remove packaging materials from the product by consumers ($\bar{X} = 3.75, SD = 0.841$); ability of packaging to effectively protect the product ($\bar{X} = 3.66, SD = 0.873$); and table water sachets and bottles contain basic information about the product ($\bar{X} = 3.58, SD = 0.911$). The overall mean score for sustainable packaging is 3.74. It can be concluded that respondents' assessment of sustainable packaging is high.

Table 5: Waste management (WM)

Code	Statement	Strongly (Agree)	Not Sure	Strongly (Disagree)	Mean	SD
WM1	Provision of waste treatment in the plant or factory for products after recovery from the market	178 (72.1%)	53 (21.5%)	16 (6.4%)	3.78	0.803
WM2	Collaboration with waste collection agencies in carrying waste generated during operations	146 (59.2%)	69 (27.7%)	32 (13.1%)	3.57	0.997
WM3	Organising training and discussions on managing waste among stakeholders	163 (66.1%)	61 (24.5%)	23 (9.4%)	3.72	0.929
WM4	Adoption of advance technology that minimizes wastes during production	157 (63.6%)	53 (21.3%)	37 (15.1%)	3.61	0.977
WM5	Form partnership with customers to promote sanitary environment through proper disposal of waste	171 (69.3%)	56 (22.7%)	20 (8%)	3.78	0.943
Overall mean and standard deviation of waste management					3.69	0.644

Table 5 shows that majority of the respondents (72.1%) agreed that their table water firms make provision for waste treatment in the plant or factory for products after recovery from the market while 6.4% of the respondents disagreed with the statement. Only 21.5% of the respondents were not sure. The mean score of 3.78 further confirms this outcome. 59.2% of the respondents agreed that their firms collaborate with waste collection agencies in carrying waste generated during operations. The mean score of 3.57 further confirms this result. 66.1% of the respondents asserted that their table water firms organise training and discussions on managing waste among stakeholders. Only 9.4% disagreed with the statement. 157 (63.6%) of the respondents agreed that their firms adopt advanced technology that minimizes waste during production while only 15.1% disagreed with the statement. Table 5 further shows that 171 (69.3%) respondents agreed that their firms form a partnership with customers to promote a sanitary environment through proper disposal of waste while 8% of them disagreed with the statement. The overall mean score for waste management is 3.69. It can be concluded that respondents' assessment of waste management is high.

Comparison of sustainable manufacturing practices

Table 6 shows the comparison of the four selected sustainable manufacturing practices in table water firms using analysis of variance (ANOVA).

Table 6: Analysis of Variance (ANOVA) and Post Hoc Results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.680	3	1.227	3.070	0.027
Within Groups	393.149	984	0.400		
Total	396.828	987			

Post Hoc - Least Significant Difference (LSD) method						
(I)	(J)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
SPD	SMPPr	-0.136*	0.057	0.017	-0.248	-0.024
	SP	-0.028	0.057	0.618	-0.140	0.083
	WM	0.023	0.057	0.680	-0.088	0.135
SMPPr	SPD	0.136*	0.057	0.017	0.024	0.248
	SP	0.108	0.057	0.059	-0.004	0.219
	WM	0.159*	0.057	0.005	0.048	0.271
SP	SPD	0.028	0.057	0.618	-0.083	0.140
	SMPPr	-0.108	0.057	0.059	-0.219	0.004
	WM	0.052	0.057	0.362	-0.060	0.163
WM	SPD	-0.023	0.057	0.680	-0.135	0.088
	SMPPr	-0.159*	0.057	0.005	-0.271	-0.048
	SP	-0.052	0.057	0.362	-0.163	0.060

*. The mean difference is significant at the 0.05 level.

The ANOVA result ($F=3.070$; $p=0.027$) shows that there is a statistically significant difference in the respondents' evaluation of the selected sustainable manufacturing practices in the Nigerian table water firms. Since the ANOVA result is found to be significant, post-hoc-test using Least Significant Difference (LSD) was conducted to categorize the sustainable manufacturing practices as evaluated by the respondents. The result shows that the evaluation of sustainable product development (SPD) is significantly different from the sustainable manufacturing process (SMPPr) with $p=0.017$. Probability (p) values of 0.618 and 0.680 for sustainable packaging (SP) and waste management (WM) respectively showed that they are not significantly different from sustainable product development (SPD). Table 6 further showed that there are significant differences between sustainable manufacturing process (SMPPr) and

sustainable product development (SPD), and waste management (WM) with p – values of 0.017 and 0.005 respectively. However, the result shows that the evaluation of sustainable manufacturing process (SMPr) is not significantly different from sustainable packaging (SP) with $\rho=0.059$. Probability (ρ) values of 0.618, 0.059 and 0.362 for sustainable product development (SPD), sustainable manufacturing process (SMPr) and waste management (WM) respectively showed that they are not significantly different from sustainable packaging (SP). Finally, Table 6 showed that there is a significant difference between waste management (WM) and sustainable manufacturing process (SMPr) with $\rho=0.005$. However, the result shows that the evaluation of waste management (WM) is not significantly different from sustainable product development (SPD) and sustainable packaging (SP) with p-values of 0.680 and 0.362 respectively.

CONCLUSION AND RECOMMENDATIONS

There has been a substantial increase in the number of studies investigating different aspects of table water in the last decade in Nigeria. As the table water industry continues to grow, there is a need for continuous studies on different emerging issues relating to the manufacturing practices in the industry to promote sustainability. In line with this, this study empirically investigated sustainable manufacturing practices in the Nigerian table water industry. Two hundred and forty seven (247) usable questionnaires were retrieved from managers and/or well-experienced representatives of selected table water firms in Delta and Edo states. They were analyzed using appropriate statistical tools. It is concluded that the following sustainable manufacturing practices (sustainable product development, sustainable manufacturing process, sustainable packaging and waste management) are important in promoting the sustainability of the industry.

The study recommends that to promote and entrench sustainability in the operations of table water firms in Nigeria, NAFDAC must be more aggressive in their surveillance role to ensure that standards are continuously maintained. It is also recommended that table water producers consistently adhere to NAFDAC standards after product registration and certification to make the products safe for consumption. Effective and regular surveillance of table water firms by NAFDAC officials and other related agencies is needed in achieving this.

REFERENCES

- Adekunle, S. A., & Dakare, O. (2020). Sustainable manufacturing practices and performance in the Nigerian table water industry: a structural equation modelling approach. *Management of Environmental Quality (Emerald Publishing Limited)*, 31(4), 1003-1022.
- Adekunle, S.A., Osunbor, I.P., Okere, O.O., Kokogho, E., Eyiario, R. O., & Folorunsho, G.T. (2023). Determinant of sustainability performance in table water industry. Proceedings of the 17th Annual International Conference of The Academy of Management Nigeria (TAMN), September 20-21, 2023. Pp. 2-18.

- Adesiji, A. R. (2012). Microbiological quality of packaged drinking water brands marketed in Minna metropolis, North Central Nigeria. *Nigerian Journal of Technology Resource*, 7, 1–7.
- Aji, M. M., Kyar, S. A., & Hussaini, M. (2015). Physiochemical and bacteriological analysis of selected sachet water in Jere and Maiduguri, Borno State, Nigeria. *International Journal of Environment*, 4, 48–57.
- Akunyili, D. N. (2003). The role of pure water and bottled water manufacturers in Nigeria. In *29th Water Engineering and Development Centre International Conference in Abuja, Nigeria*.
- Alli, J. A., Okonko, I. O., Alabi, O. A., Odu, N. N., Kolade, A. F., Nwanze, J. C., Onoh, C., & Mgbakor, C. (2011). Parasitological evaluation of some vended sachet water in South Western Nigeria. *New York Science Journal*, 4, 84–92.
- Babatunde, M. A., & Biala, M. I. (2010). Externality effects of sachet water consumption and the choice of policy instruments in Nigeria: Evidence from Kwara State. *Journal of Economics*, 1(2), 113-131.
- Bakker, K., Kooy, M., Shofiani, N. E., & Martijn, E. J. (2008). Governance failure: Rethinking the institutional dimensions of urban water supply to poor households. *World Development*, 36(10), 1891-1915.
- Bello, B. S., Shuangqin, L., & Dalibi, S. G. (2017). Social impacts of packaged and bottled water businesses in Nigeria. *International Journal of Economics, Commerce and Management*, 5(6), 590-603.
- Bukar, M., Mustapha, A., Kyari, M., & Ibrahim, F. (2015). Bacteriological analysis of sachet water in Maiduguri Metropolis. *Journal of Applied Science Research*, 2, 20–25.
- Chendo, N. A. (2013). Managers' perception of environmental sustainability in small and medium scale enterprises (SMEs): Implication for competitive marketing advantages for sachet water manufacturers in Anambra State, Nigeria. *European Journal of Business and Management*, 5(7), 186-195.
- Dada, A. C. (2009). Towards a successful packaged water regulation in Nigeria. *Science Research and Essay*, 4(9), 921-928.
- Edema, M. O., Atayese, A. O., & Bankole, M. O. (2011). Pure water syndrome: Bacteriological quality of sachet-packed drinking water sold in Nigeria. *African Journal of Food and Agricultural Nutrition Development*, 11, 4595–4609.
- Ezeokpube, N. D., Obiora, C. J., & Phil-Eze, P. O. (2014). Environmental problems of sachet water waste disposal in Nsukka urban, Enugu State, Nigeria. *Civil and Environmental Research*, 6(1), 105-113.

Adekunle & Elaho. SMPs in selected table water companies in Nigeria

- Garcia-Arca, J., Prado-Prado, J. C., & Gonzalez-Portela, A. T. (2014). Packaging logistics: Promoting sustainable efficiency in supply chains. *International Journal of Physical Distribution and Logistics Management*, 44(4), 325-346.
- Gunasekaran, A., & Spalanzani, A. (2012). Sustainability of manufacturing and services: Investigations for research and applications. *International Journal of Production Economics*, 140(1), 35-47.
- Habidin, N. F., Mohd-Zubir, A. F., Mohd-Fuzi, N., Md-Latip, N. A., & Azman, M. N. A. (2017). Critical success factors of sustainable manufacturing practices in Malaysian automotive industry. *International Journal of Sustainable Engineering*, 1-6.
- Hu, G. (2012). Market and social welfare analysis for hybrid sustainable manufacturing industry. *International Journal of Sustainable Manufacturing*, 2(4), 338-355.
- Ikon, G. M., Ohagim, P. I., Amadi, C. P., Abasioubong, V. N., Ekerenam, E. U., & Udoudo, E. M. (2017). Quality assessment of selected sachet water sold in Uyo metropolis, Nigeria. *World Journal of Pharmaceutical Research*, 6(8), 86-95.
- Ikpe, L. (2014). *Entrepreneurial development and small business management*. Lagos: National Open University of Nigeria (NOUN).
- International Trade Administration (2007). How does commerce define sustainable manufacturing? US Department of Commerce. Available at: www.trade.gov/competitiveness/sustainablemanufacturing/how_doc_defines_SM.asp
- Jackson, T. (2002). *Industrial ecology and cleaner production: a handbook of industrial ecology*. UK: Edward Elgar Publication Limited.
- Meeta, R. T. (2015). Impact of disposed drinking water sachets in Damaturu, Yobe state, Nigeria. *World Academy of Science, Engineering and Technology*, 9(10), 1218-1221.
- Micah, D. J., & Alabi, J. T. (2017). Pure water and sustainable environment in Ibadan, Oyo State, Nigeria. *International Journal of Social Sciences*, 11(1), 42-57.
- Millar, H. H., & Russell, S. N. (2011). The adoption of sustainable manufacturing practices in the Caribbean. *Business Strategy and the Environment*, 20(8), 512-526.
- Muazu, J., Muhammad-Biu, A., & Mohammed, G. T. (2012). Microbial quality of packaged sachet water marketed in Maiduguri Metropolis, North Eastern Nigeria. *British Journal of Pharmacology and Toxicology*, 3, 33-38.
- Nabhani, F., McKie, M., & Hodgson, S. (2013). A case study on a sustainable alternative to the landfill disposal of spent foundry sand. *International Journal of Sustainable Manufacturing*, 3(1), 1-19.
- National Agency for Food and Drug Administration and Control (2016). NAFDAC 2016 Annual Report. Abuja: NAFDAC Office

- Nature Cares Resource Center (2014). Challenges of bottled water in Nigeria. Retrieved from: <https://naturecares2014.wordpress.com/2014/10/22/challenges-of-bottled-water-in-nigeria/>
- Omole, D. O., Ndambuki, J. M., & Balogun, K. (2015). Consumption of sachet water in Nigeria: Quality, public health and economic perspectives. *African Journal of Science, Technology, Innovation and Development*, 7(1), 45-51.
- Onemano, J. I., & Otun, J. A. (2003, September). Problems on water quality standards and monitoring in Nigeria. *29th WEDC International Conference at Abuja Sheraton Hotel and Tower, Nigeria* (pp. 22-26).
- Onilude, A. A., Adesina, F. C., Oluboyede, O. A., & Adeyemi, B. I. (2013). Microbiological quality of sachet packaged water vended in three Local Governments of Oyo State, Nigeria. *African Journal of Food Science and Technology*, 4(9), 195-200.
- Ozigis, A. A. (2015). NAFDAC regulation and registration procedure for packaged water. NIFST Workshop at Owerri, Imo State, Nigeria.
- Salwa, H. A., Novita, S. R. A., Raja, G., & Ramayah, T. (2017). The impact of sustainable manufacturing practices on sustainability performance: Empirical evidence from Malaysia. *International Journal of Operations and Production Management*, 37(2), 182 – 204.
- Sola, O., Obamuyi, T. M., Adekunjo, F. O., & Ogunleye, E. O. (2013). Manufacturing performance in Nigeria: Implication for sustainable development. *Asian Economic and Financial Review*, 3(9), 1195.
- Stoler, J. (2013). The sachet water phenomenon in Accra: Socio-economic, environmental and public health implications for water security. In J. R. Weeks, A. G. Hill & J. Stoler (eds). *Spatial inequalities: Health, poverty and place in Accra*, Ghana (Vol. 10). Dordrecht: Springer.
- Stoler, J. (2017). From curiosity to commodity: a review of the evolution of sachet drinking water in West Africa. *Wiley Interdisciplinary Reviews: Water*, 4(3). doi:10.1002/wat2.1206
- Ulusoy, G., & Ikiz, I. (2001). Benchmarking best manufacturing practices: a study into four sectors of Turkish industry. *International Journal of Operations & Production Management*, 21(7), 1020-1043.
- Vedachalam, S., MacDonald, L. H., Omoluabi, E., OlaOlorun, F., Otupiri, E., & Schwab, K. J. (2017). The role of packaged water in meeting global targets on improved water access. *Journal of Water Sanitation and Hygiene for Development*, 1-9, washdev2017155.
- World Commission on Environment and Development (2012). Our common future. Retrieved from: <http://sustainablemanufacturing.biz>

Adekunle & Elaho. SMPs in selected table water companies in Nigeria

Youdeowei, P. O., Nwankwoala, H. O., & Desai, D. D. (2019). Dam structures and types in Nigeria: sustainability and effectiveness. *Water Conservation and Management*, 3(1), 20-26.

Zhang, N., Williams, I. D., Kemp, S., & Smith, N. F. (2011). Greening academia: Developing sustainable waste management at higher education institutions. *Waste Management*, 31(7), 1606-1616.