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Exploratory Approach to Issues and Strategy Involved in Creating Industrial Revolution Time Environmental Sustainability by Construction Firms on Sites

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Abstract: Research outcomes all over the world have indicated that the building production sector of the construction industry relates more to the environment than other sectors of the economy and is directly involved with its sustainable activities in terms of waste generation and balancing the outcome has further been enhanced through industrial revolution time. The main aim of the study, therefore, was to carry out research on issues and challenges that revolve around contractors' attitudes towards maintaining a controlled environment on construction sites. A mixed research design method that involved the quantitative and qualitative analysis was used for the study, while the samples were picked with a random sampling method. The total sample size of respondents is 100 questionnaires which were randomly selected for questionnaire administration to selected construction firms in Lagos state. The questionnaires were administered to professionals from different firms in Lagos State, Nigeria. A total of 100 questionnaires were distributed in this review while 92 questionnaires were duly returned by the respondents, which constitute 92% of the total questionnaires distributed. The categorical regression method was used in the analysis. ANOVA, Chi-square, and factor analysis were used for the analysis. The study discovered among other things that the following components of environmental sustainability are important to sustain on sites: environmental impact assessment, antiquities on-site, erodible surface, soil erosion monitoring, environmental ecosystem, and environmental biomass, rock mass found on-site, soil contamination monitoring and ecosystem services valuation, soil salinity monitoring, and water resources conservation. The study concludes by recommending that the design of an effective way of disposing of waste on-site and continually improving construction methods and procedures to enhance performance in achieving a sustainable environment are vital to sustaining a viable construction environment among other factors.

Keywords: construction; environment; erosion; sustainability; biomass

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1. Introduction

The concept of sustainability has been an interesting one and has been relevant in the manufacturing and allied sector of the national economy. The importance of was further entrenched in the United Nations Development Programme charter occupying the strategic location. The concept of sustainability was birthed from the need to sustain present resources and manage them effectively without jeopardizing the need to create reserve resources for the future generation. It centers on the need to avoid wastage of resources. The concept revolves around three effective human social and technical axioms. Human activity is noted to have been responsible for pollution and wastage which tend to create environmental pollution and social nuisance. The activity of man has destroyed

the environmental landscape and created an imbalance in environmental and ecological stability. Therefore, [1] and the [2] described the axioms of sustainability to include economic sustainability, environmental sustainability, and social sustainability. The concept of sustainability involves resources renewal and recreation. Renewal involves material methods and mechanisms. Environment renewal entails a remedial approach to resources and components of life. This ensures a natural resources and a clean, green environment. Environmental sustainability entails ensuring rapid developmental progress in the environment, especially the built environment, in the work of [2–5]. In terms of environmental sustainability, the main focus is the preservation of components of the environment towards the sustenance of the structure form and purpose of the environment and its components. It also encompasses the cultural components of the environment. This entails incorporating societal cohesion, cohesion, inter-community relations, social quality, and social cohesion among others [2,3,6]. Regarding a research carried out by [2], a business that would survive must duly incorporate the three axioms of sustainability. The economic sustainability, social sustainability, and environmental sustainability. In the context of this study, however, the study centers around an environmentally sustainable business that delivers rewards to the immediate environment in the form of corporate social responsibility. The study attempted to respond to some of the emerging questions in the study, including: What is the perception of Nigerian contractors regarding environmental sustainability? What is the component of an environmental portfolio that should be sustained on construction site? What strategies can be used for maintaining environmental sustainability on-site? Is it possible to develop a framework for site environmental sustainability?

As regards the background of the study, sustainability is most often defined as meeting the needs of the present without compromising the ability of future generations to meet theirs. It has three main pillars and parameters: economic, environmental, and social. These three pillars are informally referred to as people, planet, and profits. Environmental sustainability is the rate of renewable resource harvest, pollution creation, and non-renewable resource depletion that can be continued indefinitely. If they cannot be continued indefinitely, then they are not sustainable [1].

The concept of sustainability is important for many reasons, including environmental quality. To have healthy communities, we need clean air, natural resources, and a nontoxic environment, while healthcare and sustainability are intricately related since the quality of our environment affects public health. Sustainability: Meeting our present needs without compromising the ability of future generations to meet their own needs [3]. It has three components, which include environmental conservation, social responsibility, and economic development. While most people primarily associate sustainability with environmental conservation, it is about people and the health of our communities. The term sustainability is broadly used to indicate programs, initiatives, and actions aimed at the preservation of a particular resource. However, it refers to four distinct areas, namely human, social, economic, and environmental, known as the four pillars of sustainability.

Human sustainability aims to maintain and improve the human capital in society. Investments in the health and education systems, access to services, nutrition, knowledge, and skills are all programs under the umbrella of human sustainability. Natural resources and spaces available are limited and there is a need to balance continual growth with improvements to health and achieving economic wellbeing for everyone. In the context of business, an organization will view itself as a member of society and promote business values that respect human capital. Human sustainability focuses on the importance of anyone directly or indirectly involved in the making of products, or provision of services or broader stakeholders i.e., the human capital of the organization [2,3]. Communities around the globe may be positively or negatively affected by business activities or impacted through methods used to source raw materials. Human sustainability encompasses the development of skills and human capacity to support the functions and sustainability of the organization and to promote the wellbeing of communities and society.

Social sustainability aims to preserve social capital by investing and creating services that constitute the framework of our society. The concept accommodates a larger view of the world to include communities, cultures, and globalization. It means preserving future generations and acknowledging that what we do can have an impact on others and the world. Social sustainability focuses on maintaining and improving social quality with concepts such as cohesion, reciprocity and honesty and the importance of relationships amongst people. It can be encouraged and supported by-laws, information, and shared ideas of equality and rights. Social sustainability incorporates the idea of sustainable development as defined by the United Nations sustainable development goals. The principle of sustainable development addresses social and economic improvement that protects the environment and supports equality, and therefore the economy, society, and the ecological system are mutually dependent [2].

Economic sustainability aims to maintain the capital intact. If social sustainability focuses on improving social equality, economic sustainability aims to improve the standard of living. In the context of business, according to [7], it refers to the efficient use of assets to maintain company profitability over time. As stated by the UK Government [8]. "Maintaining high and stable levels of economic growth is one of the key objectives of sustainable development. Abandoning economic growth is not an option, but sustainable development is more than just economic growth, the quality of growth matters as well as the quantity." Critics of this model acknowledge that a great gap in modern accounting practices is not to include the cost of damage to the earth in market prices [7]. A more recent approach to economic sustainability acknowledges the limited incorporation of the ecological and social components in this model. The new economics is inclusive of natural capital (ecological systems) social capital (relationships amongst people) and challenges. The mantra of capital that continual growth is good and bigger is better should be encouraged [6–9].

Environmental sustainability aims to improve human welfare through the protection of natural capital (e.g., land, air, water, minerals etc.). Initiatives and programs are defined as environmentally sustainable when they ensure that the needs of the population are met without the risk of compromising the needs of future generations. Environmental sustainability, as described by [2], emphasizes how business can achieve positive economic outcomes without doing any harm, in the short- or long term, to the environment. According to [2], an environmentally sustainable business seeks to integrate all four sustainability pillars. To reach this aim, each one needs to be treated equally, as also supported [10–12].

The principle of the four pillars of sustainability states that for complete sustainability problems to be solved, all four pillars of sustainability need to be maintained. Although in some cases these may overlap, it is important to identify the specific type of green business to focus on, as the four types present unique characteristics. Businesses need to make a strategic decision about whether to effectively incorporate the chosen approach into their policies and procedures (RMIT University). This study has contributed to the body of knowledge by developing the component of an environmental portfolio that should be sustained on construction sites, the presentation of strategies that can be used in maintaining the environmental sustainability on site, and development of a framework for construction site environmental sustainability.

2. Materials and Methods

To ensure that the study's objectives are met in a systematic and orderly manner, a survey research design was used in this research. To accomplish this, a proper and accurate research methodology was developed to avoid deviating from the study's aims and objectives and to have a better understanding of how the study can be carried out effectively.

2.1. The Research Design, Questions and Study Hypotheses

2.1.1. Research Questions

The study attempted to respond to some of the emerging questions in the study, including: What is the perception of Nigerian contractors regarding environmental sustainability? What is the component of an environmental portfolio that should be sustained on construction site? What strategies can be used in maintaining the environmental sustainability on-site? Is it possible to develop a framework for site environmental sustainability?

2.1.2. Research Objectives

The study articulated certain objectives for the purpose of providing data to answer the research question earlier presented. Some of the objectives, responding to some of the emerging questions in the study, include: (i) To study the perception of Nigerian contractors regarding environmental sustainability; (ii) To identify the component of an environmental portfolio that should be sustained on construction site; (iii) To profile strategies that can be used in maintaining the environmental sustainability on-site; (iv) To develop a framework for site environmental sustainability.

2.1.3. Research Design

A mixed research design was used in this study, it involves the qualitative and quantitative research design. The qualitative aspect of the study involved the use of an interview with structured questions while the qualitative aspect involves the use of a structured questionnaire design in a semantic rating scale of one (1) to five (5). One-hundred (100) questionnaires were used for the study while 10 interviewees were used in the study to compliment and validate some of the objectives and the variables used in developing the framework presented in this study.

2.1.4. Research Hypotheses

The following hypotheses were tested and used to corroborate research results in his study.

Hypothesis 1 H. *There is a high level of uniformity of opinion among the respondents concerning environmental sustainability strategies to be adopted by firms on construction sites.*

Hypothesis 1 Ho. *There is no uniformity of opinion among the respondents regarding the ranking of the strategies to be adopted by firms on construction sites.*

Hypothesis 2 Ho. *There is strong support and consensus as regards the challenges confronting site environment sustainability.*

Hypothesis 2 Hi. *There is strong support and consensus as regards the challenges confronting site environment sustainability.*

Hypothesis 3 Ho. *There is no divergence in terms of support and consensus as regards the components of the environmental portfolio for site environment sustainability in industrial revolution time.*

Hypothesis 3 Hi. *There is strong divergence in terms of support and consensus as regards the components of the environmental portfolio for site environment sustainability in industrial revolution time.*

2.2. Method of Data Collection

A mixed research method that involved qualitative and quantitative methods was used in this study. The primary method of data collection was adopted using the quantitative application of questionnaire administration. This method of data collection, as a

questionnaire, was designed and distributed to selected construction companies requesting information from their responses.

2.3. Study Population

The population frame of 150 respondents from construction firms in Lagos state was used in this study. The population data of construction firms in Lagos were obtained from the Lagos Ministry of Works to learn more about the government-approved construction projects undertaken by various construction firms. Lagos State has a population of 9,013,534 people, compared to 140,003,542 people in the country, according to the 2006 National Census. However, according to UN-Habitat and international development agencies' estimates, Lagos State's population in 2015 was estimated to be around 24.6 million. The current metro area population of Lagos in 2021 is 14,862,000, a 3.44% increase from 2020.

2.4. Sample Sizing and Basis of the Design of Questionnaire and the Sampling Process

Sample sizing and basis for selection of respondents: The sample size for this analysis was determined. According to Institute for Work & Health, sample size refers to the number of participants or observations included in a study. The total sample size of respondents is 100 questionnaires which were randomly selected for administration to selected construction firms in Lagos state. The questionnaires were administered to professionals from different firms in Lagos state. Questionnaire design and administration: A total of 100 questionnaires were distributed in this review while 92 were duly returned by the respondents, which constitute 92% of total questionnaires distributed. The Ministry of Works respondents used for the study include architects, builders, structural engineer, contractors, quantity surveyors, and urban and regional planners. The core of the respondents are construction professionals working on site, and thereby in a good position to participate in the survey.

Representation of the Samples: Architect (21), Builders (55), Structural Engineer (10), Quantity Surveyors (6).

2.5. Basis of Questionnaire Design

The questionnaire was design based on the research variable calibrated at the beginning of the study as presented towards the end of the introduction section, some of the variables includes: contractor perception of the concept of environmental sustainability, issues involved in site environmental sustainability, component of sustainable environmental portfolio on a construction, issues involved in site environmental sustainability, strategies that can be used by construction firms in maintaining the environmental sustainability on site, and success drivers for achieving construction site environmental sustainability by construction firms. The variables were divided into seven (7) sections:

Section A: Respondents Bio-data information

Section B: Contractor perception of the concept of environmental sustainability

Section C: Issues involved in site environmental sustainability

Section D: Component of sustainable environmental portfolio on a construction

Section E: Issues involved in site environmental sustainability

Section F: Strategies that can be used by construction firms in maintaining the environmental sustainability on site

Section G: Success drivers for achieving construction site environmental sustainability by construction firms. The questionnaire was designed with a semantic rating Likert Scale from 1 to 5 to cover sections B–G, while Section A was designed to capture the respondents' bio-data information and presented in simple percentages.

Data collection is essential to ensuring that the studies' goals are met in a timely and coordinated manner. To do so, the proper and sufficient research methodology must be developed to avoid deviating from the specified goals and objectives, allowing for a clearer understanding of how the analysis can be carried out effectively. The questionnaire was designed as the primary method of data collection, requesting information from the selected

firms. Staff, managers, and experts in construction firms and sites used the questionnaire system as their primary source of knowledge. A well-designed questionnaire was used to collect data. The second source was a survey of the subject's available literature, which included books, journals, and magazines. In a study carried out by [13], the research design was described as being responsible for having an effective research outcome. The study described the research design as the pillar of the research protocol. Therefore, in this study, survey research was used to carry out a study on the issues and challenges involved in Nigerian contractors' attitude to the construction environment's sustainability while a random sampling technique was used to pick the sample size for the study. The study area was Lagos state, which was chosen on account of the concentration of construction activities with several locations of environmental challenges that warrant sustainability.

2.6. Data Analytical Tool

The relative agreement index (R.A.I) was used to evaluate the collated results of the collated questionnaire. The index of relevant agreements is given as R.A.I = 5SA + 4A + 3SD + 2D + 1N/5(SA + A + SD + D + N), where SA = Strongly Agree, A = Agree, SD = Strongly Disagree, D = Disagree, N = Neutral. Moreover, the mean index was calculated for each of the variables while Spearman ranking and the simple percentage were used in data classification. Similarly, the Mann–Whitney U test was used to validate the relevant hypothesis.

In the context of this study, this study has contributed to the body of knowledge by developing the component of an environmental portfolio that should be sustained on construction sites, the presentation of strategies that can be used in maintaining the environmental sustainability on site, and development of a framework for construction site environmental sustainability among others.

3. Results

3.1. Data Presentation and Analysis

3.1.1. Data Reliability Test (Cronbach Alpha Test)

Reliability analysis was carried out on the calibrated questions in the questionnaire and interview conducted on respondents using the Cronbach Alpha test. The results are indicated in Table 1.

In Table 1 Cronbach-Alpha reliability test data case scores are presented. Seven valid cases were established and constitute 46.7% of the test cases with eight excluded cases.

Table 1. Data Reliability Analysis. (**a**) Cronbach-Alpha Reliability Test Data Case Scores. (**b**) Cronbach Alpha Reliability Test Statistics.

(**a**)			
Items	**Detail**	**Sample (N)**	**Percent (%)**
Cases	Valid	7	46.7
	Excludeda	8	53.3
	Total	15	100.0
(**b**)			
Cronbach's Alpha Coefficient		**Number of Items**	
0.942		39	

In Table 1b, the results of data reliability are presented for 39 items on the calibrated questionnaires administered to the respondents. It was discovered the test results indicated that 0.942 was obtained as Cronbach Alpha coefficient for the analysis. This indicate high level reliability and consistency being very close to 1.0. This tends to lay credence to the validity of the results obtained from the analysis.

3.1.2. Years of Working Experience

This section shows the analysis of the work experience of respondents.

Table 1 represents the work experience of the respondents from the field survey carried out. The results obtained show work experience of the respondents with less than 5 years (12) (13%), 5–10 years (19) (20.7%), 10–30 years (38) (41.3%), and above 20 years (23) (25.0%). As regards the academic qualification of respondents as presented in Table 1, it can be deduced that five (5.4%) respondents are HND holders, six (6.5%) are B.Sc. holders, 24 (26.1%) are M.Sc. respondents, and 57 (62.0%) are PHD holders. Table 1 shows the professionals who responded to the questionnaire.

3.1.3. Representation of Respondents

The result obtained shows the professions of the respondent. A total of 21 (22.8%) architects responded, 55 (59.8%) of the respondents are builders, six (6.5%) are quantity surveyors, and ten (10.9%) are structural engineers. As regards the size of an organization, it is understood that 21 (22.8%) of the respondent are from a small organization, 45 (48.9%) are from medium organizations and 26 (28.3%) are from large organizations. This indicates that most respondents work for a large-sized organization in line with submissions by [8–11]. Finally, the category of respondents includes 58 (63%) contractors while 34 (37%) are consultants.

3.1.4. Perception of Environmental Sustainability in Industrial Revolution Time

The importance of environmental education has been recognized by the most experienced experts in the subject concerned by the understanding that the absence of the concept of sustainability is one of the causes of degradation being experienced all over the world. Table 2 contains contractors' perceptions of the concept of environmental sustainability. Education can be seen as the great hope for world change. However, education is not an isolated process. It is a participatory process between the educator and person instructing, being necessary to share with others the knowledge, experience, and impression. In this learning process, according to [8] "the interaction between the learner and the instructor is essential, and that learning occurs totally, it is necessary that the object of learning is known and comprehended by educated and it usually happens when he experiences and interacts with the object". The environmental sustainability concept means a lot to different races and kinds. The study extracted the perception of the respondent as related to the meaning and presented the summary in Table 3. In industrial revolution time, the paradigm of automation has changed people's perception as regards the methodology of becoming environmentally sustainable. It was discovered that there was a consensus among the respondents that environmental sustainability brings about green projects and eco-friendly projects that will enhance the Nigerian construction environment, thus providing more sustainable homes, while the knowledge of a green environment was birthed by the concept of the industrial revolution. Meanwhile, the industrial revolution has enhanced our understanding of the concept, where environmental sustainability is perceived as a key to future conservation of resources and environmental development. The expressed view could be seen as corroborated in the works of erudite minds like [7] on education for sustainability in construction management curricula, [6] on the contractor's role in green buildings, as well as [5,6] on sustainable development trends in construction among others.

Some concepts are germane to the study of environmental sustainability as depicted in this study, such as the nature of environmental sustainability, the interpretation of the concept, and applicable areas of the concept. For instance, the importance of the concept and its meaning cannot be overemphasized, as presented in Table 3. The parameters were ranked accordingly. The first factor, "environmental sustainability brings about green projects and eco-friendly projects that will enhance Nigerian construction environment thus providing better sustainable homes", is ranked first and the highest with RAI of 0.800 followed by "How significant is the concept of environmental sustainability to the Nigerian environment" with RAI of 0.795. Awareness of environmental sustainability

concept is highly essential with an RAI of 0.778 an was ranked 2nd, whereas environmental sustainability is key to achieving sustainable construction with RAI of 0.700 and was ranked 3rd. Environmental sustainability in construction is about evaluating the cost and benefits of a project to the society environment, with an RAI of 0.687 and was ranked 4th Fulfilling the concept of environmental sustainability is expensive with RAI of 0.670 was ranked 5th. Having an organized work environment with RAI of 0.661 was ranked 6th. The concept of environmental sustainability is considered as secondary to the project under execution with RAI of 0.648 was ranked 6th. Finally, the variable "There is a lack of tools and plants required to effectively fulfil environmental sustainability" with RAI of 0.648 and "How has Nigerian contractor perspective impacted environmental sustainability" with RAI of 0.598 were ranked 7th and 8th respectively. The view above is supported by [10,13,14].

Table 2. Respondents' Bio data Information.

Parameters	Frequency	Valid Percent	Cumulative Percent
Year of Experience Less than 5	12	13.0	13.0
Between 5–10	19	20.7	33.7
Between 10–20	38	41.3	75.0
Above 20 Total	23 92	25.0 100.0	100.0
Qualification			
HND	5	5.4	5.4
B.SC.	6	6.5	12.0
M.SC.	24	26.1	38.0
PHD Total	57 92	62.0 100.0	100.0
Organization Small	21	22.8	22.8
Medium	45	48.9	71.7
Large Total Representation of Respondent	26 92	28.3 100.0	100.0
Builders	55	59.8	59.8
Consultant [Architect] Structural Engineer Quantity Surveyors	21 10 6	22.8 10.9 6.5	100.0
Total	92	100.0	100.0

Source: Authors Field survey, 2020.

Table 3. Contractor perception of the concept of environmental sustainability in Industrial Revolution Time.

Parameters	RAI	MIS	Rank
Environmental sustainability brings about green projects and eco-friendly projects that will enhance the Nigerian construction environment thus providing better sustainable homes	0.800	4.00	1st
How significant is the concept of environmental sustainability to the Nigerian environment?	0.795	3.975	2nd
Awareness of environmental sustainability concept is highly essential	0.778	3.89	3rd

Table 3. *Cont.*

Parameters	RAI	MIS	Rank
Environmental sustainability is key to achieving sustainable construction	0.700	3.500	4th
Environmental sustainability in construction is about evaluating the cost and benefits of a project to the social environment.	0.687	3.435	5th
Fulfilling the concept of environmental sustainability is expensive	0.670	3.350	6th
Having an organized work environment	0.661	3.305	7th
The concept of environmental sustainability is considered secondary to project under execution	0.648	3.240	8th
There are lack of tools and plants required to effectively fulfil environmental sustainability	0.646	3.230	9th
How has the Nigerian contractor perspective impacted environmental sustainability	0.595	2.975	10th

Source: Authors Field survey, 2020. RAI Relative Agreement Index; MIS: Mean Item Scores.

3.1.5. Statistical Analysis on Agreement Level among Contractor Perceptive in Environmental Sustainability Industrial Revolution Time

Statistical analysis of the data on perceptions of respondents on environmental sustainability was carried out and results are presented in Table 3. Chi-square analysis was carried out on the data collated to see the pattern of agreement as regards various issues raised. Some of the issues on the sustainability concept covered include the significance of the concept, awareness of the concept, influence of the concept, sustainability tools, and need for an organized sustainable environment. Details are as presented in Tables 3 and 4.

The Chi-square test was carried out at a *p*-value of 0.05 while the value of the individual variables was matched against this. The following variables have Sig. values less than or equal to 0.000 which leads their Null hypotheses to be rejected at a 95% degree of freedom. Therefore, the opinions of the respondents was not different on the following variables: Environmental sustainability is key to achieving sustainable construction with Sig. value of 0.034 and having an organized work environment is essential to a sustainable environment with Sig. value 0.09. However, the null hypotheses for other variables were accepted since their Sig. value was higher than the *p*-value of 0.05. The reason for this could be traced to the interpretation given by the professionals to the various concepts. Therefore, there is variation in the pattern of agreement as relates to the influence of the variables. However, the variable "environmental sustainability brings about green projects and eco-friendly projects that will enhance Nigerian construction environment thus providing better sustainable home" was ranked first by the respondents while the variable "how significant is the concept of environmental sustainability to Nigerian environment" was ranked second by the respondents. The concept of environmental sustainability has been adjudged to be new to the construction sector in Nigeria. Therefore, the need for further practice to ensure the spread is typical of developing countries, as corroborated by [2,3].

Table 4. Chi-square Test on Agreement among Contractor perception of environmental sustainability.

Perspectives	t	df	Sig. (2-Tailed)	95% Confidence Interval of the Difference	
				Lower	Upper
The concept of environmental sustainability is significant to environmental sustainability	1.34	4	0.251	−13.92	39.92
The contractor perspective has a positive influence on environmental sustainability	1.37	4	0.242	−13.92	41.12
Awareness of environmental sustainability concept is highly essential	1.59	4	0.188	−10.200	37.40
Environmental sustainability is key to achieving sustainable construction	3.17	4	0.034	1.703	25.50
The concept of environmental sustainability is secondary to the project under execution	1.41	3	0.254	−2.410	55.41
Environmental sustainability brings about green projects and eco-friendly projects	1.64	4	0.177	−9.472	36.68
Environmental sustainability is expensive	2.49	4	0.068	−1.571	28.77
Lack of tools and plants is effective in fulfilling environmental sustainability	1.50	4	0.208	11.581	38.78
Having an organized work environment	4.70	4	0.009	5.572	21.63
Environmental sustainability in construction is about evaluating the cost and benefits of a project to the social environment.	2.27	4	0.086	−3.026	30.23

3.1.6. Environmental Portfolio That Should Be Sustained on a Construction Site Industrial Revolution Time

Communities around the globe may be positively or negatively affected by business activities or impacted through methods used to source raw materials. Human sustainability encompasses the development of skills and human capacity to support the functions and sustainability of the organization and to promote the wellbeing of communities and society. In maintaining the environmental wellbeing of a sustainable environment, certain criteria has to be taken into consideration, including environmental portfolio, human activity, social interaction, economic interaction, and ecological landscape [7]. Stressed the need for a thorough understanding of the concept of sustainability as key to unlocking the benefits of environmental sustainability. In the context of this study, the component of environmentally sustainable activities is benchmarked and presented in Table 5. Some of the environmental portfolio relevant to the discussion includes environmental impact assessment, existing features like antiquities on site, soil erosion monitoring, environmental ecosystem, environmental biomass, ecosystem services valuation, rock mass found on-site, soil contamination monitoring, soil salinity monitoring, and water resource conservation, among others, as corroborated in [5].

Concerning submissions by [5,6,11], some areas of the construction process and activities are sustainable in the real sense of the world, and some of them are summarized and

presented in Table 5. It is indicated that the ranking of components of an environmental portfolio should be sustained on a construction site. Environmental impact assessment is the highest ranked with an RAI of 0.783 and ranked 1st, followed by existing features like antiquities on-site with RAI of 0.772 which was ranked 2nd, soil erosion monitoring with RAI of 0.731 was ranked 3rd, environmental ecosystem with RAI of 0.726 was ranked 4th, while environmental biomass with the RAI of 0.700 was ranked 5th. Rock mass found on-site, soil contamination monitoring, and ecosystem services valuation with an RAI of 0.685 ranked 6th. Soil salinity monitoring with RAI of 0.681 was ranked 7th, while water resource conservation on-site with the RAI of 0.624 was ranked last. Similarly, the view about the environmental portfolio is supported in [11–13], stating the following as common environmental portfolio components: environmental ecosystem, environmental biomass, and ecosystem services valuation among others.

Table 5. Component of Sustainable Environmental Portfolio on a Construction Site in Industrial Revolution Time.

Parameters	RAI	MIS	Rank
Environmental impact assessment	0.783	3.915	1st
Existing features like antiquities on site	0.772	3.600	2nd
Soil erosion monitoring	0.731	3.655	3rd
Environmental ecosystem	0.726	3.630	4th
Environmental biomass	0.700	3.500	5th
Ecosystem services valuation	0.685	3.425	6th
Rock mass found on site	0.685	3.425	6th
Soil contamination monitoring	0.685	3.425	6th
Soil salinity monitoring	0.681	3.405	9th
Water resources conservation on site	0.624	3.120	10th

Source: Authors Field survey, 2020. RAI Relative Agreement Index; MIS: Mean Item Scores.

Chi-square Test on Interview Results Respondents Opinion on Component Environmental Portfolio That Should Be Sustained on Construction Site

Hypothesis 1 Ho. *There is no divergence in term of support and consensus as regards the components of Environmental portfolio for site environment sustainability in Industrial revolution time.*

Hypothesis 1 H1. *There is strong divergence in term of support and consensus as regards the components of Environmental portfolio for site environment sustainability in industrial revolution time.*

An interview was conducted with 10 respondents that consisted of five architects and five builders to establish the agreement of opinion among respondents what should be the component of the environmental portfolio in industrial revolution time. A Chi-square test was carried out to validate the hypothesis, the results was presented in Table 6 and usually the null hypothesis is rejected when the test value is less than 0.05. However, from the Chi-square test results, the test value is higher than 0.05 in the analysis. Therefore, the null hypothesis is accepted. Therefore, there is no divergence in terms of support and consensus as regards the components of the environmental portfolio for site environment sustainability in industrial revolution time. However, the opinion was strong among the ten interviewed respondents as regards the following factors: environmental biomass, site ecosystem, environmental impact assessment, soil salinity, consistent energy supply, creating adequate awareness and soil contamination control and monitoring among others.

Table 6. Test Statistics.

Portfolio Parameters	Chi-Square	df	Asymp. Sig.
Existing features like antiquities on site	1.600a	2	0.449
Water resources conservation on site	1.600a	2	0.449
Environmental biomass	0.600b	3	0.896
Site Ecosystem	0.600b	3	0.896
Environmental Ecosystem	0.000c	3	1.000
Environmental Impact Assessment	0.600b	3	0.896
Soil salinity	0.000d	4	1.000
Consistent Energy supply	0.000d	4	1.000
Creating adequate awareness	0.000d	4	1.000
Soil Contamination control and monitoring	0.600b	3	0.896

Source: Authors Field Survey, 2020.

3.1.7. Issues Involved in Site Environmental Sustainability in Industrial Revolution Time

In contemporary time, issues that border sustainable development have become topical items of discussions, especially in the current industrial revolution era. There have been various states of art that have led to striking innovations and development. Therefore, there are issues that surround the successful operations towards creating sustainable development. There are technologies that enable the study of environmental sustainability education in the construction industry. For instance, [6] carried out a study on education for sustainability in construction management in construction industry. One of the cardinal issues militating against the study of the environmental sustainability is the issue of the digital divide. There are restrictions on bilateral agreement in the exchange of knowledge towards the exchange of resources in the study of environmental sustainability. Therefore, it is an important issue of concern in developing countries such as Nigeria. Similarly, in Table 7, issues that influence site environmental sustainability in industrial revolution time include the following: The need to help construction stakeholders understand sustainability and recognize what it means to the construction environment, which was ranked 1st with RAI of 0.822, followed with tracking progress, communicating actions and meeting expectations as regards the sustainable environment, which was ranked 2nd with RAI of 0.796. Centering investment decisions in construction on sustainability was ranked 3rd with RAI of 0.792, engaging with construction stakeholders on carrying out green projects with RAI of 0.791 was ranked 4th, and setting up laws that control the use of the environment during construction work with RAI 0.782 was ranked 5th. The adoption of insulation throughout the envelope to optimize thermal efficiency and the government establishment of agencies that monitor construction projects, ensuring they achieve sustainable environmental goals were ranked 14th and 15th respectively with RAI values 0.712 and 0.704. The order of issues presented above toes the line of submissions by [3,4,7,10,11,13].

Table 7. Issues involved in Site Environmental Sustainability in Industrial Revolution Time.

Parameters	RAI	MIS	Rank
Helping construction stakeholders understand sustainability and recognize what it means to the construction environment.	0.822	4.11	1st
Tracking progress, communicating actions and meeting expectations as regards the sustainable environment	0.796	3.98	2nd
Centring investment decisions in construction on sustainability	0.792	3.960	3rd
Engaging with construction stakeholders on carrying out green projects	0.791	3.955	4th
Setting up of laws that control the use of environment during construction work	0.782	3.910	5th
Establishment of sustainability environment data banks to collect data that serves as a guideline for future construction projects.	0.766	3.83	6th
Establish systems and processes that measure construction performance towards achieving a sustainable environment	0.765	3.825	7th
Continually improving construction methods and procedures to enhance performance in achieving a sustainable environment	0.761	3.805	8th
Encouraging contractors, investors to invest in technologies that aid a sustainable environment	0.761	3.805	8th
Setting goals for contractors in the construction industry towards achieving a sustainable environment	0.759	3.795	10th
Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment	0.730	3.650	11th
Adoption of the use of renewable energy and energy-efficient machinery in construction	0.728	3.640	12th
Investment in carbon reduction during construction activities	0.728	3.640	12th
Adoption of insulation throughout the envelope to optimize thermal efficiency	0.712	3.56	14th
Government should put in place agencies that checkmate construction projects ensuring they achieve sustainable environmental goals	0.704	3.520	15th

Source: Authors Field survey, 2020.

3.1.8. Developing Framework for Environmental Sustainability in Industrial Revolution Time

The issues involved in site environmental sustainability are presented in Table 7, ranked based on the analysis of the administered questionnaire. According to [6,8,14,15], it helps construction stakeholders understand sustainability and recognize what it means to the construction environment as the 1st and highest with RAI of 0.822 followed by tracking progress, communicating actions, and meeting expectations as regards sustainable environment with RAI of 0.796 which was ranked 2nd. Then, centering investment decisions in construction on sustainability with RAI of 0.792 was ranked 3rd, engaging with construction stakeholders on carrying out green projects with the RAI of 0.791 was ranked 4th, setting up laws that control the use of the environment during construction work

with RAI of 0.782 was ranked 5th, while the establishment of sustainability environment data banks to collect data that serve as a guideline for future construction projects with RAI of 0.766 was ranked 6th. The establishment of systems and processes that measure construction performance towards achieving a sustainable environment with RAI of 0.765 was ranked 7th, encouraging contactors and investors to invest in technologies that aid sustainable environment and continually improving construction methods and procedures to enhance performance in achieving a sustainable environment with RAI of 0.761 was ranked 8th. Setting goals for contractors in the construction industry towards achieving a sustainable environment with RAI of 0.759 was ranked 9th, replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment with RAI of 0.730 was ranked 10th. Investment in carbon reduction during construction activities and the adoption and use of renewable energy and energy efficient machinery in construction with RAI of 0.728 ranked 11th. The adoption of insulation throughout the envelope to optimize thermal efficiency with RAI of 0.712 was ranked 12th, while governmental establishment of agencies that checkmate construction projects, ensuring they achieve sustainable environment goals, with RAI of 0.704 was ranked 13th. The issues presented above that border social, economic, and political inclinations are supported by [5,7,9,10]. Similarly, the submission above draws strength from previous submissions on the three pillars of sustainability which were cross-validated from other researchers' points of view, such as [4,7,9–11], among others authors.

A framework was developed using certain censored parameters with aid of the factor analysis method as presented in Table 8. Representative factors were picked from among the factors that were rotated for the purpose of framework development. Therefore, Table 9 contains the extracted components.

Table 8. Factor Analysis of Parameters for Environmental Sustainability in Industrial Revolution Time.

Environmental Sustainability Parameters Communalities		
	Initial	**Extraction**
Tracking progress, communicating actions and meeting expectations as regards the sustainable environment	1.000	0.964
Engaging with construction stakeholders on carrying out green projects	1.000	0.964
Setting up of laws that control the use of environment during construction work	1.000	0.964
Setting goals for contractors in the construction industry towards achieving a sustainable environment	1.000	0.964
Establish systems and processes that measure construction performance towards achieving a sustainable environment	1.000	0.963
Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment	1.000	0.970
Investment in carbon reduction during construction activities	1.000	0.970
The adoption of insulation throughout envelope building for optimal thermal efficiency	1.000	0.970
Encouraging contractors, investors to invest in technologies that aid a sustainable environment	1.000	0.963
Establishment of sustainability environment data banks to collect data that serves as a guideline for future construction projects.	1.000	0.963
Continually improving construction methods and procedures to enhance performance in achieving a sustainable environment	1.000	0.963

Table 8. *Cont.*

Environmental Sustainability Parameters Communalities		
	Initial	**Extraction**
Government should put in place agencies that checkmate construction projects	1.000	0.963
Adoption of the use of renewable energy and energy-efficient machinery in construction	1.000	0.294
Government should put in place agencies that checkmate construction projects	1.000	0.901
Extraction Method: Principal Component Analysis.		

Source: Authors Field Survey, 2020.

Extracted Factors Group1 (with Factor 0.970): Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment (0.970); Investment in carbon reduction during construction activities (0.970), The adoption of insulation throughout envelope building for optimal thermal efficiency (0.970).

Extracted Factors Group 2 (with Factor 0.964): Tracking progress, communicating actions and meeting expectations as regards sustainable environment (0.964); Engaging with construction stakeholders on carrying out green projects (0.964); Setting up of laws that control the use of environment during construction work (0.964); Setting goals for contractors in the construction industry towards achieving a sustainable environment (0.964).

Extracted Factors Group 3 (with Factors 0.963): Encouraging contractors, investors to invest in technologies that aid sustainable environment (0.963); Establishment of sustainability environment data banks to collect data that serves as a guideline for future construction projects (0.963); Continually improving construction methods and procedures to enhance performance in achieving sustainable environment (0.963).

3.1.9. Component Analysis of Environmental Sustainability Parameters

The component matrix in Tables 7 and 8 above corroborates the presentations in Table 8. The division of the factors in Table 9 was achieved after the factors were rotated using Varimax with Kaiser normalization. The factors with values from 0.900 and above were used for the framework development and formed the variables of the developed framework.

3.1.10. Maintaining the Environmental Sustainability on Site in Industrial Revolution Time

Maintaining the environmental component of the environment is of utmost importance considering the level of waste material often left on the site after construction activities. There are different levels of waste often generated on construction sites, some including chemical waste, wood waste, solid waste, and others. The environment macro and macrofauna thus need to be maintained in an undisturbed position irrespective of environmental activities, here lies the need to maintain construction environment sustainability. Sustainability is most often defined as meeting the needs of the present without compromising the ability of future generations to meet theirs. It has three main pillars: economic, environmental, and social. In the work of [7,9,15], an action plan for sustainability was indicated and was premised around industrial revolution gains. The pillars of sustainable development was indicated as posited in [1]. Industrial revolution time, however, has created a conducive atmosphere for the provision of successful machinery for the three pillars of sustainability. These three pillars are informally referred to as people, planet, and profits. Environmental sustainability is the rate of renewable resource harvest, pollution creation, and non-renewable resource depletion that can be continued indefinitely. If they cannot be continued indefinitely then they are not sustainable [1]. In an industrial revolution time context, the adoption of concept of sustainability is important for many reasons, including environmental quality. To have healthy communities, we need clean air, natural resources, and a nontoxic environment. Sustainability and healthcare are intricately related since the

quality of our environment affects the public health. Sustainability: Meeting our present needs without compromising the ability of future generations to meet their own needs. Ref. [2] submitted that it has three components which include environmental conservation, social responsibility, and economic development. While most people primarily associate sustainability with environmental conservation, it is about people and the health of our communities. A component of the strategies that could be adopted towards achieving environmental sustainability in the construction environment is as presented in Table 9.

Table 9. Rotated Component Matrix for Environmental Sustainability Parameters.

Rotated Component Matrix			
	Component		
	1	**2**	**3**
Tracking progress, communicating actions and meeting expectations as regards the sustainable environment	0.958	0.212	
Engaging with construction stakeholders on carrying out green projects	0.958	0.212	
Setting up of laws that control the use of environment during construction work	0.958	0.212	
Setting goals for contractors in the construction industry towards achieving a sustainable environment	0.911	−0.295	0.214
Establish systems and processes that measure construction performance towards achieving a sustainable environment	0.911	−0.295	0.214
Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment	0.911	−0.295	0.214
Investment in carbon reduction during construction activities	0.911	−0.295	0.214
The adoption of insulation throughout envelope building for optimal thermal efficiency	0.911	−0.295	0.214
Encouraging contractors, investors to invest in technologies that aid a sustainable environment		0.984	
Establishment of sustainability environment data banks to collect data that serves as a guideline for future construction projects.		0.984	
Continually improving construction methods and procedures to enhance performance in achieving a sustainable environment		0.984	
Government should put in place agencies that checkmate construction projects		0.137	−0.938
Adoption of the use of renewable energy and energy-efficient machinery in construction	0.292	0.131	0.438
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 4 iterations.			

Source: Authors Field Survey, 2020.

Several challenges are associated with particular concepts such as environmental sustainability. Some challenges have to do with technical related factors, international policy, environmental law, and protocol among others. Therefore, challenges encountered by construction firms in achieving environmental sustainability on-site were profiled and presented in Table 8. According to Table 8, designing an effective way of disposing waste on site was ranked the highest with RAI of 0.792 followed by continually improving construction methods and procedures to enhance performance in achieving a sustainable environment with RAI of 0.778, ranked 2nd. The setting up of laws that control the use

of environment during construction work with RAI of 0.761 was ranked 3rd. Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment with RAI of 0.743 was ranked 4th. Investment in carbon reduction during construction activities and compliance with environmental law on-site with RAI of 0.739 was ranked 5th. Similarly, "Carefully protect the ecosystem found on construction site" with RAI of 0.731 was ranked 6th. This trend toes the line of a submission by [15]. The use of an eco-friendly energy source on construction sites provided an RAI of 0.704. The adoption of insulation throughout envelope building for optimal thermal efficiency with RAI of 0.685 was ranked 7th while "Carefully complying with ways of handy materials during construction operation" with the RAI of 0.676 was ranked 86th. The view presented in the table above is corroborated by the works of [7,8,16]. Leading among the strategies that could be used to facilitate effectiveness of sustainability operations are tracking progress, communicating actions and meeting expectations as regards the sustainable environment, engaging with construction stakeholders on carrying out green projects, setting up laws that control the use of environment during construction work, and setting goals for contractors in the construction industry towards achieving a sustainable environment as postulated by [2,3,5,6].

3.1.11. Maintaining the Environmental Sustainability on Site

Hypothesis 2 Hi. *There is a high level of uniformity of opinion among the respondents on environmental sustainability strategies to be adopted by firms on construction sites.*

Hypothesis 2 Ho. *There is no uniformity of opinion among the respondents in the ranking of the strategies to be adopted by firms on construction sites.*

An analysis of variance was carried out on the variables to ascertain the extent of the variability of the data collated from the respondents. Results are presented in Table 10. The Sig. values were found to be less than the *p*-value "−0.05". Therefore, the null hypothesis was rejected at a 95% confidence interval and 4 degrees of freedom. There is therefore uniformity of opinion among the respondents. Therefore, it can be concluded that there is a high level of uniformity of opinion among the respondents on environmental sustainability strategies to be adopted by firms on construction sites.

Table 10. Strategies that can be used by Construction Firms in Maintaining the Environmental Sustainability on Site Industrial Revolution Time.

Parameters	RAI	M.I.S	Rank
Designing an effective way of disposing waste on site	0.792	3.96	1st
Continually improving construction methods and procedures to enhance performance in achieving. sustainable environment	0.778	3.89	2nd
Setting up of laws that control the use of environment during construction work	0.761	3.805	3rd
Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment	0.743	3.715	4th
Investment in carbon reduction during construction	0.739	3.695	5th
Compliance with environmental law on-site	0.739	3.695	5th
Carefully protect ecosystem found on construction site	0.731	3.655	7th
Use of eco-friendly energy source on construction sites	0.704	3.52	8th
The adoption of insulation throughout envelope building for optimal thermal efficiency	0.685	3.425	9th
Carefully complying with ways of handy materials during construction operation	0.676	3.38	10th

Source: Field survey, 2020. RAI Relative Agreement Index; MIS: Mean Item Scores.

4. Achieving Construction Site Environmental Sustainability by Construction Firms

The term sustainability is broadly used to indicate programs, initiatives, and actions aimed at the preservation of a particular resource. However, it refers to four distinct areas, namely human, social, economic, and environmental, known as the four pillars of sustainability. In previous research [8,9] submitted that sustainability tends to provide a platform for enhancing sustainable development. In contemporary industrial revolution time, the digitalization of events and systems has enhanced further development concerning the issue of environmental sustainability. There are electronic systems that could be used to predict changes in the environment for the purpose of viable development. This view was supported in [5,7,11,12]. The industrial revolution has made possible human sustainability. Human sustainability aims to maintain and improve the human capital in society. Investments in the health and education systems, access to services, nutrition, knowledge, and skills are all programs under the umbrella of human sustainability. Natural resources and spaces available are limited and there is a need to balance continual growth with improvements to health and achieving economic wellbeing for everyone. In the context of business, an organization will view itself as a member of society and promote business values that respect human capital. Human sustainability focuses on the importance of anyone directly or indirectly involved in the making of products, or provision of services or broader stakeholders, i.e., the human capital of the organization. This fact was corroborated by submissions from [4,5,8,9].

Success drivers of site environmental sustainability in Table 11 have been ranked based on the analysis from the administered questionnaire. The first factor, "the ranking should assist construction stakeholders to understand sustainability and recognize what it means to the construction environment", was the highest with RAI of 0.822 followed by tracking progress, communicating actions and meet expectations as regards sustainable environment with RAI of 0.796 which was ranked 2nd. Then, centering investment decisions in construction on sustainability with RAI of 0.792 was ranked 3rd, while engaging with construction stakeholders on carrying out green projects with the RAI of 0.791 was ranked 4th. Setting up laws that control the use of environment during construction work with RAI of 0.782 was ranked 5th. Establishing sustainability environment data banks to collect data that serve as a guideline for future construction projects with RAI of 0.766 was ranked 6th. The establishment of systems and processes that measure construction performance towards achieving a sustainable environment with RAI of 0.765 was ranked 7th, while encouraging contractors and investors to invest in technologies that aid sustainable environment and continually improving construction methods and procedures to enhance performance in achieving sustainable environment with RAI of 0.761 was ranked 8th. Setting goals for contractors in the construction industry towards achieving a sustainable environment with RAI of 0.759 was ranked 9th. Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment with RAI of 0.730 was ranked 10th. Investment in carbon reduction during construction activities and adoption of the use of renewable energy and energy-efficient machinery in construction with RAI of 0.728 was ranked 11th, while the adoption of insulation throughout the envelope to optimize thermal efficiency with RAI of 0.712 was ranked 12th. Government establishment of agencies that monitor construction projects, ensuring they achieve sustainable environmental goals with RAI of 0.704 was ranked 13th. The view above was supported in [3,4] respectively. The authors respectively supported helping construction stakeholders understand sustainability and recognize what it means to the construction environment, as well as replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment among other factors. However, going further, the industrial revolution has led to renaissance of ecological friendly material inclusion in environmental development. There are ecofriendly materials that tend to resuscitate environmental biomass and the like, as well as electronic items that could lead to early detection of problem for the purpose of mitigating them. This is supported by submissions in works of authors such as [13,14], and [14] among others.

Table 11. ANOVA of Respondents Perspectives on Strategies to Maintaining the Environmental Sustainability on Site.

Sustainability Strategies	Group Parameters	Sum of Squares	df	F	Sig.
Compliance with environmental law on-site	Between Groups	1880.000	4		0.000
	Within Groups	0.000	0		0.000
Investment in carbon reduction during construction activities	Between Groups	1965.200	4		0.000
	Within Groups	0.000	0		0.000
Setting up of laws that control the use of environment during construction work	Between Groups	1469.200	4		0.000
	Within Groups	0.000	0		0.000
Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment	Between Groups	367.200	4		0.000
	Within Groups	0.000	0		0.000
Carefully complying with ways of handy materials during construction operation	Between Groups	1748.000	3		0.000
	Within Groups	0.000	0		0.000
Use of eco-friendly energy source on construction sites	Between Groups	1381.200	4		0.000
	Within Groups	0.000	0		0.000
Designing an effective way of disposing waste on site	Between Groups	597.200	4		0.000
	Within Groups	0.000	0		0.000
Carefully protect ecosystem found on construction site	Between Groups	1645.200	4		0.000
	Within Groups	0.000	0		0.000
Continually improving construction methods and procedures to enhance performance in achieving a sustainable environment	Between Groups	167.200	4		0.000
	Within Groups	0.000	0		0.000

Source: Authors Field Survey, 2020.

Hypothesis 3 Ho. *There is no divergence of opinion and consensus as regards the challenges confronting site environment sustainability in industrial revolution time.*

Hypothesis 3 H1. *There is strong divergence and consensus as regards the challenges confronting site environment sustainability in industrial revolution time.*

Ten (10) respondents were interviewed, the analysis is as presented in Tables 12 and 13, the respondents include two architects and four builders, two quantity surveyors, and two structural engineers, to establish the agreement of opinion among respondents concerning what should be the challenges confronting site environment sustainability in industrial revolution time. A Chi-square test was carried out to validate the hypothesis, and usually, the null hypothesis is rejected when the test value is less than 0.05. However, from the Chi-square test results, the test value is higher than 0.05 in the analysis. Therefore, the null hypothesis is accepted. Therefore, there is no divergence in terms of support and consensus as regards the challenges confronting site environment sustainability in industrial revolution time.

Table 12. Chi Square Analysis of Interview Data of Respondents on Challenges on Maintaining Environmental Sustainability on Site in industrial revolution time.

Test Parameters	Builders	Architect	Quantity Surveyor	Structural Engineer
Chi-Square	1.200	2.800	4.400	2.000
df	7	7	3	5
Asymp. Sig.	0.991	0.903	0.221	0.849

Source: Authors Field Survey, 2020.

4.1. Success Drivers for Achieving Construction Site Environmental Sustainability by Construction Firms Industrial Revolution Time

The success drivers towards achieving construction site environmental sustainability in industrial revolution time are presented in Table 13 The project professionals that constitute the project managers were grouped together and labelled as managers in the table. The professionals include architects, builders, quantity surveyors, and structural engineers. From the analysis, the factors in the order of ranking includes the following: Helping construction stakeholders understand sustainability and recognize what it means to the construction environment which was ranked first (1st), tracking progress, communicating actions, and meeting expectations as regards the sustainable environment was ranked second (2nd), centering investment decisions in construction on sustainability was ranked third (3rd), while engaging with construction stakeholders on carrying out green projects and setting up of laws that control the use of environment during construction work were ranked fourth (4th) and fifth (5th) respectively. However, the following were ranked least of the factors: Adoption of insulation throughout the envelope to optimize thermal efficiency was ranked fourteenth (14th) and Government establishment of agencies that monitor construction projects, ensuring they achieve sustainable environmental goals was ranked fifteenth (15th). In related studies, there are researches that focused on harnessing the gains of concept of sustainability, thereby suggesting ways the concept could be further enhanced for further development. For instance, [7] suggested embroidering the sustainability concept as a fashion, [3,7,16–18] suggested encapsulating it in the company policy as part of corporate social responsibility, corporate goals, or a developmental programme for corporate and private organization among many other submissions. Similarly, corporate organizations should then start viewing the issue of environmental sustainability through the lens of the industrial revolution since digitalization has proven to be a game changer in creating turnaround progress on environmental development and sustainability. This view toes the line of submissions in the works presented by [15–17].

Table 13. Success drivers for achieving construction site environmental sustainability by Construction firms Industrial Revolution Time.

Parameters	Managers RAI Rank	Rank	Professional RAI Rank	Rank
Helping construction stakeholders understand sustainability and recognize what it means to the construction environment.	0.822	1st	0.813	1st
Tracking progress, communicating actions and meeting expectations as regards the sustainable environment	0.796	2nd	0.789	3rd
Centring investment decisions in construction on sustainability	0.792	3rd	0.789	3rd
Engaging with construction stakeholders on carrying out green projects	0.791	4th	0.790	2nd
Setting up of laws that control the use of environment during construction work	0.782	5th	0.761	4th

Table 13. *Cont.*

Parameters	Managers RAI Rank	Rank	Professional RAI Rank	Rank
Establishment of sustainability environment data banks to collect data that serves as a guideline for future construction projects.	0.766	6th	0.672	12th
Establish systems and processes that measure construction performance towards achieving a sustainable environment	0.765	7th	0.757	5th
Continually improving construction methods and procedures to enhance performance in achieving a sustainable environment	0.761	8th	0.698	8th
Encouraging contractors, investors to invest in technologies that aid a sustainable environment	0.761	8th	0.673	11th
Setting goals for contractors in the construction industry towards achieving a sustainable environment	0.759	10th	0.750	6th
Replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment	0.730	11th	0.704	7th
Adoption of the use of renewable energy and energy-efficient machinery in construction	0.728	12th	0.678	10th
Investment in carbon reduction during construction activities	0.728	12th	0.653	14th
Adoption of insulation throughout the envelope to optimize thermal efficiency	0.712	14th	0.679	9th
Government should put in place agencies that checkmate construction projects ensuring they achieve sustainable environmental goals	0.704	15th	0.658	13th

Source: Field survey, 2020.

4.2. Relationship between the Research Variables and Results Variables Obtained

The ideal approach in this type of research is descriptive research, being a component of investigative research. Descriptive research is fitted to a study allowing the collection of enough information about some research variables to make an inference with a view to using the resultant variables for policy formulation and investigation. Therefore, in the context of this study, enough information is needed to be able to understand the extent of coverage arc of important areas so as to assist in the environmental sustainability component of the site environment and how it should be preserved. In this stead, therefore, enough information about the environmental sustainability, about the what, how, when, and where answers of environmental sustainability on construction sites needed to be resolved, which necessitates the use of descriptive research that could be carried out either through qualitative and qualitative research or a combination of both methods. Similarly, the Delphi technique can be used in order to compliment the questionnaire about or be used in isolation. Therefore, this study resorts to the use of a questionnaire design with a 1–5 point Likert scale, which tends to capture more variables than the Delphi method can accommodate. This enables the study to identify characteristics, frequencies, trends, and correlations as carried out in the study. This accurately describes the research problem of this study which concerns an exploratory approach to issues and strategies involved in creating industrial revolution time environmental sustainability in construction firms on sites. Seven (7) variables were articulated in this research with corresponding results obtained and presented in the next section.

4.3. Summary of Research Results and Relating Research Variables with Results

Variable I: Contractor perception of the concept of environmental sustainability.

It could be inferred from the research variable on perception of contractors about the concept of environmental sustainability articulated in the study that the concept of environmental sustainability has been adjudged to be new to the construction sector in Nigeria. Therefore, there is a need for further reinforcement of the associated practice in order to ensure the effective spread of the practice.

Variable II: These are contractor perception of the concept of environmental sustainability.

Variable III: Component of Sustainable Environmental Portfolio on a Construction.

In maintaining the environmental wellbeing of a sustainable environment, the study presented the following as some of the core portfolio criteria that could be focused on while aiming at a sustainable environmental portfolio. Some of the key criteria generated has to be taken into consideration, including the environmental portfolio, human activity, social interaction, economic interaction, and ecological landscape. Some of the portfolio deduced from the study in line with the research variables includes environmental impact assessment, existing features like antiquities on site, soil erosion monitoring, environmental ecosystem, environmental biomass, ecosystem services valuation, rock mass found on site, soil contamination monitoring, soil salinity monitoring, and water resources conservation on site.

Variable IV: Issues involved in Site Environmental Sustainability.

The study identified the following issues as germane to solving environmental challenges in industrial revolution time, including helping construction stakeholders understand sustainability and recognize what it means to the construction environment, tracking progress, communicating actions, and meeting expectations as regards the sustainable environment, centering investment decisions in construction on sustainability, engaging with construction stakeholders on carrying out green projects, setting up of laws that control the use of environment during construction work, establishment of sustainability environment data banks to collect data that serve as a guideline for future construction projects, and establishing systems and processes that measure construction performance towards achieving a sustainable environment among others.

Variable V: Strategies that can be used by Construction Firms in Maintaining the Environmental Sustainability on Site.

The results of analysis brought to the fore the following parameters in response to the research variable measured. Designing an effective way of disposing waste on site, continually improving construction methods and procedures to enhance performance in achieving sustainable environment, setting up of laws that control the use of environment during construction work, replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment, investment in carbon reduction during construction, compliance with environmental law on-site, carefully protect ecosystem found on construction site, use of eco-friendly energy source on construction sites, the adoption of insulation throughout envelope building for optimal thermal efficiency, and carefully complying with material handling procedures during construction operation.

Variable VI: In this section there were strategies that can be used by construction firms in maintaining the environmental sustainability on site.

Variable VII: Success drivers for achieving construction site environmental sustainability by Construction firms.

In response to the measured research variable, the following success drivers were articulated: Helping construction stakeholders understand sustainability and recognize what it means to the construction environment, tracking progress, communicating actions and meeting expectations as regards the sustainable environment, centering investment decisions in construction on sustainability, engaging with construction stakeholders on carrying out green projects, and setting up laws that control the use of the environment during construction work.

4.0 Conclusion: Contextualizing the results with respect to previous and present theoretical background and empirical research.

The aim at the beginning of this research work was to carry out an exploratory approach to study issues and strategies involved in creating industrial revolution time environmental sustainability in construction firms on sites.

The first objective was centered on perception of professionals about the concept of environmental sustainability. The importance of the concept and its meaning cannot be overemphasized, and it is presented as such in the study. The parameters were ranked accordingly. The factor "environmental sustainability tends to bring about green projects and eco-friendly projects that will enhance the Nigerian construction environment, thus providing more sustainable homes" ranked first and the highest. This is followed by "how significant is the concept of environmental sustainability to the Nigerian environment?", a factor considered highly essential and ranked 2nd. Environmental sustainability is key to achieving sustainable construction was ranked 3rd, and this follows the line of submissions in the works of erudite minds like [17] on education for sustainability in construction management curricula, [18] on the contractor's role in green buildings, and [12,13] on sustainable development trends in construction among others.

Similarly, the second objective was centered on formulating the content of a portfolio that could be used in managing environmental sustainability in the construction industry. Concerning submissions by [18,19] some areas of the construction process and activities are sustainable in the real sense of the world as postulated by the authors. However, in this study, it was discovered that some of the portfolio includes environmental impact assessment, which was ranked highest, followed by sustaining existing features like antiquities on site, soil erosion monitoring, environmental ecosystem management, environmental biomass, rock mass found on-site, soil contamination monitoring and ecosystem services valuation, soil salinity monitoring, and water resource conservation. Similarly, the view about the environmental portfolio is supported by [20–22] stating the following as common environmental portfolios: environmental ecosystem, environmental biomass, and ecosystem services valuation among others.

Moreover, determining issues militating against the effective management of environmental sustainability in industrial revolution time was the third objective. Some of the benchmarked issues include: designing an effective way of disposing waste on site, continually improving construction methods and procedures to enhance performance in achieving sustainable environment, setting up of laws that control the use of environment during construction work, replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment, investment in carbon reduction during construction, compliance with environmental law on-site, carefully protect ecosystem found on construction site, use of eco-friendly energy source on construction sites, the adoption of insulation throughout envelope building for optimal thermal efficiency, and carefully complying with ways of handy materials during construction operation. The issues listed above toes the line of submission and draws strength from previous submissions on the three pillars of sustainability which was cross-validated from other researchers' points of view such as [3–5,10,13,22] among others authors.

Furthermore, a workable framework was developed that could be used in ensuring environmental sustainability. Factor analysis was used in reducing 30 factors to four groups of factors that represent factors that could serve as template for managing environmental sustainability. The study has addressed all the research questions and objectives set. The study has answered the questions posed at the beginning of this study, including: What is the perception of Nigerian contractors regarding environmental sustainability? What is the component of an environmental portfolio that should be sustained on a construction site? What strategies can be used in maintaining environmental sustainability on-site? Is it possible to develop a framework for site environmental sustainability? As regards the perception of the workers, they believe that environmental sustainability brings about green projects and eco-friendly projects that will enhance the construction environment thus

providing better sustainable homes, that the concept is very significant to environmental sustainability. Moreover, that awareness of environmental sustainability concept is highly essential and is the key to achieving sustainable construction. Similarly, it was observed that there was a high degree of agreement among the respondents as regards certain concepts that touch on the sustainability of the construction environment. For instance, helping construction stakeholders understand sustainability and recognize what it means to the construction environment was regarded as the paramount factor, and tracking progress, communicating actions and meeting expectations as regards sustainable environment. Finally centering investment decisions in construction on sustainability is highly essential to the success of any developmental programme being proposed per time.

The following recommendation is suggested as a way of ensuring effective environmental sustainability on construction sites: designing an effective way of disposing of waste on-site, continually improving construction methods and procedures to enhance performance in achieving a sustainable environment, setting up laws that control the use of environment during construction work, replacing outdated construction tools and equipment with greener eco-friendly modern tools and equipment, investment in carbon reduction during construction activities, compliance with environmental law on-site and careful protection of ecosystems found on construction sites. Moreover, compliance with environmental law on-site, carefully protecting ecosystems found on construction sites, as recommended in a similar study by [7], use of eco-friendly energy source on construction sites, the adoption of insulation throughout envelope building for optimal thermal efficiency, and carefully complying with ways of handling materials during construction operation toe the line of views presented by [8,10,11].

Individuals who live or work in sustainable structures better appreciate indoor air quality notwithstanding various other wellbeing and health benefits. Since sustainable structure materials are liberated from disease-causing substances and unsafe poisons, the neighbourhood and the general condition likewise benefit from green development. As indicated by the Environmental Protection Agency, outdoor air is multiple times less dirtied than indoor air. Building and outfitting materials, e.g., paints, cleaning items, and floor coverings, can be perilous for human wellbeing. The utilization of practical materials can help with the cleansing of the air. Similarly, a good indoor air environment has the capability to influence employees' healthy and the living conditions of residents. Therefore, environmental health is very important. Similarly, during construction works, adequate precaution needs to be taken to prevent the leakage of harmful gases during construction work. Some of the fumes can rise above the surface of the earth and thereby constitute an environmental risk. Gas mixing chambers could be made available on site as part of the workplace design for chemical mixing and the like as this would prevent construction operation jeopardizing the wellbeing of workers and residents around the construction environment.

Finally, [22] submitted that construction is a $10 trillion industry, but its financial struggles cannot be ignored, hence the need for giving sustainability issues a priority. With its effectiveness and improved rate of up to 30%, savvy and utilitarian options are seen to be of utmost importance. Economic development can give extraordinary assistance in that direction. Generally speaking, a green structure costs less than an ordinary structure would because fewer assets (for example water and energy) are required for the consummation of the venture. The estimation of the property is altogether expanded with a sustainable building. Reduced operational and upkeep costs imply large reserve funds that would then be able to be contributed somewhere else, e.g., in higher worker wages or item improvement.

4.4. Future Direction of Research

The following are suggested as areas of improvement in the study of sustainability: factors influencing environmental sustainability of micro and macrostructure of a construc-

tion environment, and blending social sustainability and environmental sustainability to achieve sustainable construction practice.

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