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Operations Improvement Function and Environmental Sustainability of Petroleum Tank Farms in South South, Nigeria.

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ABSTRACT
The study assessed the nexus between operations improvement function (dimensions by preventive maintenance and benchmarking) and environmental sustainability of petroleum tank farms in South South, Nigeria. The theoretical underpinnings are the theory of routine dynamics and the stakeholder theory, while the underlying research philosophy is positivism. Adopting a cross-sectional survey research design, first-hand data were generated usingquestionnaire.The elements of the accessible population are 820 middle and top-level managers of the selected tank farms. The Krejcie& Morgan's sample size determination technique was deployed and 10% adjustment was made to provide forattritions and non-responses, bringing the adjusted sample size to 288 respondents. The dataset satisfied the assumptions of normality, linearity and equality of variance and the Structural Equation Modelling was deployed to test the hypotheses at 0.05 significance level. Thestudy concludes that management commitment to preventive maintenance significantly amplifies environmental sustainability. Similarly, there is empirical evidence that benchmarking boosts environmental sustainability. Therefore, it is recommended that management of petroleum tank farms should increase the adoption of preventive maintenance by allowing engineers feel free to order spare parts to perform preventive maintenance activities, while ensuring that the spare parts are durable and meet quality standards. The study further recommends that managers of petroleum tank farms should improve their level of benchmarking by effectively and actively encouraging employees to learn from the experience and expertise of other colleagues and organizations.

KEYWORDS: Operations improvement function; Preventive maintenance; Benchmarking;Environmental sustainability; Petroleum Tank Farms.

I. INTRODUCTION

Nigeria is among the top oil producers in the world and the oil and gas sector has grown phenomenally over the past twenty years. The sector accounts for more than 98% of export earnings, above 14% of its gross domestic product, almost 95% of foreign exchange earnings, and about 65% of government budgetary revenues (Ewubare&Kakain, 2017). Petroleum tank farms facilities are pivotal parts of the downstream oil and gas business. With the cultivation of massive amounts of money from the operations of petroleum tank farm facilities, Nigeria has also reaped havoc upon its environment, risking local communities, crops and ecosystems, most of which are given little attention to, when petroleum tank farms are carrying outoperations (Uwakonye, Osho & Anucha, 2006).Specifically, evaporation of hydrocarbons and their products from above the ground storage tanks of petroleum tank farmshas been of special concern in the recent years. Other impacts of petroleum tank farms operations include: road damages by trucks and other heavy equipment, accidents and traffic delays from increased truck traffic on local roads;injury/loss of life from work place hazards, as well as company-community conflicts such as vandalisation, kidnapping etc.Emissions from storage tanks are responsible not only for a depletion of the product supply but also for contributions to atmospheric air pollution. Storage tank of hydrocarbons are important evaporation source of volatile organic compounds (VOC) and nonorganic gases such as carbon monoxide and hydrogen sulphide (Tadros, 2020). Therefore, there is an urgent need to address this challenge as one consequential effect of this type of unsustianable business operation, is that the life expectancy in Nigeria has dropped from 57 years in 2000 to 55 years in 2021. Moreover, the reasons for the drive for a more sustainable approach to businessinclude:

to withstand the pressures of globalization and to answer the calls for greater scrutiny of business by external stakeholders (Kielstra, 2008). Environmental sustainability is the intersection of human activities and ecological systems and this might be seen as adding depth to a portion of the meaning of the most common definition of sustainable development, i.e., “meeting the needs of the current generation without compromising the ability of future generations to meet their needs (Morelli, 2011).

Scholars have suggested several means to enhance environmental sustainability such as contingency planning (Mitroff, 2001), internal improvement (Horak, Arya & Ismail, 2018), adequate regulations (Ross, 2017) and continous improvement processes (Berger, 2017). However, despite the prepondrance of studies on environmental sustainability, one thing that has been least discussed, is from the context of operations improvement functionas a predictor construct. This study therefore, seeks to close the gap in literature by critically examining operations improvement function (measured by preventive maintenance and benchmarking) and how it affects environmental sustainability of petroleum tank farms in South South, Nigeria.

1.1 Objectives and hypotheses

The aim of this study is to investigate the nexus between operations improvement function and environmental sustainability of petroleum tank farms in South South, Nigeria. The specific objectives of the study are to:

i. Evaluate the relationship between preventive maintenance and environmental sustainability.

ii. Ascertain the nexus betweenbenchmarking and environmentalsustainability.

The following research questions directed the investigation:

iii. What is the association between preventive maintenance and environmental sustainability?

i. What is the link between benchmarking and environmentalsustainability?

The following null hypotheses were formulated to provide tentative answers to the above research questions:

H_{01}: There is no significant relationship between preventive maintenance and environmental sustainability.

H_{02}: There is no significant relationship between benchmarking and environmental sustainability.

II. LITERATURE REVIEW

2.1 Theoretical framework: The underpinning theories for the study are the theory of routine dynamics (Feldman & Pentland, 2008) and the stakeholder theory (Freeman, 1984).The theory of routine dynamics was propounded by Feldman and Pentland (2008). They argued that organizational routines are widely misunderstood as rigid, mundane, mindless, and explicitly stored somewhere, rather, routines are generative systems that produce repetitive, recognizable patterns of interdependent action carried out by multiple participants. As such, live routines are best conceptualized as generative systems that can produce a wide variety of performances depending on the circumstances.core insight from research on routine dynamics is the close connection among routines, practices, and process (Howard-Grenville & Rerup, 2016). Indeed, routine dynamics is based on the idea that routines not only connect inputs with outputs, but also that, as practices, they emerge through their own enactment and in relation to other practices (Feldman & Orlikowski, 2011). The theory of routine dynamics is relevant to this study as understanding the intricacies of the routine dynamics of an organisation, will enable petroleum tank farm operators adequately put in place necessary contingent plans, carry out preventive maintainance and assistthe management with the requisite insight for controlling the system. On the other hand, thestakeholders theory which involves organisational management and ethics and was propunded by Freeman (1984).The theory suggests that a firm depends on and needs to put into consideration, any group or individual who can affect or is affected by the achivement of the firm’s objectives. As such, companies needed to understand their relationships with not only traditional groups such as suppliers, customers, and employees, but also non-traditional groups such as government, environmentalists, and special interest groups to manage their organizations more effffectively. The stakeholder theory is relevant to the study, as it provides a useful basis for understanding the value every stakeholder is adding to the firm.

2.2 Conceptual framework: The predictor variable - operations improvement function and its dimensions (preventive maintenance and benchmarking) were adopted from Umoh and Wokocha (2013), Theodros (2017) and Abbas (2014), while the criterion variable- environmental sustainability was adopted from Nicolaesal, Alpopi and Zacharia (2015) and Cella-De-Oliveira (2013).

2.2.1 Operations Improvement Function: Operations refers to the transformation of inputs into finished goods/or creation of services in order to satisfy the customer needs. This uses different inputs including the6M's namely, man, material, machine, money, method and management. Operations improvement is the ability to do the right things better and make it a part of a continuous process. Therefore it is important to adopt efficient operations improvement technique so as to ensure individuals and organizations growth in productivity.

2.2.2 Preventive Maintenance: Maintenance has become more and more part of the integrated business concept and there is aa shift from failure-based to use-based maintenance and increasingly towards preventive maintenance. Maintenance therefore is all the necessary work done to preserve a facility with its furnishes and fittings, so that it continues to provide the same or almost the same facilities, amenities and serves as it did when it was first built (White 1975). Similarly, Lind and Muyingo (2009) argued that maintenance is the "restoring to or retain to a state in which an item can perform an initially specified function and all actions aimed towards this are maintenance activities".

2.2.3 Benchmarking: Benchmarking is a continuous, systematic process for evaluating the products, services and work processes with those recognized as representing the best practices, for the purpose of organizational improvement (Brah, Ong & Rao, 2000). Henczel (2002) contended that when organizations want to improve their performance, they benchmark and compare and measure their policies, philosophies, and performance against high-performing organizations anywhere in the world. Benchmarking process is used to identify useful business practices, new and innovative ideas, effective operating procedures and winning strategies that can be adopted by an organization to ensure cost improvement besides improve quality and productivity (Long, 2005).

2.2.4 Environmental Sustainability: Environmental sustainability refers to a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity (Morelli, 2011).

2.3 EMPIRICAL REVIEW: The nexus between operations improvement function and environmental sustainability has been of interest to researchers. Adopting a generalistic perspective, Miidom, Nwuche and Ayanwu (2016) investigated the relationship between operations management activities and organizational sustainability in Oil and Gas Companies in Rivers State. The study adopted quasi-experimental research design as it is a cross-sectional survey. A sample size of 234 was determined from an accessible population of 565 heads of departments and Operational Managers using Krejcie and Morgan sample table. 234 copies of questionnaire were distributed out of which 191 copies were retrieved and analyzed using Spearman's Rank Order Correlation Coefficient Statistic with the aid of SPSS version 21.0. The findings revealed a positive and significant relationship between operations management activities and organizational sustainability (Rho values between 0.316 and 0.774, P=0.000<0.01). Hence, the study concluded that Operations management activities affect Organizational Sustainability in oil and gas companies in Rivers State, and recommended that management should embark on effective aggregate planning on the economic, environmental and social sustainability issues.These findings could not be generalized to all business organizations, as all dimensions of operations management activities were not discussed in this paper. Besides, a parametric statistical approach can be modelled to further validate the latent constructs. Therefore, a contextual and methodological gap is identified. However, from the context of the nexus between predictive maintenance- a strand of preventive maintenance- and organisational sustainability, Polese, Gallucci, Carrubbo, and Santulli (2021) investigated predictive maintenance as a driver for corporate sustainability. Drawing on the Quadruple Helix model and adopting the users' (fourth helix) perspective, this paper followed an exploratory approach, and applied case study methodology to present the research outcomes of the D.I.A.S.E.I. Project, a co-financed research and development (R&D) project. Using a mixed-methods approach, narrative and quantitative, the study highlights that investing in predictive maintenance. The study found that if companies support investment in predictive maintenance through correct financial decisions, they may create value over time and favor sustainable business balance. The scholars carried out five *t*-tests (mean difference tests) and measured as a dummy with two modalities, 1 when the company introduces the preventive maintenanceand 0 when the company does not, and quantitative continuous variables (ratios and indexes). Through the application of a bivariate analysis, the scholars tested five hypotheses of association and verified that all are supported by results. First, theyverified the assumption of homoscedasticity through the application of Levene's test (H0: the variance between the two groups is homogeneous). Its *p*-value was lower than 0, with a *p*-value of 0.05 for the relationships PdM–ROS, PdM–ROI and PdM–EVA.Accordingly, it was interpreted that the assumption of homogeneity cannot be considered as verified, and, thus, the robust *t*-tests was used. Their *p*-values were lower than 0.05; hence, the null hypotheses were rejected and suggest that the means of ROS (+2.43%), ROI (0.11%) and EVA (0.15) are higher in the hypothesis of adoption of preventive maintenance. Apart from using t-test to test the mean differences, a correlational study can be undertaking to establish the link between the variables under study. This indicates the presence of a methological gap. Deng, (2015) studied the process of measuring and benchmarking the performance of sustainability development of organizations as a multi-criteria analysis problem and presents an objective approach for solving the problem in a simple manner. An objective approach is developed for benchmarking the sustainability development performance of individual organizations in the context of multi-criteria analysis. The relative importance of the sustainability indicators is determined independent of the subjective preferences of the decision maker using the concept of information entropy. A modified technique for order preference by similarity to ideal solutions is used for effectively incorporating the objective indicator weights into the process of determining the overall performance of sustainability development of each organization. As a result, an unbiased overall ranking of individual organizations on the performance of their sustainability development was obtained. The study found that the proposed approach is applicable for measuring and benchmarking the performance of organizational sustainability development through the presentation of an example. This study covers South South of Nigeria, utilising the structural equation modelling .Thus a contextual and contextual and methodological gap is revealed.

III. RESEARCH METHODS:

The research philosophy is positivism, which supports object realism. Accordingly, the cross-sectional survey research design was adopted, as the researcher could not control or manaipulate the study variables.The population of this study comprises all the petroleum tank farmsin South South, Nigeria. Data retrieved from the Department of Petroleum resources (DPR) in Port Harcourt (https://www.dpr.gov.ng), reveals that there are 124 petroleum tank farms in Nigeria, out of which 37 petroleum tank farms are located in South South, Nigeria. Thus, theelements of the accessible population are the 820 middle and top level managers of all the 29 petroleum tank farms owned by members of the Independent Petroleum Products Importers, in South South, Nigeria. A sample size of 288 respondents was determined using the Krejcie& Morgan's (1970) formula, while a 10% adjustment was made to accommodate outliers, non-responses and attrition, bringing the adjusted sample size to 288 respondents. The representative proportionate samples from each tank farm were calculated using the Bowley's proportional sample allocation formula .In order to ensure that each member of the accessible population has equal chance of being selected, the simple random sampling was adopted, while the questionnaire was the source of data collection. In all,230 usable questionnaire were retrieved and analysed. Structural Equation Modelling was deployed to test the hypotheses at 0.05significance level.

IV. DATA PRESENTATION

This section presents data with regards to how the respondents' responses to the research instrument. It is presented thematically in line with the study variables. The questionnaire were structured according to Likert's 5-point scale of Strongly agree (SA), Agree (A), Undecided (U), Disagree (D), and Strongly disagree (SD).

4.1.1 Responses on Preventive Maintenance

Data relating to the responses for preventive maintenancemeasured on a set of multi-item instrument with 7 indicators each, all scaled on a five points Likert's scales were presented thus: with regards to item one, " our engineers feel free to order spare parts to perform preventive maintenance" showed that 17(7.4%) of our respondents strongly agreed; 54(23.5%) agreed, 105(45.7%) were undecided, 34(14.8%) disagreed and 20(8.7%) strongly disagreed. Similarly, for item two which sought to access " the spare parts used for machines to do preventive maintenance are durable and meet the quality standards**",** the responses follow thus: 13(5.7%) of our respondents strongly agreed; 40(17.4%) agreed, 114(49.6%) were undecided, 48(20.9%) disagreed and 15(6.5%) strongly disagreed. Also, for item three which sought to access " our firm has dedicated and skilled preventive maintenance planner", the responses showed that 19(8.3%) of our respondents strongly agreed; 53(23%) agreed, 92(40%) were undecided, 45(19.6%) disagreed and 21(9.1%) strongly disagreed. Furthermore, with regards to item four, which assessed "our management is committed for preventive maintenance execution", the responses showed that 26(11.3%) of our respondents strongly agreed; 54(23.5%) agreed, 83(36.1%) were undecided, 48(20.9%) disagreed and 19(8.3%) strongly disagreed. On the other hand, with regards to item five, which examined "all our critical machines and equipment have preventive maintenance", the responses showed that 20(8.7%) of our respondents strongly agreed; 43(18.7%) agreed, 87(37.8%) were undecided, 59(25.7%) disagreed and 21(9.1%) strongly disagreed. Also, with regards to item six, which assessed "our preventive maintenance program is audited timely", the responses showed that 40(17.4%) of our respondents strongly agreed; 65(28.3%) agreed, 60(26.1%) were undecided, 45(19.6%) disagreed and 20(8.7%) strongly disagreed. Lastly, with regards to item seven, which examined "most employees understands the link between preventive maintenance and the company's strategy", the responses showed that 22(9.6%) of our respondents strongly agreed; 59(25.7%) agreed, 81(35.2%) were undecided, 47(20.4%) disagreed and 21(9.1%) strongly disagreed.

4.1.2 Responses on Benchmarking

Data relating to the responses for benchmarking measured on a set of multi-item instrument with 6 indicators each, all scaled on a five points Likert's scales were presented thus: with regards to item one, "our firm actively encourages employees to learn from the experience and expertise of other colleagues and organizations through comparing practices and processes" showed that 24(10.4%) of our respondents strongly agreed; 52(22.6%) agreed, 77(33.5%) were undecided, 50(21.7%) disagreed and 27(11.7%) strongly disagreed. Similarly, for item two which sought to access "our firm compares performance levels of a process/activity with other organizations – therefore, comparing against benchmarks", the responses follow thus: 31(13.5%) of our respondents strongly agreed; 42(18.3%) agreed, 86(37.4%) were undecided, 55(23.9%) disagreed and 16(7.0%) strongly disagreed. Also, for item three which sought to access "we follow a structured process for comparing performance levels and learn why better performers have higher levels of performance and adapt/implement those better practices", the responses showed that 54(23.5%) of our respondents strongly agreed; 57(24.8%) agreed, 73(31.7%) were undecided, 29(12.6%) disagreed and 17(7.4%) strongly disagreed. Furthermore, with regards to item four, which assessed "in our organizations, better practices that have been identified through benchmarking are communicated to employees", the responses showed that 68(29.6%) of our respondents strongly agreed; 50(21.7%) agreed, 67(29.1%) were undecided, 30(13%) disagreed and 15(6.5%) strongly disagreed. On the other hand, with regards to item five, which examined "our benchmarking project teams usually consist of people from different areas/departments", the responses showed that 49(21.3%) of our respondents strongly agreed; 51(22.2%) agreed, 50(21.7%) were undecided, 41(17.8%) disagreed and 39(17.0%) strongly disagreed. Lastly, with regards to item six, which examined "my management ensures that a benchmarking code of conduct is understood and followed by all employees", the responses showed that 56(24.3%) of our respondents strongly agreed; 73(31.7%) agreed, 58(25.2%) were undecided, 29(12.6%) disagreed and 14(6.1%) strongly disagreed.

4.1.3 Responses on Enviromental Sustainability

Data relating to the responses for environmental sustainability measured on a set of multi-item instrument with 7 indicators each, all scaled on a five points Likert's scales were presented thus: with regards to item one, "my organization makes public its environmental and social objectives" showed that 21(9.1%) of our respondents strongly agreed; 46(20.0%) agreed, 74(32.2%) were undecided, 15(22.2%) disagreed and 38(16.5%) strongly disagreed. Similarly, for item two which sought to access "my organization usually analyzes sustainability-related risks and chances with stakeholders", the responses follow thus: 19(8.3%) of our respondents strongly agreed; 57(24.8%) agreed, 59(25.7%) were undecided, 68(29.6%) disagreed and 27(11.7%) strongly disagreed. Also, for item three which sought to access "environmental sustainability is embedded in the corporate strategy of my organization", the responses showed that 18(7.8%) of our respondents strongly agreed; 39(17.0%) agreed, 87(37.8%) were undecided, 52(22.6%) disagreed and 34(14.8%) strongly disagreed. Furthermore, with regards to item four, which assessed "in our firm, there is a mechanism for the prevention of pollution and contamination by environmentally hazardous substances e.g. PMS, AGO, DPK", the responses showed that 22(9.6%) of our respondents strongly agreed; 28(12.2%) agreed, 83(36.1%) were undecided, 61(26.5%) disagreed and 36(15.7%) strongly disagreed. On the other hand, with regards to item five, which examined "in our company, environmentally hazardous substances management policy is clear", the responses showed that 46(20.0%) of our respondents strongly agreed; 49(21.3%) agreed, 48(20.9%) were undecided, 46(20.0%) disagreed and 41(17.8%) strongly disagreed. Also, with regards to item six, which assessed “my company have a programme for monitoring our current level of environmental performance”, the responses showed that 48(20.9%) of our respondents strongly agreed; 50(21.7%) agreed, 52(22.6%) were undecided, 40(17.4%) disagreed and 40(17.4%) strongly disagreed. Lastly, with regards to item seven, which examined “in my company, there is an appointed person with responsibility for environmental matters”, the responses showed that 20(8.7%) of our respondents strongly agreed; 39(17.0%) agreed, 88(38.3%) were undecided, 54(23.5%) disagreed and 29(12.6%) strongly disagreed.

Table 1.1: Reliability Statistics

SN	CONSTRUCT	NO. OF ITEMS	CRONBACH’S ALPHA STATISTICS
1.	Preventive Maintenance	7	0.796
2.	Benchmarking	7	0.821
3.	Environmental Sustainability	6	0.736

Source: Researcher’s Desk, SPSS 25.0 Outputs 2021.

The instrument was subjected to test of reliability with the following Cronbach’s alpha values:preventive maintenance (0.796), benchmarking (0.821) and environmental sustainability (0.736). As recommended by Nunnally and Bernstein, (1994) an alpha value of 0.7 and above indicates reliability of the measured constructs.

Table 1.2: Normality Statistics
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PREVENTIVE MAINTENANCE	230	9	35	21.36	5.039	.078	.160	.049	.320
BENCHMARKING	230	6	30	19.73	5.267	-.249	.160	-.410	.320
ENVIRONMENTAL SUSTAINABILITY	230	9	35	20.28	5.321	.160	.160	-.457	.320

3.1 Assessement of Normality: All the items in the dataset were found to be normally distributed with the skewness in each case in the range of ±1.0, with standard error of 0.160,and kurtosis values in the range of ±1.0, with standard error of 0.320 (George & Mallery, 2010). Table 1.3 shows the mean, standard deviation, skewnessand kurtosis values for each construct. This confirms that there was no major issue of non-normality of the data.

3.2 Assessement of Linearity: Linearity between two variables is assessed roughly by inspection of bivariate scatterplots. If both variables are normally distributed and linearly related, the scatterplot is oval-shaped, but if one of the variables is nonnormal, then the scatterplot between latent constructs is not oval-shaped (Tabachnick & Fidell, 2007). The evidence from the scatterplots of all the latent constructs, shows that the scatterplots between latent constructs are oval-shaped, therefore the assumption of linearity was not violated.

Table 1.3: Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
PREVENTIVE MAINTENANCE	Based on Mean	1.023	4	225	.396
	Based on Median	.989	4	225	.414

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	Based on trimmed mean	1.024	4	225	.396
BENCHMARKING	Based on Mean	1.100	4	225	.358
	Based on Median	1.099	4	225	.358
	Based on trimmed mean	1.032	4	225	.392
ENVIRONMENTAL SUSTAINABILITY	Based on Mean	.537	4	225	.709
	Based on Median	.502	4	225	.735
	Based on trimmed mean	.544	4	225	.704

3.3 Assessement of Homogeneity of Variance: In this study, Levene's test in SPSS 25.0 was used to determine the presence of homogeneity of variance in the dataset (see Tables 1.4) using Age of Respondents as a non-metric variable on the one-way ANOVA. The results of the ANOVA and Levene's tests revealed that all of the latent variables were non-significant (i.e. p>0.05), thus the assumption of homogeneity of variance was not violated.

3.4 Measurement Model: The measurement modelrides on the common factor model which is represented by the fundamental equation:$y_j = \lambda_{j1}\, ŋ_1 + \lambda_{j2}\, ŋ_2 + . . . + \lambda_{jm} ŋ_m + \varepsilon_j$where $y_j$represents the j the of p indicators obtained from a sample of $n$independent subjects, λ_{jm}represents the factor loading relating variable j to the *mth* factor ŋ, and ε_j represents the variance that is unique to indicator y_j and is independent of all ŋ sand all other εs. The two stages of the measurement model are : (i) the examination of the goodness of fit indices after the indicators have been loaded into the latent variable, and (ii) the interpretation of the parameter estimates.The acceptable model fit is defined by the following criteria: RMSEA (≤0.6), SRMR (≤0.8), CFI (≥0.95), TLI (≥0.95), GFI (≥0.90), NFI (≥0.95) PCLOSE (≥0.5) and AGFI (≥0.90);χ^2/df <5 preferable <3 (Hu & Bentler, 1999; Byrne, 2010; Carmines & McIver, 1981). Where : RMSEA = Root Mean Squared Error of Approximation, CFI = Comparative Fit Index, TLI = Turker-Lewis index, GFI = Goodness-of-Fit-Index, AGFI = Adjusted Goodness-of-Fit-Index, SRMR = Standardized Root Mean Residual, NFI = Normed Fit Index and PCLOSE = Probability of Close Fit. Furthermore, Parameter estimatesshould be greater than 0.5 and preferably above 0.7 (Byrne, 2010).

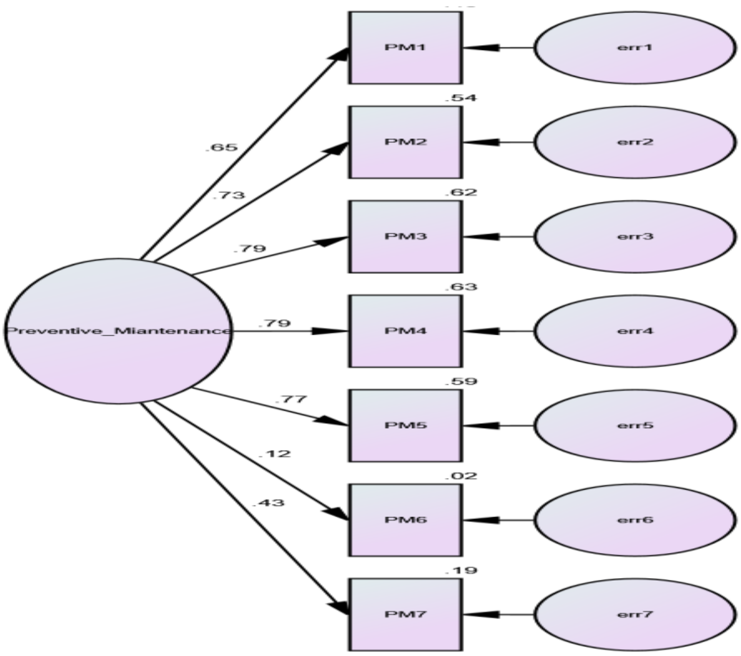

Figure 1.1:Measurement Model of Preventive Maintenance

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Table 1.4: Measurement Model Analysis of Preventive Maintenance

Model	Chi-Square(df), Significance	χ^2/df	NFI	TLI	CFI	RMSEA	Variable	Factor Loading Estimates	Error VAR
Preventive Maintenance	(5df) =33.591, P=0.02	2.399	0.941	0.946	0.946	0.78	PM1	0.65	0.55
							PM2	0.73	0.54
							PM3	0.79	0.62
							PM4	0.77	0.63
							PM5	0.76	0.59
							PM6	0.12	0.02
							PM7	0.43	0.19

Source: Amos 24.0 output on research data, 2021

The results of the goodness of fit indices indicated acceptable fit to the data for one-factor model (chi-square (5df)=33.591, χ^2/df=2.399, p=0.02, RMSEA=0.78, CFI=0.946, NFI=0.941 and TLI=0.946).Table 4.1.35 summarized the goodness of fit indices, the factor loading estimates and the error variances. Factor loading estimates revealed that five indicators were strongly related to latent factor preventive maintenance and were statistically significant. The indicators PM1-PM5 had factor loadings of 0.65, 0.73, 0.79, 0.77, and 0.76 respectively and error variances of 0.55, 0.54, 0.62, 0.63, and 0.59 respectively. However, the weak indicators PM6 and PM7 were deleted from the model, because they their weak loadings were 0.12 and 0.43 respectively. The first five freely estimated standardized parameters were statistically significant. These parameters are consistent with the position that these are reliable indicators of the construct ofpreventive maintenance. The second sub-scale of operations improvement function is benchmarking. The sub-scale had six items and were combined to ensure benchmarking which describe thea continuous, systematic process for evaluating the products, services and work processes with those recognized as representing the best practices, for the purpose of organizational improvement.The justification for the measurement model procedures in this study is based on evidence provided by Abbas (2014).

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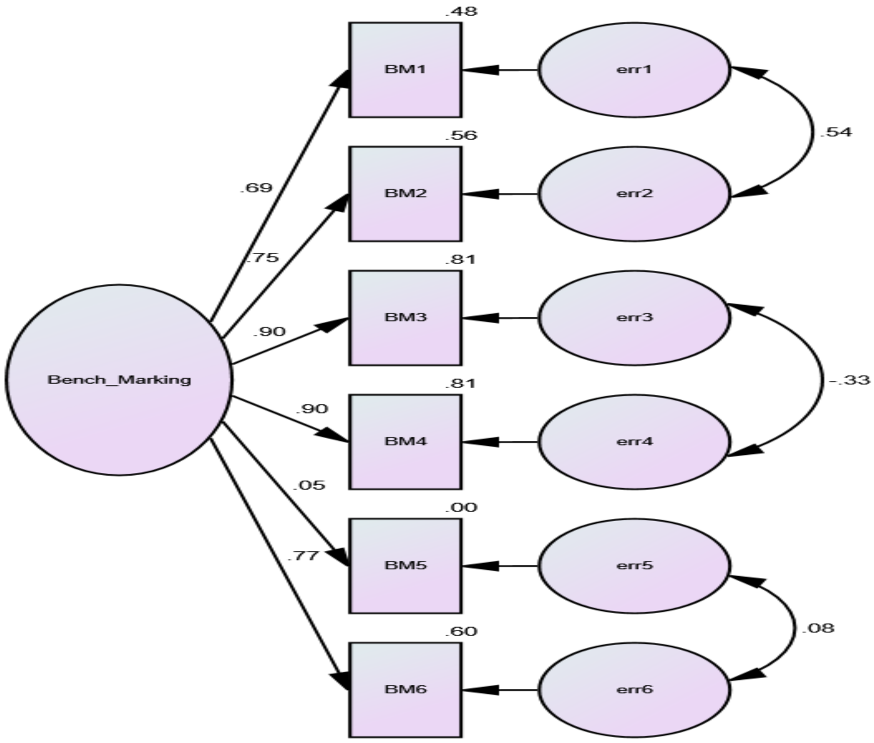

Table 1.5: Measurement Model Analysis of Benchmarking

Model	Chi-Square(df), Significance	χ^2/df	NFI	TLI	CFI	RMSEA	Variable	Factor Loading Estimates	Error VAR
Benchmarking	(9df) =66.751, P=0.000	7.417	0.914	0.874	0.924	0.167	BM1	0.780	0.61
							BM2	0.820	0.67
							BM3	0.863	0.75
							BM4	0.837	0.70
							BM5	0.061	0.00
							BM6	0.768	0.59

Source: Amos 24.0 output on research data, 2021

The results of the goodness of fit indices indicated mediocre fit to the data for one-factor model (chi-square (9df)=66.751, χ^2/df=7.417, p=0.000, RMSEA=0.167, CFI=924, NFI=0.914 and TLI=874). Table 4.1.36 summarized the goodness of fit indices, the factor loading estimates and the error variances. Factor loading estimates revealed that five indicators were strongly related to latent factor - benchmarking - and were statistically significant. The indicators BM1, BM2, BM3, BM4 and BM6 had factor loadings of 0.780, 0.820, 0.863, 0.837, and 0.68 respectively and error variances of 0.48, 0.56, 0.81, 0.81, and 0.60 respectively. However, indicator BM 5 had factor loading of 0.61 and error variance of 0.00. To improve the model, indicator BM5 was deleted and covariances were added between the error terms err1 and err2, err3 and err4, and err5 and err6. After the model modification, the results of the goodness of fit indices indicated accaptable fit to the data for one-factor model (chi-square (6df)=10.447, χ²/df=1.741, p=0.107, RMSEA=0.057, CFI=994, NFI=0.987 and TLI=985). Apart from BM5, all the other freely estimated standardized parameters were statistically significant. These parameters are consistent with the position that these are reliable indicators of the construct of benchmarking.

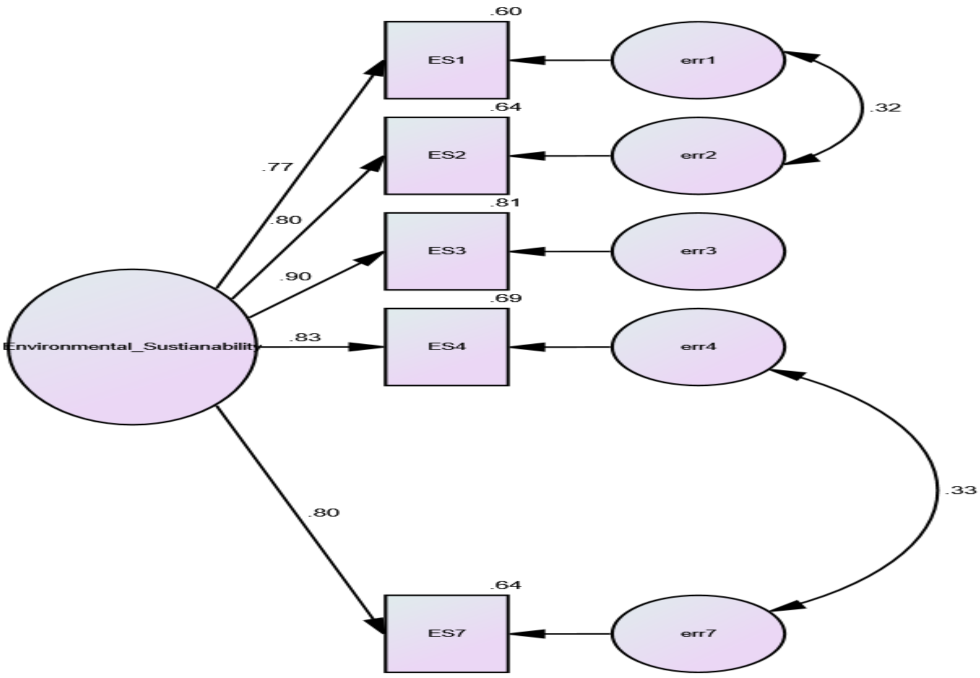

Figure 1.3: Modified Measurement Model of EnviromentalSustainability

Table 1.6 :Modified Measurement Model Analysis ofEnviromentalSustainability

Model	Chi-Square(df), Significance	χ²/df	NFI	TLI	CFI	RMSEA	Variable	Factor Loading Estimates	Error VAR
EnviromentalSustainability	(3df) =5.228 P=0.156	1.743	0.994	0.991	0.997	0.057	ES1	0.774	0.60
							ES2	0.802	0.64
							ES3	0.901	0.81
							ES4	0.833	0.69
							ES5	deleted	-
							ES6	deleted	-
							ES7	0.797	0.64

Source: Amos 24.0 output on research data, 2021

Having deleted ES5 and ES6, the factor loadings of ES1-ES4 and ES7 improved to 0.795, 0.820, 0.875, 0.859 and 0.828 respectively. However, the goodness of fit indices retuned mediocre values (chi-square (5df)=42.630, χ²/df=8.526, p=0.000, RMSEA=0.181, CFI=0.955, NFI=0.949 and TLI=0.909).To improve the goodness of fit indices, coveriances were added between err1 -err2 and err4-err7 as dipected in figure 1.2. The resultant model produced significant factor loadings of 0.774, 0.802, 0.901, 0.833 and 0.797 respectiveley for indicators ES1-ES4, and the goodness of fit indices indicated aaceptable fit to the data for one-factor model (chi-square (3df)=5.228,

χ^2/df=1.743, p=0.000, RMSEA=0.057, CFI=0.997, NFI=0.994 and TLI=0.991, as summarised in table 1.6. All freely estimated standardized parameters were statistically significant. These parameters are consistent with the position that these are reliable indicators of the construct ofenviromentalsustainability.

Table 1.7 : Correlations andAverage Variance Extracted

Variable	PM	BM	ES	AVE	Sq. Root of AVE
PM	**1.0**	0.537	0.611	**0.550**	**0.742**
BM	0.537	**1.0**	0.639	**0.650**	**0.806**
ES	0.611	0.639	**1.0**	**0.698**	**0.836**

Source: SPSS 25.0 and Amos 24.0 output on research data, 2021

3.4.1 Convergent Validity: The results in Tables 1.8 show that all variables have average variance extracted (AVE) values exceeding the 0.50 threshold recommended by Fornell and Larcker (1981). In addition, all the degrees of freedom, are greater than zero, thus, all the models are over-identified. The AVE>0.5 and the standardised estimates >0.7, shows that the model has evidence of convergent validity.

3.4.2 Discriminant Validity: Discriminant validity was accessed based on the criterion recommended by Fornell and Larcker (1981) which states that "the square root of AVE of each construct must be greater than its correlations with other constructs". Therefore, the model has evidence of discriminant validity.

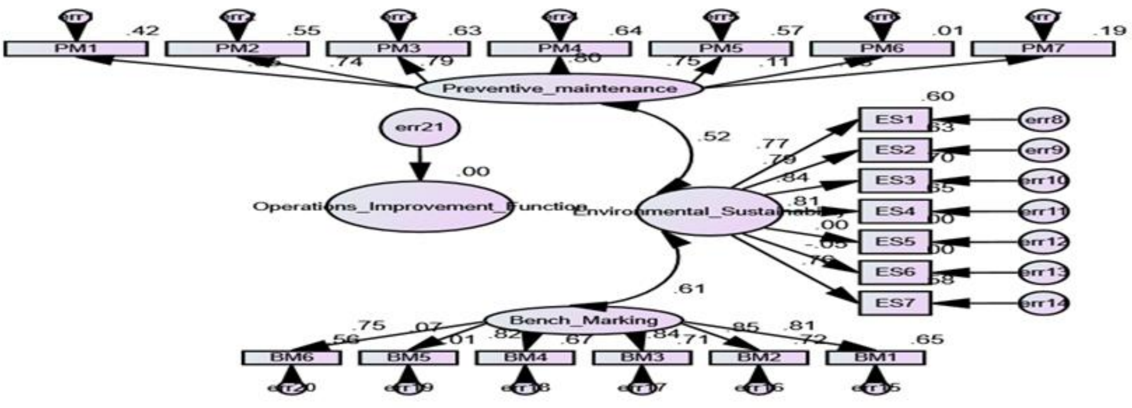

Figure 1.4 Structural model (linking the hypotheses)

The relationship between constructs is specified after the transition from the measurement model to the structural model. The model, adopted the multiple-indicator measurement approach, using the reflective indicators, reflective measurement model and recursive structural model.

Table 1.8 : Test of Hypotheses

S/N	Mediation Stage	Hypotheses	Standardised Estimate (Beta value) > 0.5; or ≥ 0.7	Critical Ratio (C.R)the t-value) ≥ 1.96	P-value < 0.05	Remark	Decision
1	PM →ES (Hypothesis 1)	There is no significant relationship between preventive maintenance and environmental sustainability.	0.538	5.503	0.001	Positive and Significant	Not supported
2	BM →ES (Hypothesis 2)	There is no significant relationship between benchmarking and environmental sustainability.	0.795	3.495	0.000	Positive and Significant	Not supported

3.6 Interpretation of Results (Inferential Analysis):

The hypotheses where tested based on the reported SEM findings in table 1.9. As suggested by Bryne (2006), the standard decision rules for not supporting the null hypotheses are (1) Standardised regression weight (β) should be greater than 0.5 and preferably above 0.7 (Byrne, 2010); (2) C.R value is greater than or equal 1.96 (where C.R, which is the critical ratio is equivalent to t-value); (3) p-value is less than or equal 0.05. This means that two constructs were statistically significantly different with t-value ≥1.96, and at the same time, significantly related with p-value ≤0.05 (tested at 0.05 level of significance). The first hypothesis (Ho:1), states that there is no significant relationship between preventive maintenance and environmental sustainability. However, table 1.9 indicates thatpreventive maintenancehas a positive and significantrelationship with environmental sustainability of petroleum tank farms in South-South Nigeria (β=0.538, C.R=5.503, p=0.001). Thus, Ho:1 was not supported and the alternate hypothesis is hereby accepted. The evidence presents preventive maintenance as a strong predictor of environmental sustainability of petroleum tank farms in South-South Nigeria. Statistically, it shows that when preventive maintenance goes up by 1 standard deviation, environmental sustainability goes up by 0.538 standard deviation. In other words, when environmental sustinabilitygoes up by 1 std, preventive maintenance goes up by 5.503 std. The regression weight for preventive maintenance in the prediction of environmental sustainability is significantly different from zero at the 0.05 level of significance(two-tailed). The second hypothesis (Ho:2), states that there is no significant relationship between benchmarking and environmental sustainability. However, table 1.9 indicates thatbenchmarkinghas a positive and significantrelationship with environmental sustainability of petroleum tank farms in South-South Nigeria (β=0.795, C.R=3.495, p=0.000). Thus, Ho:4 was not supported and the alternate hypothesis is hereby accepted. The evidence presents benchmarking as a strong predictor of environmental sustainability of petroleum tank farms in South-South Nigeria. Statistically, it shows that when benchmarking goes up by 1 standard deviation, environmental sustainability goes up by 0.795 standard deviation. In other words, when environmental sustainability goes up by 1 std, benchmarking goes up by 3.495 std. The regression weight for benchmarking in the prediction of environmental sustainability is significantly different from zero at the 0.05 level of significance(two-tailed).

3.7 Discussion of Findings: Theaim of the study is to assess the nexus between operations improvement function (dimensions by preventive maintenance and benchmarking) andenvironmental sustainabilityof petroleum tank farms in South South, Nigeria. The theoretical underpinnings are the theory of routine dynamics (Feldman & Pentland, 2008) and the stakeholder theory (Freeman, 1984), while the underlying research philosophy is positivism.

3.7.1 Positive and Significant Relationship between Preventive Maintenance and Environmental Sustainability

The first specific objective was to evaluate the relationship between preventive maintenance and environmental sustainability. This objective was captured by a research question and expressed under Ho:1.It was postulated in Ho:1 that there is no significant relationship between preventive maintenance and environmental sustainability. This theorising logic was not supported. The result shows that there is a positive and significant relationship between preventive maintenance and environmental sustainability of petroleum tank farms in South South, Nigeria. In other words, increase in preventive maintenance is associated with increase in environmental sustainability. This finding aligns with Polese, Gallucci, Carrubbo and Santulli (2021) who found that if companies support investment in predictive maintenance through correct financial decisions, they may create value over time and favour sustainable business balance. Furthermore, this finding is consistent with Emelia et al. (2015) who found that maintenance performance measures are imperative for sustainability. To buttress the fact, this finding also synchronizes with the work ofHardt et al. (2021) who empirically confirmed that an innovative approach to preventive maintenance of complex equipment, could help many industrial companies to increase production and maintain efficiency, and ensure sustainability. Indeed, this findingsupports the theoretical assertion extracted from the Theory of Routine Dynamics (Feldman & Pentland, 2008) which suggetsthat organizational routines are widely misunderstood as rigid, mundane, mindless, and explicitly stored somewhere, rather, routines are generative systems that produce repetitive, recognizable patterns of interdependent action carried out by multiple participants. Furthermore, this finding further validates the theoretical assertion of the stakeholders theory (Freeman, 1984) which suggests that a firm depends on and needs to put into consideration, any group or individual who can affect or is affected by the achivement of the firm's objectives.

3.7.2 Positive and Significant Relationship between Benchmarking and Environmental Sustainability

One of the specific objectives was to determine the relationship between benchmarking and environmental sustainability and was captured by a research question and expressed under Ho:2. This hypothesis stated that there is no significant relationship between benchmarking and environmental sustainability. The outcome of the data analysis did not support the hypothesis. The result shows that there is a positiveand significant relationship between benchmarking and environmental sustainability of petroleum tank farms in South South, Nigeria. This implies that increase in benchmarking is associated with increase in environmental sustainability. This position is corroborated by Abazeed (2017) who found that benchmarking culture play an important role in performance improvement. Furthermore, this finding is in agreement with Singh, Grover & Singh (2017) who found that external benchmarking, performance benchmarking and internal benchmarking are the first three ranks that give basis for several critical success factors namely: planning, reliability, standardization, time behavior, usability, etc., as part of benchmarking using in service industries. Also, this finding syncronizes with Simatupang and Widjaja (2012) who found that benchmarking of innovation capability in the digital industry is determined primarily by the quality of human resources who are capable to learn continuously and to follow the changing trend in technology, since their organization structures are not too rigid to avoid complex bureaucracy that can hold up their creativity.This finding further validates the theoretical assertion extracted from the Theory of Routine Dynamics (Feldman & Pentland, 2008) which suggetsthat organizational routines are widely misunderstood as rigid, mundane, mindless, and explicitly stored somewhere, rather, routines are generative systems that produce repetitive, recognizable patterns of interdependent action carried out by multiple participants.

3.8 Conclusion and Recommendations:

The main conclusion of this study is that operations improvement function enhances environmental sustainability. In essence, management commitment to preventive maintenance significantly amplifies the environmental sustainability of petroleum tank farms in South-South. Similarly, there is empirical evidence that benchmarking boosts environmental sustainability of petroleum tank farms in South-South. Therefore, it is recommended that management of petroleum tank farms should increase the adoption of preventive maintenance by allowing the engineers feel free to order spare parts to perform preventive maintenance activities, ensuring that the spare parts used for machines to do preventive maintenance are durable and meet quality standards, while ensuring that majority of theemployees understand the link between preventive maintenance and the company's strategy. The study further recommends that managers of petroleum tank farms should improve their level of benchmarking by effectively and actively encouraging employees to learn from the experience and expertise of other colleagues and organizations through comparing performance levels of their processes/activities with other organizations.

3.9 Contributions to knowledge: The findings of this study validatesthe theory of routine dynamics (Feldman & Pentland, 2008) and the stakeholder theory (Freeman, 1984) by measuring and validating the structural fitnessbetween operations inprovement function and environmental sustainability.The findings serves as a means of enriching decision making and efficiency regarding the operations of petroleum tank farms in the South-South, Nigeria.

3.10 Suggestion for Further Studies: Subsequent studies on operations improvement function and environmental sustainability can be carried out in other sectors and within other geographical contexts as a way of cross-validating the model presented by this study.

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