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Preventive Maintenance and Organizational Sustainability of Petroleum Tank Farms in South South, Nigeria

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Abstract: The study investigated the link between preventive maintenance and organizational sustainability (measured by environmental sustainability and social sustainability) of petroleum tank farms in South-South, Nigeria. The underlying theory is the theory of routine dynamics, while objectivism is the philosophical underpinning. The cross-sectional survey research design was adopted, as the researcher could not manipulate the study variables. The questionnaire was the data collection instrument and the elements of the study population consist of 820 managers of petroleum tank farms in South South, Nigeria. A sample size of 262 was determined using the Krejcie & Morgan's formula and this was adjusted by 10% to provide for attritions. The Bowley's proportional sample allocation and the simple random sampling were deployed. The null hypotheses were tested at 0.05 significance level by means of Structural Equation Modelling. The results revealed that increase in preventive maintenance is associated with increase in environmental sustainability and social sustainability. It is concluded that management commitment to preventive maintenance significantly enhances the measures of organizational sustainability of petroleum tank farms in South-South. It is recommended that managers 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 the quality standards. Also, managers should ensure that majority of the employees understand the link between preventive maintenance and the company's strategy.

Keywords: Preventive maintenance; Organizational sustainability; Petroleum Tank Farms; Environmental Sustainability; Social sustainability.

1. Introduction

Petroleum tank farms refer to areas used for the storage of oil and/or petrochemical products in large tanks either above ground or underground. These tank farms normally consist of: tankage, either above ground or underground and gantries for the discharge of products into road tankers or other vehicles (such as barges) or pipelines. However, petroleum tank farms facilities face enormous challenges, including those related to inadequate social infrastructure, Government underpayment of petroleum subsidies, as well as organizational sustainability challenges. The importance of organizational sustainability cannot be over emphasized. Cellade-Oliveira (2013) argued that organizational sustainability balances the economic, environmental and social development of the organization. On the other hand, Eccles, Ioannou and Serafeim (2011) posited that high sustainability

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companies significantly outperform their counterparts over the long-term, both in terms of stock market and accounting performance.

Moreover, Ballinger (2011) argued that the reasons for the drive for a more sustainable approach to business include: to withstand the pressures of globalization; to limit corporate scandals; to provide a panacea to the global economic crisis and to answer the calls for greater scrutiny of business by external stakeholders. Lavanderos and Fiol (2010) stated that organizational sustainability is an organization's conservative strategy, as a relational system, from structural or configurationally changes in the relationships, determined from the culture. Elkington (1999) advocates that organizational sustainability should not be measured by only economic factors but should be expanded to include organization's environmental and social performance, as well as the financial. The consequential environmental and social impacts of the inadequate organizational sustainability practices of petroleum tank farm operators have almost become unquantifiable. The common environmental impacts are linked water pollution from leakages, accidental spills and washouts, road damages, accidents and traffic delays from increased truck traffic on local roads; injury/loss of life from work place hazards, and accidents as well as company-community conflicts such as vandalisation, kidnapping etc.

Similarly, Oluwatuyi, Omotoba and Ileri (2013) noted that majority of the causes of petroleum tanker disaster could be traced to the negligence on the part of the drivers, as most of the tanker drivers use drugs, are illiterates, could hardly recognize the road signs, and prefer to travel by night with consequential weariness and tiredness. Several organizational sustainability strategies have been suggested by scholars, to reduce the impact of the operations of petroleum tank farms and their tankers on the society. Akintayo (2018) suggested that there should be improvement on road rehabilitation and proper maintenance of the roads by the agencies responsible, while the petrol tanker drivers should be made to strictly adhere to road signs and signals and driving under the influence of drugs or alcohol and at late nights, should be discouraged.

Also the fire service agencies should be made functional and people should be disaster conscious. Despite the myriad of possible panaceas put forward by various scholars in tackling the problem of ineffective organizational sustainability, only few studies have considered addressing the problem from the context of preventive maintenance. Moreover, studies that have deployed structural equation modeling (SEM) as a statistical technique to investigate the nexus between preventive maintenance and organizational sustainability are scanty. As such, there exists a contextual and mythological gap in literature. Therefore, this study seeks to close the lacuna by critically examining preventive maintenance and how it affects organizational sustainability (measured by environmental sustainability and social sustainability) of petroleum tank farms in South South, Nigeria, by means of structural equation modeling as a statistical technique.

1.1 Objectives and hypotheses

The aim of this study is to examine the relationship between preventive maintenance and organizational sustainability of petroleum tank farms in South South, Nigeria. The specific objectives of the study are to:

1. Examine the relationship between preventive maintenance and environmental sustainability.
2. Ascertain the relationship between preventive maintenance and social sustainability.

The following research questions directed the investigation:

1. What is the relationship between preventive maintenance and environmental sustainability?

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Ii. What is the link between preventive maintenance and social sustainability?

Accordingly, the following null hypotheses were formulated to answer 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 preventive maintenance and social sustainability.

2. LITERATURE REVIEW

Theoretical framework: This study is underpinned by the stakeholder 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 achievement of the firm's objectives. As such, companies need 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 effectively. Some interpretations of stakeholder theory maintain that ethical business practices must incorporate the notion that stakeholders are ends rather than means. The stakeholder theory is a strategic management theory which involves organizational management and ethics (Phillips et al., 2003).

The stakeholder theory assumes that values are a part of doing business and disputes the separation thesis (Freeman et al., 2004), which asserts that ethics, and for that matter CSR, and economics are mutually exclusive. Freeman's (1984) stakeholder theory is essentially a normative theory with instrumental and descriptive dimensions. It tells managers and organizations how to treat the interest of stakeholders in a moral and appropriate way. Donaldson and Preston (1995) analysed and justified the stakeholder theory from the instrumental, descriptive and normative points of view. They concluded that though the three approaches are different, they are complementary and that the normative approach is the "critical" base for the theory (Dialo & Ewusie, 2011). They presented the following four central theses of stakeholder theory: (i) Stakeholder Theory is descriptive in that it presents a model of the corporation as an amalgamation of cooperative and competitive interests. It describes how managers deal with stakeholders and how their interests are represented.

The stakeholder theory reflects and directs how managers operate (Freeman et al., 2004). Irrespective of which aspect of stakeholder theory a firm holds, the power and influence of the appropriate stakeholders need to be well understood in order to effectively manage their potential impact on the project (Bourne and walker, 2006). A firm with a stakeholder perspective shapes its strategy based on certain moral obligations to its stakeholders. Examples of this is a fair contracts approach (Freeman, 1994), property rights (Donaldson and Preston, 1995) and feminist ethics (Wicks et al., 1994). The stakeholder theory is managerial in the broad sense, it does not simply describe existing situations or predict cause-effect relationships; it also recommends attitudes, structures, and practices that, taken together, constitute stakeholder management and will lead to effective and efficient management of petroleum tank farms. 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. Understanding the stakeholders theory, will help operators of petroleum tank farms to bear in mind the impact of their operations on the environment, the economy and the social wellbeing of the stakeholders.

2.2 Conceptual framework: Preventive maintenance was adopted from Theodros (2017), as a single construct, while organizational sustainability was measured by economic sustainability and social sustainability as adopted from Nicolaesal, Alpopi and Zacharia (2015) and Cella-De-Oliveira (2013).

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2.2.1 Preventive maintenance: Preventive maintenance is one of the most common types of maintenance strategies used in different industries to prevent equipment from breakdown, and the preventive maintenance activities (inspection, repair, replacement, etc.) are performed at regular intervals (Theodros, 2017). The intervals can be based on fixed number of operation cycles, fixed cumulative outputs, calendar- based (may be in weeks, months or years) or number of operating hours (run time based) (Kelly,1997). According to Alsyouf (2007), preventive maintenance means the regularly scheduled repair and maintenance needed to keep a facility component operating at peak efficiency and extend its useful life. It includes scheduled activities intended to prevent breakdowns, such as periodic inspections, lubrication, calibrations, and replacement of equipment. Replacing filters in an air-handling unit on a regularly scheduled basis is an example of preventive maintenance, as prolonging the life of major facility systems requires periodic replacement of equipment (Theodros, 2017).

2.2.2 Organizational Sustainability: Sustainability is a state in which an organization or a society exhibits a relation to economic, environmental and social aspects (Munck & Souza, 2009). In essence, when it is said that an organization or a society is sustainable, it is meant that it holds a certain state of sustainability (Cella-De-Oliveira , 2013). According to Pappenbroock & Österberg (2017), one common characterization of organizational sustainability suggests that it includes three dimensions, namely environmental, social, and economic sustainability, which can be referred to as the triple bottom line of sustainability (Elkington, 1999).

2.2.3 Environmental Sustainability: Environmental sustainability refers to measures to ensure that the environment is not depleted or damaged further than it has already. This is a particular aspect of the broader sustainable development debate which encompasses a broader range of social economic and environmental goals. As argued by Basiago (1999), environmental sustainability involves ecosystem integrity, carrying capacity and biodiversity. It requires that natural capital be maintained as a source of economic inputs and as a sink for wastes. Essentially, Goodland (1995) argued that the theory of environmental sustainability suggests a planning process that allows human society to live within the limitations of the biophysical environment. Nicolăescu, Alpopi and Zaharia (2015) argued that a sustainable environment lasts if we exist within the planet's regenerative and absorptive strength and the shortfall for preserving sustainability is on a route to develop further in the predictable future. Environmental sustainability is a subset of ecological sustainability, which 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).

2.2.4 Social Sustainability: As social sustainability principles are crucial in developing and building a vibrant society, it is therefore imperative that the requirements underlying the social sustainability principles are clearly set out to drive the social processes and systems towards achieving their intended objectives. According to Basiago (1999), social sustainability encompasses notions of equity, empowerment, accessibility, participation, sharing, cultural identity, and institutional stability. It seeks to preserve the environment through economic growth and the alleviation of poverty (Basiago, 1999). In the most basic sense, social sustainability implies a system of social organization that alleviates poverty. In a more fundamental sense, however, social sustainability establishes the nexus between social conditions such as poverty and environmental decay (Ruttan, 1991).

2.3 EMPIRICAL REVIEW: Several researchers have assessed the link between preventive maintenance and organizational sustainability measures. For instance, Polese, Gallucci, Carrubbo,

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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 the advantages of investing in predictive maintenance. The scholars carried out five *t*-tests (mean difference tests) and measured it as a dummy with two modalities, '1' when the company introduces the preventive maintenance and '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, they verified 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. 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. Furthermore, Similarly, Emelia - Sari et al. (2015) investigated sustainable maintenance performance measures: a pilot survey in Malaysian automotive companies. The paper developed the initial framework for measuring sustainable maintenance performance (SMP) where 15 measures at the corporate level, 20 measures at the tactical level and 43 measures at the functional level, are identified. In sequence, this paper established the importance level of these measures through a pilot survey in Malaysian automotive companies. The population of automotive companies which are listed in Malaysia Automotive Institute is 185. A validated questionnaire was sent to 20 respondents and return rate is 100%. The questionnaire comprised of three main sections. The first section of the questionnaire was intended to obtain the characteristics of respondent. The second section was aimed to obtain the background of company in terms of general information, maintenance management and SMM. The results show that social factor is considered as the most crucial factor in measuring SMP with an importance value of 3.70 and importance percentage is 73.95%.

3. Research Methods: The cross-sectional research design was adopted and the underlying philosophy is positivism. The population of this study comprises all the petroleum tank farms in South South, Nigeria and the accessible population consists of 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. Sample size of 262 respondents was determined using the Krejcie & Morgan's (1970) formula, however, this was adjusted upwards by 10% to 288, to make provision for attritions. Proportional sample allocation was achieved using the Bowley's formula and the simple random sampling was adopted to give each member of the accessible population equal opportunity of being selected. Only 230 usable copies of the questionnaire were retrieved and analysed. Univariate analysis involve the use of mean and standard deviation while the the hypotheses were tested at 0.05 significance level, using the Structural Equation Modelling.

Table 1: Descriptive Statistics for Preventive Maintenance

	N	Minimum	Maximum	Mean	Std. Deviation
Our engineers feel free to order spare parts to perform preventive maintenance.	230	1	5	3.06	1.013

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The spare parts used for machines to do preventive maintenance are durable and meet the quality standards.	230	1	5	2.95	.933
Our firm has dedicated and skilled preventive maintenance planner	230	1	5	3.02	1.061
Our management is committed for preventive maintenance execution.	230	1	5	3.09	1.106
All our critical machines and equipment have preventive maintenance.	230	1	5	2.92	1.075
Our preventive maintenance program is audited timely.	230	1	5	3.26	1.208
Most employees understand the link between preventive maintenance and the company's strategy.	230	1	5	3.06	1.100
Valid N (listwise)	230				

Source: SPSS output (2022)

Table 1 describes the distribution for the data on Preventive Maintenance. This describes the regularly scheduled repair and maintenance needed to keep a facility component operating at peak efficiency and extend its useful life. The distributions for the variables are revealed to be moderate but yet significant, given the central tendencies for the indicators – PM1: Our engineers feel free to order spare parts to perform preventive maintenance, has a moderate and significant mean (mean = 3.06, SD=1.01) suggesting that respondents agree with the statement; PM2: The spare parts used for machines to do preventive maintenance are durable and meet the quality standards, has a moderate but yet significant mean (mean = 2.95, SD=0.93) affirming that majority of the respondents consider the statement as being a true position of their views; PM3: Our firm has dedicated and skilled preventive maintenance planner, has a substantial and significant mean (mean = 3.02, SD=1.06) which indicates that most of the respondents consider the statement to be correct.

Similarly, PM4: Our management is committee to preventive maintenance execution, is associated with a high and significant mean (mean = 3.09, SD=1.11) implying that a majority of the respondents believe the statement aligns with their own views too; PM5: All our critical machines and equipment have preventive maintenance, has a high and significant mean (mean = 2.92, SD=1.18) suggesting that most of the respondents identify with the statement; PM6: Our preventive maintenance program is audited timely, has a strong and significant mean (mean = 3.06, SD=1.10) indicating that a majority of the respondents affirm to the statement as being true. PM7: Most employees understand the link between preventive maintenance and the company's strategy, has a strong and significant mean (mean = 3.06, SD=1.10) indicating that a majority of the respondents affirm to the statement as being true.

Based on the evidence presented for the preventive maintenance, it is affirmed that all 7 of the statement items for the latent variable,are substantially and significantly manifested by the respondents and their respective organizations. This suggests the strong manifestation of preventive maintenance as being evident in the dataset.

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Table 2: Descriptive Statistics Environmental Sustainability

	N	Minimum	Maximum	Mean	Std. Deviation
My organization makes public its environmental and social objectives.	230	1	5	2.83	1.194
My organization usually analyzes sustainability-related risks and chances with stakeholders.	230	1	5	2.88	1.156
Environmental sustainability is embedded in the corporate strategy of my organization.	230	1	5	2.80	1.126
In our firm, there is a mechanism for the prevention of pollution and contamination by environmentally hazardous substances e.g. PMS, AGO, DPK.	230	1	5	2.73	1.154
In our company, environmentally hazardous substances management policy is clear.	230	1	5	3.06	1.390
My company has a programme for monitoring our current level of environmental performance.	230	1	5	3.11	1.385
In my company, there is an appointed person with responsibility for environmental matters.	230	1	5	2.86	1.114
Valid N (listwise)	230				

Source: SPSS data output (2022)

Table 2 illustrates the distribution for Environmental Sustainability. This describes 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. The distributions for the variables are revealed to be moderate and significant, given the central tendencies for the indicators – ES1: My organization makes public its environmental and social objectives, has a moderate and significant mean (mean = 2.83, SD=1.19) suggesting that respondents agree to the statement; ES2: My organization usually analyzes sustainability-related risks and chances with stakeholders, has a moderate but yet significant mean (mean = 2.88, SD=1.16) affirming that majority of the respondents consider the statement as being a true position of their views.

Similarly, ES3: Environmental sustainability is embedded in the corporate strategy of my organization, has a moderate and significant mean (mean = 2.80, SD=1.13) which indicates that most of the respondents consider the statement to be factual. Similarly, ES4: In our firm, there is a mechanism for the prevention of pollution and contamination by environmentally hazardous substances e.g. PMS, AGO, DPK, is associated with a moderateand significant mean (mean = 2.73, SD=1.15) implying that a majority of the respondents believe the statement aligns with their own views too; ES5: In our company, environmentally hazardous substances management policy is clear, has a moderate but significant mean (mean = 3.06, SD=1.39) suggesting that most of the respondents identify with the statement; ES6: My company has a programme for monitoring our current level of

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environmental performance, has a moderate and significant mean (mean = 3.11, SD=1.39) suggesting that respondents agree with the statement; ES7: In my company, there is an appointed person with responsibility for environmental matters, has a moderate but yet significant mean (mean = 2.86, SD=1.11) affirming that majority of the respondents consider the statement as being a true position of their views.

Based on the evidence presented for the environmental sustainability distribution, it is affirmed that all 7 of the statement items for the latent construct,are substantially and significantly manifested by the respondents and their respective organizations.

	N	Minimum	Maximum	Mean	Std. Deviation
My organization offers safety conditions and occupational health, minimizing rates of lesions, occupational illness, sick days, days off and deaths related to work.	230	1	5	2.75	1.177
My organization assists people with special needs, immigrants, minorities, etc.	230	1	5	3.17	1.222
My organization has a concern with the quality of life of its workers and the society.	230	1	5	3.14	1.159
My organization communicates social policies to the society collaborators and disseminate them through all hierarchical levels.	230	1	5	3.07	1.207
My company offer free training and education to its workers and the society.	230	1	5	3.26	1.156
My organization has a friendly relationship with the stakeholders, without exploiting them, aiming to create lasting partnerships.	230	1	5	3.11	1.078
Valid N (listwise)	230				

Source: SPSS data output (2022)

Table 3 illustrate the distribution for Social Sustainability. This is the third measure of organizational sustainability and is associated with integrating the operational activities, social, ethical and environmental concerns beyond those required by law and whose outcomes may result in an improved quality of life for most stakeholders. The result indicates that based on the adopted criterion for moderate and significant levels of manifestations ($2.5< x <3.7$), all the indicators are revealed to have moderate and significant mean values. SS1: My organization offers safety conditions and occupational health, minimizing rates of lessons, occupational illness, sick days, days off and deaths related to work. The associated and significant mean (mean =2.75, SD=1.18) indicates

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that on the average, that respondents consider this statement as aligning with their view. SS2: My organization assists people with special needs, immigrants, minorities, etc., has a substantial and significant mean (mean = 3.17, SD=1.22) indicating that most of the respondents possibly agree with the statement.

Also, SS3: My organization has a concern with the quality of life of its workers and the society, with a substantial and significant mean (mean = 3.14, SD=1.16) affirming the generality of the position of the respondents that they speak positively about their firm's concern of the quality of life of its workers and the society. SS4: My organization communicates social policies to the society collaborators and disseminated through all hierarchical levels, has a moderate and evident mean (mean = 3.07, SD=1.21) implying that a substantial and significant number of the respondents possibly agree with the statement. SS5:My company offer free training and education to its workers and the society, has a high mean and significant mean (mean = 3.26, SD=1.16),iindicating that a majority of the respondents consider the statement justified and as being correct. SS6: My organization has a friendly relationship with the stakeholders, without exploiting them, aiming to create lasting partnerships, has a substantial and evident mean (mean =3.11, SD=1.08) suggesting that majority of the respondents are in agreement with the statement as being true; The result from the analysis presents the respondents as being favorably disposed to integrating the operational activities, social, ethical and environmental concerns beyond those required by law and whose outcomes may result in an improved quality of life for most stakeholders. The implications are that the management of petroleum tank farms should continue to improve social sustainability issues, in order to enhance organizational sustainability.

Table 4: Reliability Statistics

SN	CONSTRUCT	NO. OF ITEMS	CRONBACH'S ALPHA STATISTICS
1.	Preventive Maintenance	7	0.796
2.	Environmental Sustainability	7	0.736
3.	Social Sustainability	6	0.939

Source: Researcher's Desk, SPSS 25.0 Outputs 2022.

The threshold of 0.7 was taken as the Cronbach's alpha cut-off point, as recommended by Nunnally and Bernstein, (1994). The following were the alpha values. Preventive maintenance (0.796); Environmental sustainability (0.736); Social sustainability (0.939).

Table 5: 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
ENVIRONMENTAL	230	9	35	20.28	5.321	.160	.160	-.457	.320

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SUSTAINABILITY									
SOCIAL SUSTAINABILITY	230	6	30	18.49	6.135	-.014	.160	-.515	.320
Valid N (listwise)	230								

Source: Researcher's Desk, SPSS 25.0 Outputs 2022.

4.1. Assessment 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, as depicted in Table 5, showing the mean, standard deviation, skewness and kurtosis values for each construct.

Table 6: 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
	Based on Median and with adjusted df	.989	4	219.253	.414
	Based on trimmed mean	1.024	4	225	.396
ENVIRONMENTAL SUSTAINABILITY	Based on Mean	.537	4	225	.709
	Based on Median	.502	4	225	.735
	Based on Median and with adjusted df	.502	4	221.747	.735
	Based on trimmed mean	.544	4	225	.704
SOCIAL SUSTAINABILITY	Based on Mean	.343	4	225	.849
	Based on Median	.346	4	225	.847
	Based on Median and with adjusted df	.346	4	218.850	.847
	Based on trimmed mean	.358	4	225	.838

Using Age of Respondents as a categorical variable on the one-way ANOVA, the Levene's test in SPSS 25.0 was used to determine the presence of homogeneity of variance in the data. The results of the ANOVA and Levene's tests revealed that the differences in variances among the latent constructs were not significant (i.e. $p>0.05$). The results confirm homogeneity of variance in the dataset and

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suggest that variance for all the constructs within the proposed model were equal within and between groups for the various age groups.

4.2 Measurement Model: The measurement model rides on the common factor model. The common factor model is represented by the fundamental equation:

$$y_j = \lambda_{j1}\,\eta_1 + \lambda_{j2}\,\eta_2 + \ldots + \lambda_{jm}\eta_m + \varepsilon_j$$

where y_j represents the j of the 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. Bentler (1999) suggested that 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) (Byrne, 2013). 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. Also, Carmines and McIver, (1981) suggested that the value of ratio of the χ^2 statistic to its degree of freedom (χ^2/df), should be less than 5 or preferable less than 3 to indicate an acceptable fit (χ^2/df <5 preferable <3). Furthermore, scholars, (Byrne, 2010; Ukoha, 2010) suggested that standardised regression weights should be greater than 0.5 and preferably above 0.7.

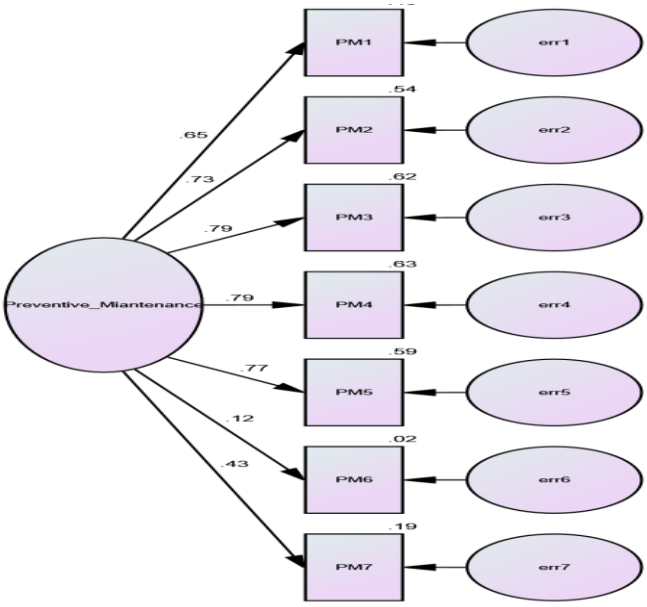

Figure 1: Measurement Model of Preventive Maintenance

Table 7: 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

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							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 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 of preventive maintenance.

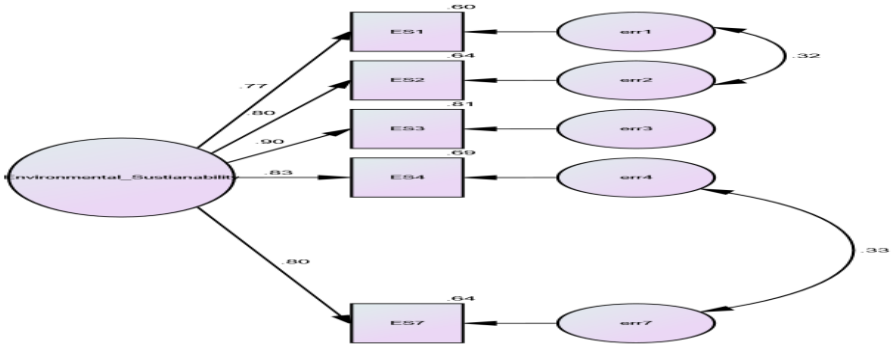

Figure 2: Modified Measurement Model of Environmental Sustainability

Table 8: Modified Measurement Model Analysis of Environmental Sustainability

Model	Chi-Square(df), Significance	χ^2/df	NFI	TLI	CFI	RMSEA	Variable	Factor Loading Estimates	Error VAR
Environmental Sustainability	(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

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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 returned mediocre values (chi-square (5df)=42.630, χ^2/df=8.526, p=0.000, RMSEA=0.181, CFI=0.955, NFI=0.949 and TLI=0.909) (Ukoha, 2010). To improve the goodness of fit indices, covariance were added between err1 -err2 and err4-err7 as depicted in figure 4.31. The resultant model produced significant factor loadings of 0.774, 0.802, 0.901, 0.833 and 0.797 respectively for indicators ES1-ES4, and the goodness of fit indices indicated acceptable 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 summarized in table 4.1.41. All freely estimated standardized parameters were statistically significant. These parameters are consistent with the position that these are reliable indicators of the construct of environmental sustainability.

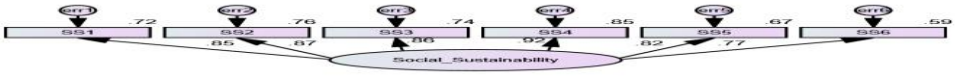

Figure 3: Modified Measurement Model of Social Sustainability

Table 9: Modified Measurement Model Analysis of Social Sustainability

Model	Chi-Square(df), Significance	χ^2/df	NFI	TLI	CFI	RMSEA	Variable	Factor Loading Estimates	Error VAR
Social Sustain-ability	(9df) =41.085 P=0.000	4.565	0.965	0.954	0.973	0.125	SS1	0.848	0.72
							SS2	0.870	0.76
							SS3	0.860	0.74
							SS4	0.921	0.85
							SS5	0.819	0.67
							SS6	0.770	0.59

Source: Amos 24.0 output on research data, 2021

The results of the goodness of fit indices indicated an acceptable fit to the data for one-factor model (chi-square (9df)=41.085, χ^2/df=4.565, p=0.000, RMSEA=0.125, CFI=0.973, NFI=0.965 and TLI=0.954). Factor loading estimates revealed that the six indicators were related to latent factor -social sustainability- and were statistically significant. The indicators SS1-SS6 had factor loadings of 0.848, 0.870, 0.860, 0.921, O.819 and 0.770 respectively and error variances of 0.72, 0.76, 0.74, 0.85, 0.67 and 0.59 respectively. All freely estimated standardized parameters were statistically significant.

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These parameters are consistent with the position that these are reliable indicators of the construct of social sustainability.

Table 10 : Correlations andAverage Variance Extracted

Variable		PM				ES	SS			AVE	Sq. Root of AVE
PM		**1.0**				0.611	0.641			**0.550**	**0.742**
ES		0.611				**1.0**	0.763			**0.698**	**0.836**
SS		0.641				0.763	**1.0**			**0.723**	**0.850**
	Where: PM=Preventive maintenance, ES= Environmental Sustainability, SS=Social Sustainability, AVE= average variance extracted, Sq. Root of AVE= square root of average variance extracted. Correlation is significant at the 0.01 level (2-tailed).										

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

4.3.1 Convergent Validity: As revealed in Tables 10, all the constructs have average variance extracted (AVE) values exceeding the 0.50 threshold and all the degrees of freedom, are greater than zero, thus, all the models are over-identified. As recommended by Fornell and Larcker (1981), the model has shown evidence of convergent validity, with the AVE>0.5 and the standardised estimates >0.7.

4.3.2 Discriminant Validity: In tandem with the Fornell and Larcker's (1981) criterion, it is sufficient to assert that the model has evidence of discriminant validity, as the square roots of AVE of each construct are greater than the construct correlations.

4.4 Structural Model: Adopting the reflective, reflective and reclusive model, the relationships between latent variables are hereby specified after the transition from the measurement model to the structural model.

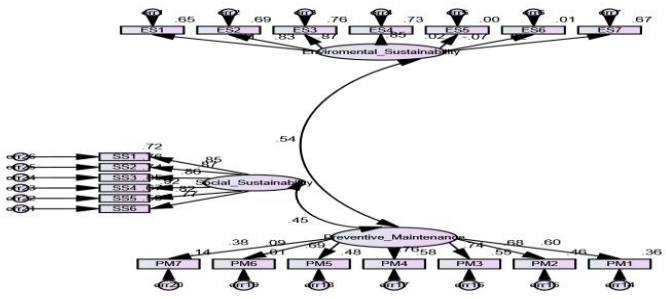

Figure 4 Structural models (linking the hypotheses)

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Table 11 : 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	PM →SS (Hypothesis 3)	There is no significant relationship between preventive maintenance and social sustainability.	0.797	4.778	0.000	Positive and Significant	Not supported

4.5. Interpretation of Results (Inferential Analysis): The first hypothesis (Ho:1), states that there is no significant relationship between preventive maintenance and environmental sustainability. However, table 11 indicates that preventive maintenance has 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). 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). 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, this shows that a unit increase in preventive maintenance is associated with 53.8% increase in environmental sustainability.

Therefore, when management is committed to preventive maintenance execution and employees understand the link between preventive maintenance and the company's strategy, there will be a mechanism for the prevention of pollution and contamination by environmentally hazardous substances e.g. PMS, AGO and DPK. The second hypothesis ($Ho:_2$), states that there is no significant relationship between preventive maintenance and social sustainability. However, table 11 also suggests that preventive maintenance has a positive and significant relationship with social sustainability of petroleum tank farms in South-South Nigeria (β=0.797, C.R=4.778, p=0.000). The regression weight for preventive maintenance in the prediction of social sustainability is significantly different from zero at the 0.05 level of significance (two-tailed). Therefore, $Ho:_2$ was not supported and the alternate hypothesis is hereby accepted. Thismeans that preventive maintenance is a good predictor of social sustainability of petroleum tank farms in South-South Nigeria. Statistically, it shows that a unit increase in preventive maintenance is associated with 79.7% increase in social sustainability. Therefore, when managers allow engineers feel free to order spare parts to perform preventive maintenance, the organization will offer safety conditions and occupational health, minimizing rates of occupational illness, sick days, days off and deaths related to work.

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4.6 Discussion of Findings: The aim of the study is to ascertain the nexus between preventive maintenance and organizational sustainability (measured by environmental sustainability and social sustainability) of petroleum tank farms in South South, Nigeria. The study was underpinned by the stakeholder theory (Freeman, 1984).

4.6.1 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. This finding supports 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 achievement of the firm's objectives.

4.6.2Relationship between Preventive Maintenance and Social Sustainability

The second objective was to investigate the relationship between preventive maintenance and social sustainability and was captured by a research question and expressed under Ho:$_2$. This hypothesis stated that there is no significant relationship between preventive maintenance and social sustainability. The outcome of the data analysis did not support the hypothesis. The result shows that there is a strong and significant relationship between preventive maintenance and social sustainability of petroleum tank farms in South South, Nigeria. This implies increase in preventive maintenance is associated with increase in social sustainability. This finding synchronizes with the work of Hardt 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. Furthermore, this finding validates the Freeman (1984)'s stakeholders theory 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 achievement of the firm's objectives.

4.7 Conclusion and Recommendations: This study practically implies that Management of petroleum tank farms can enhance both environmental and social sustainability drives by the implementing the framework of preventive maintenance. Therefore, it is recommended that Management of petroleum tank farms should increase the adoption of preventive maintenance by having a dedicated and skilled preventive maintenance planner, ensuring that critical machines and equipment have preventive maintenance, ensuring that the preventive maintenance program is audited timeously, and ensuring that majority of the employees understand the link between preventive maintenance and the company's strategy.

4.8 Contributions to knowledge: The findings reinforces the theoretical assertions of the stakeholder theory (Freeman, 1984) and validates the structural affinity between preventive maintenance and the measures of organizational sustainability (environmental sustainability and social sustainability).

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