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The Impact of Oil Spillage on the Built Environment

Oriaku Nzubechi Augustine[1, A, *] Ekpoanwan Alfred Bassey[2] Okechukwu Uzoma Iheme[2]

[1, A] School of Environment, Nanjing Normal University, Nanjing City, Jiangsu, China.

[2] Key Laboratory of Vegetation Restoration and Management of Degraded Ecosystems, South China Botanical Garden, Chinese Academy of Sciences, Guangzhou, 510650, China.

TEL: +2349072535427

oriakunzube24@gmail.com

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ABSTRACT

Oil spillage, the accidental or deliberate release of liquid petroleum hydrocarbons, constitutes a severe environmental hazard with profound consequences for the built environment. This study investigates the effects of oil spills on the structural integrity, economic value, and long-term sustainability of infrastructure, including buildings, roads, and drainage systems, within Nigeria's oil-producing regions. Employing a descriptive research design, data were collected via structured questionnaires from 200 respondents in affected communities. Quantitative analysis of the responses revealed that 45% of participants observed moderate infrastructural damage, with 25% reporting severe damage. Economically, 40% noted moderate losses, while 35% experienced significant devaluation of properties and assets. Regarding governance, 35% rated existing regulatory frameworks as only moderately effective, and 30% deemed them ineffective. The findings demonstrate that oil spillage critically undermines both physical infrastructure and local economic stability, with current regulatory measures providing insufficient mitigation. Consequently, the study underscores an urgent need for enhanced preventive maintenance, robust community-led monitoring, and comprehensive rehabilitation strategies to safeguard the built environment in these vulnerable regions.

***Keywords*:** Oil spillage, Built environment, Infrastructure integrity, Niger Delta, Economic devaluation, Regulatory frameworks, Community perception.

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INTRODUCTION

The built environment refers to human-made surroundings that provide the setting for human activity, ranging from buildings and roads to parks and infrastructure.[1] It is a critical component of sustainable development as it supports the social, economic, and cultural functions of society. On the other hand, oil spillage is defined as the accidental or deliberate release of petroleum products into the environment, particularly water bodies, soil, and land areas, resulting in environmental degradation and socio-economic disruption.[2]

Oil spills are frequently reported in oil-producing regions, especially in developing countries where extraction and distribution activities are intensive. Oil spillage is known to have adverse effects on the built environment by contaminating the soil and water that support infrastructure, leading to structural instability and accelerated deterioration of buildings, roads, and other physical assets.[3]

Historically, oil exploration and production in Nigeria began in the late 1950s, with the first commercial oil discovery at Oloibiri in 1956. Since then, the expansion of oil activities has been accompanied by recurring oil spills, which have progressively affected the physical and socio-economic structures of surrounding communities.[3] Oil spillage has also had socio-economic implications. Bourdeau (2004) affirmed that contaminated environments discourage investment in property development and urban expansion, as the risk of infrastructural failure deters developers and homeowners. Communities affected by oil spills often face property devaluation, relocation pressures, and a decline in public infrastructure quality.

Oil spills are a major environmental challenge that significantly affects the built environment, particularly in oil-producing regions worldwide. According to Nwilo and Badejo (2005), oil spills occur due to operational failures, pipeline leaks, sabotage, and poor handling of petroleum products, leading to extensive contamination of land and water. They reported that oil contamination weakens the structural integrity of buildings and other infrastructure, resulting in rapid deterioration and increased maintenance costs. Eze and Okoye (2021) asserted that communities exposed to repeated oil spill incidents experience both economic and social disruptions, as property values decline and repair costs escalate. They further stated that oil spillage reduces the usability of land for construction purposes, as contaminated soils lose their bearing capacity, making them unsuitable for long-term infrastructural development.

Okoh and Okafor (2019) contended that oil pollution contributes to environmental hazards, such as soil infertility and water contamination, which, in turn, compromise the sustainability of the built environment and urban development. Furthermore, it is affirmed that oil spills negatively influence urban planning and public infrastructure projects. Bourdeau (2004) reported that the integration of contaminated sites into urban settlements without proper remediation increases vulnerability to structural failure and environmental health risks. The recurring nature of oil spills is often linked to insufficient monitoring, lack of strict enforcement of environmental regulations, and inadequate community awareness, which exacerbate the susceptibility of the built environment to degradation.[2]

Oil spillage refers to the accidental or deliberate release of crude oil or petroleum products into the environment, including land, water bodies, and soil. It is a phenomenon that occurs predominantly in regions engaged in oil exploration, production, transportation, and storage.

According to Nwilo and Badejo (2005), oil spillage is often caused by pipeline corrosion, equipment failure, human error, sabotage, and inadequate operational procedures, resulting in widespread environmental pollution. Oil spills vary in magnitude and duration, but even small-scale incidents are capable of causing long-term ecological and socio-economic damage.

Oil spillage is hazardous because it contaminates soil and water, rendering land unsuitable for agriculture, reducing soil fertility, and compromising water quality. Eze and Okoye (2021) reported that such contamination extends to the built environment, where oil seeping into the ground weakens foundations, erodes construction materials, and accelerates the deterioration of buildings and infrastructure. On the other hand, the persistence of oil pollutants creates challenges for urban planning, as construction on contaminated land increases the risk of structural failures and endangers the safety of residents.

Communities in oil-producing regions are particularly vulnerable, as reported by Okoh and Okafor (2019), who stated that recurrent oil spills reduce property values, disrupt local economies, and impose high costs for repair and rehabilitation of damaged structures. Moreover, ineffective monitoring systems and limited enforcement of environmental regulations exacerbate the problem, allowing oil spills to recur and continue affecting both natural and built environments. The concept of oil spillage, therefore, encompasses both its environmental and infrastructural dimensions, highlighting the need for sustainable management, preventive strategies, and remediation efforts to safeguard human settlements and economic assets.

Oil spillage occurs in various forms, each with distinct characteristics and environmental impacts. Oil spills are generally classified into operational spills and accidental spills. Operational spills are minor releases that occur during routine oil production, transportation, refining, or storage activities, often due to equipment leaks, pipeline corrosion, or handling errors.[3] Accidental spills, on the other hand, are unplanned, large-scale events caused by pipeline ruptures, tanker accidents, sabotage, or natural disasters. Eze and Okoye (2021) reported that both types of spills significantly affect the environment and the built environment by contaminating soil, water, and infrastructure.

The causes of oil spillage are multifaceted. Inadequate maintenance of pipelines and storage facilities is a major contributor, as aging infrastructure becomes prone to leaks and bursts.[2] Human error, such as improper handling of oil during transfer and transportation, was identified as another significant cause. On the other hand, sabotage and vandalism by individuals or groups often result in intentional spills that disrupt oil operations and damage surrounding communities. Equipment failure, poor operational practices, and lack of adherence to safety protocols further exacerbate the risk of spills.

Environmental factors also play a role in causing oil spillage. Natural hazards like floods and storms may damage pipelines and storage tanks, leading to uncontrolled releases of petroleum products.[5] Additionally, insufficient monitoring and enforcement of environmental regulations allow spills to occur and persist without timely intervention, increasing the vulnerability of communities and infrastructure.

The impacts of these types and causes of oil spillage extend beyond environmental pollution; they affect the structural integrity of buildings, roads, and other infrastructure in affected areas. Repeated exposure to oil pollutants reduces soil stability, accelerates the deterioration of construction materials, and imposes high economic costs on property owners and government authorities.[7]

The built environment encompasses the human-made surroundings that provide the setting for human activity, including buildings, roads, bridges, parks, and other infrastructure.[1] It is a crucial aspect of societal development, as it supports economic activities, social interactions, and cultural functions. The quality and sustainability of the built environment directly influence the safety, health, and well-being of communities. On the other hand, the built environment is vulnerable to various environmental and human-induced challenges, with oil spillage being one of the most significant threats in oil-producing regions.

According to Eze and Okoye (2021), the integrity of the built environment is heavily dependent on the stability of the land, the quality of construction materials, and proper maintenance of infrastructure. Oil spillage affects these factors by contaminating the soil and water systems that support buildings and public infrastructure. The seepage of oil into the ground reduces soil bearing capacity, leading to foundation weakening, structural instability, and accelerated deterioration of construction materials. Okoh and Okafor (2019) reported that areas exposed to recurrent oil spills often experience property damage, erosion of roads, and compromised drainage systems, which together reduce the functionality and aesthetic quality of the built environment.

The built environment also serves as an indicator of urban and rural development. Well-planned and resilient infrastructure enhances community livelihoods, encourages investment, and promotes sustainable growth.[3] On the other hand, degradation caused by environmental hazards like oil spills undermines these benefits, imposing economic burdens on residents and local governments for repair, maintenance, and rehabilitation. Understanding the characteristics, vulnerabilities, and dynamics of the built environment is essential for urban planners, policymakers, and environmental managers to implement effective strategies that protect infrastructure and promote sustainable development in affected regions.

Oil spillage has profound and far-reaching effects on the built environment, particularly in oil-producing regions where infrastructure is often exposed to repeated contamination. According to Nwilo and Badejo (2005), one of the primary effects of oil spillage is the weakening of soil structure, which compromises the stability of building foundations, roads, and bridges. The infiltration of oil into the ground reduces the soil's bearing capacity, causing subsidence, cracks in buildings, and erosion of pavements. On the other hand, this degradation increases maintenance costs and accelerates the deterioration of public and private infrastructure, thereby placing a financial burden on property owners and government authorities.

Oil spillage severely degrades the quality and durability of construction materials. As noted by Eze and Okoye (2021), exposure to petroleum hydrocarbons initiates deleterious chemical reactions within asphalt, concrete, and other common building materials, compromising their structural integrity. This degradation accelerates the wear and tear of critical infrastructure, including roads, drainage networks, and building components. Consequently, residential and commercial properties in spill-affected zones frequently suffer from associated issues such as water contamination, persistent dampness, and structural cracking, which collectively undermine both safety and aesthetic value.

Case studies from Nigeria's oil-producing regions provide stark evidence of these impacts. The 2008 pipeline spill in Bodo Community, Rivers State, offers a prominent example. As documented by Eze and Okoye (2021), the extensive contamination led to soil destabilization, causing significant structural damage to buildings and rendering roads and drainage systems unusable. The spill also precipitated severe economic losses for residents through diminished property values and lost income.

Similarly, chronic spillage in Ogoniland has inflicted long-term damage on infrastructure. Persistent oil seepage has weakened building foundations, contributing to the collapse of structurally unsound homes, while frequently disrupting roads and bridges to hinder community mobility.[2] Remediation efforts in the region have often failed to keep pace with environmental damage, leaving infrastructure rehabilitation incomplete.

The literature unequivocally establishes that oil spillage is a potent agent of degradation for the built environment, acting through well-understood physicochemical pathways to cause material decay, functional failure, and economic decline. The Niger Delta presents a critical case where these impacts are exacerbated by systemic regulatory failures and the high density of both infrastructure and oil networks. Future research must pivot towards generating technical data for resilience standards, developing predictive planning tools, and crafting inclusive, prevention-focused governance models to safeguard communities and their physical assets.

RESEARCH METHODOLOGY

To analyze the study variables, a quantitative approach utilizing descriptive statistics was applied. Frequencies and percentages were calculated and presented in tabular form. This analytical technique facilitates meaningful interpretation of the data and enables inferences to be drawn from the observations.

POPULATION OF STUDY

The population of a study is a group of persons or aggregate items, things the researcher is interested in getting information to examine the impact of oil spillage on the built environment. A total of four hundred (400) respondents formed the population of the study.

A sample is the set of people or items that constitute part of a given population sampling. Due to the large size of the target population , the researcher used the Taro Yamani formula to arrive at the sample population of the study.

$$n = \frac{N}{1+N(e)^2}$$

n: describes the sample size.

N: describes the total number of populations of the area

e: describes maximum variability or margin of error = 0.05.

1: describes the probability of the event occurring.

$$n = \frac{400}{1+400(0.05)^2}$$

$$n = \frac{400}{1+400(0.0025)}$$

n= 400 / (1+1) = 400 / 2 = 200.

VALIDATION OF RESEARCH INSTRUMENT

A structured questionnaire served as the principal data collection instrument. Designed to elicit specific and relevant information, it contained approximately 12 items organized into two distinct sections (A and B). Data collection involved the direct administration of the questionnaire, with the majority of respondents self-reporting their answers by selecting from provided options. To ensure inclusivity and accommodate varying literacy levels, a subset of questionnaires was administered orally by the researcher, who subsequently recorded the responses. The protocol allowed for respondent anonymity, with identity disclosure being optional.

METHOD OF DATA COLLECTION

Data for this study were gathered from two distinct sources: primary and secondary.

Primary Data: Primary data refer to original information collected firsthand by the researcher for the specific objectives of this investigation. For this study, primary data were obtained directly from respondents through the administration of a structured questionnaire.

Secondary Data: Secondary data consists of existing information that was originally compiled for other purposes. This study utilized secondary data sourced from published materials such as textbooks, academic journals, handbooks, and official administrative records. Various unpublished works and relevant literature were also consulted to provide context and support the analysis.

METHOD OF DATA ANALYSIS

The methodological approach to data analysis was designed to address both the research questions and test the study's hypotheses.

Hypothesis Testing: To verify the null hypotheses, inferential statistical tests were employed. Specifically, the Chi-Square (χ^2) test of independence was used to examine associations between categorical variables. For continuous variables, the Pearson product-moment correlation coefficient (r) was calculated to assess the strength and direction of linear relationships, and its significance was tested using a t-test. All statistical tests were conducted at a 5% ($\alpha = 0.05$) significance level, representing the threshold for accepting the risk of a Type I error.

Descriptive Analysis: To answer the research questions, the data were analyzed using descriptive summary statistics. The primary emphasis was on calculating absolute frequencies and corresponding percentages for all categorical responses. Frequency refers to the count of occurrences for each response, while percentage expresses this count as a proportion of the total.

Answers to the research questions were subsequently derived by systematically comparing the response percentages for each item in the questionnaire. This analytical process transformed the raw data into meaningful information, enabling the interpretation of findings, the formulation of evidence-based conclusions, and the development of valuable recommendations.

The simple percentage method is believed to be a straightforward easy to easy-to-interpret, and understandable method. In this research, a simple percentage method was used.

The percentage formula is shown as

% = f/N x 100/1

Where f = frequency of respondent's response

N = Total Number of responses of the sample, 100 = Consistency in the percentage of respondents for each item contained in the questions.

STATISTICAL ANALYSIS

The demographic profile of the study participants was characterized using descriptive statistics. Frequency distributions and their corresponding percentages were calculated for all categorical demographic variables. All analyses were performed using SPSS version 11.

DATA ANALYSIS, RESULTS, AND DISCUSSION

This section presents the results of the questionnaire data analysis. Responses are summarized in tables and analyzed using descriptive statistics, specifically simple percentages, to directly answer the study's research questions.

PRESENTATION AND ANALYSIS OF DATA

Data analysis was conducted using frequency tables and simple percentages. A total of 200 questionnaires were distributed and successfully retrieved, resulting in a complete dataset for analysis.

THE SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

This section deals with the description of the characteristics of all the respondents (200) involved in the study by random selection of respondents from the study area. The characteristics of respondents include age, gender, and educational level.

TABLE 1. Demographic Profile of Respondents.

Demographic Variable	Category	Frequency	Percent (%)	Cumulative Percent (%)
Gender	Male	120	60	60
	Female	80	40	100
Age (Years)	18–25	40	20	20
	26–35	70	35	55
	36–45	60	30	85
	46–55	20	10	95
	56+	10	5	100
Education Level	Secondary	50	25	25
	Diploma/NCE	60	30	55
	Degree	70	35	90
	Postgraduate	20	10	100

Occupation	Civil Servant	60	30	30
	Private Sector	50	25	55
	Self-Employed	70	35	90
	Unemployed	20	10	100

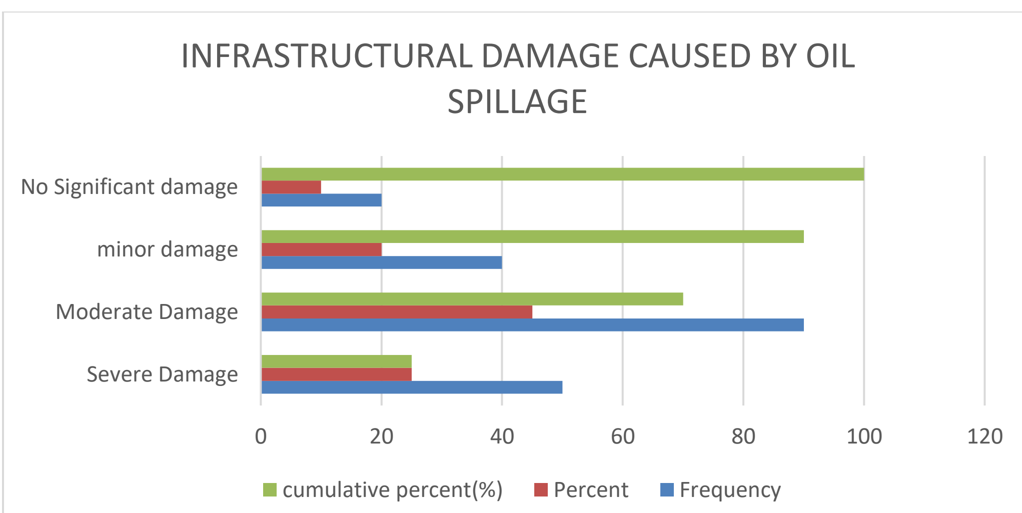
The respondent profile reveals a sample of working-age adults, with 65% between 26 and 45 years old and a gender distribution of 60% male to 40% female. Educationally, 70% possessed a post-secondary qualification. The occupational distribution was varied, led by self-employed individuals (35%) and civil servants (30%), reflecting a cross-section of the local economy.

RE-STATEMENT OF RESEARCH QUESTIONS

RQ1: What is the extent of infrastructural damage caused by oil spillage in affected areas?

Extent of Damage	Frequency	Percent (%)	Cumulative Percent (%)
Severe Damage	50	25	25
Moderate Damage	90	45	70
Minor Damage	40	20	90
No Significant Damage	20	10	100

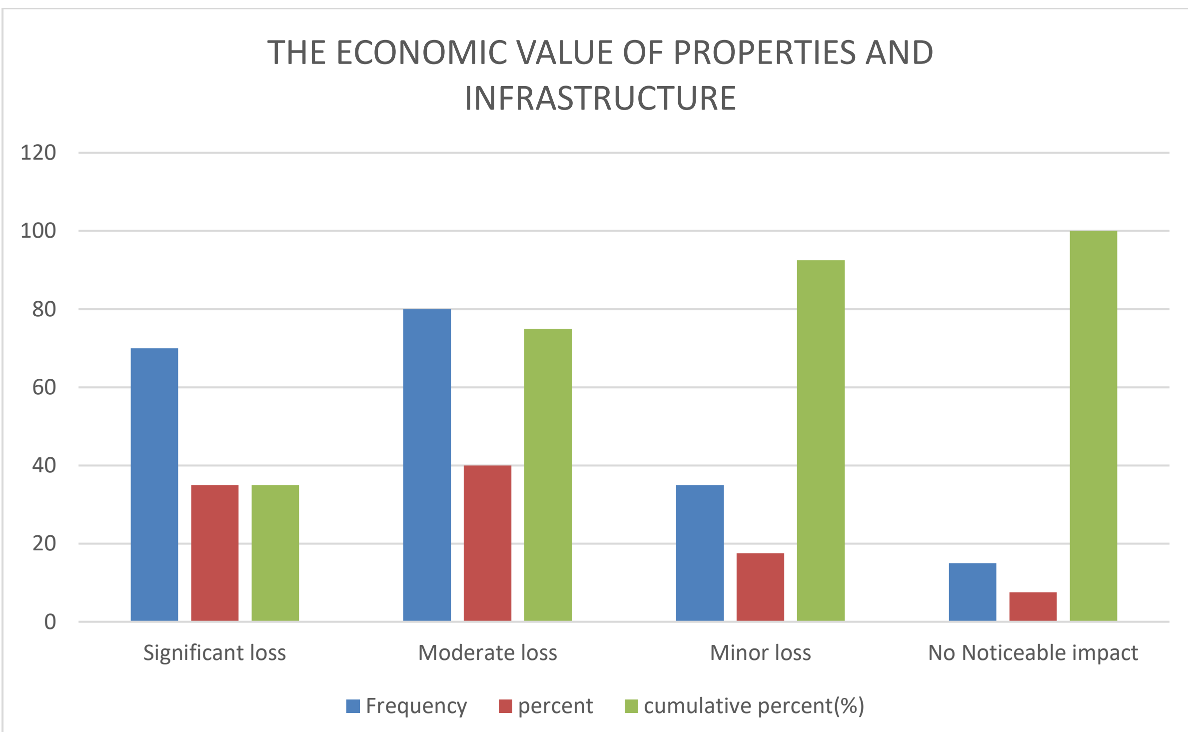
The prevalence and severity of infrastructure damage are clear. A full 70% of respondents report moderate to severe impacts, confirming that oil spillage is a primary agent of deterioration for housing, transport networks, and utilities. The low incidence of unaffected areas (10%) highlights the pervasiveness of the problem. This scale of damage demands prioritized investment in spill prevention and resilient infrastructure repair.



RQ2: How does oil spillage impact the economic value of properties and public infrastructure?

Economic Impact	Frequency	Percent (%)	Cumulative Percent (%)
Significant Loss	70	35	35
Moderate Loss	80	40	75
Minor Loss	35	17.5	92.5
No Noticeable Impact	15	7.5	100

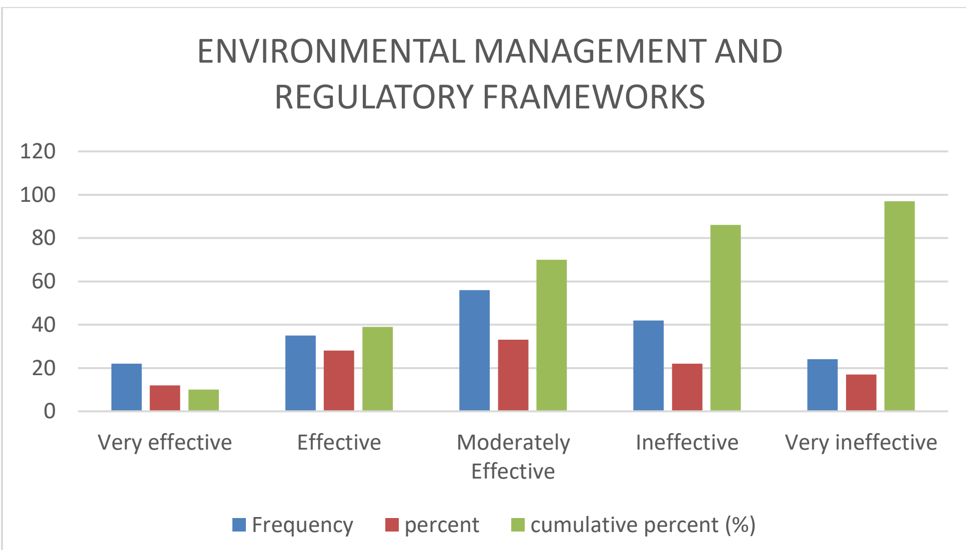
The findings reveal a clear economic dimension to the oil spill crisis. A dominant 75% majority of respondents reported measurable financial damage, categorizing it as moderate (40%) or significant (35%). This widespread economic detriment, stemming from asset devaluation and costly repairs, translates into weakened local economic resilience, suppressed investment, and chronic fiscal strain on public budgets. The minimal share (7.5%) reporting no impact further underscores the pervasive nature of this financial shock.



RQ3: How effective are existing environmental management and regulatory frameworks in mitigating oil spillage effects?

Level of Effectiveness	Frequency	Percent (%)	Cumulative Percent (%)
Very Effective	22	12	10
Effective	35	28	39
Moderately Effective	56	33	70
Ineffective	42	22	86
Very Ineffective	24	17	97

The assessment of current environmental regulations reveals a significant credibility gap. A substantial 65% of respondents perceive the frameworks as having, at best, moderate effectiveness in mitigating spill-related damage, with a full 30% finding them ineffective. This consensus on institutional weakness, attributed to poor enforcement and monitoring, signals a pressing need for reform. To be credible, the regulatory regime must transition from passive rule-making to active, accountable oversight coupled with meaningful community engagement.



RQ4: What strategies can be adopted to protect and rehabilitate the built environment in oil-affected regions?

Strategy Adopted/Recommended	Frequency	Percent (%)	Cumulative Percent (%)
Regular Maintenance and Repair of Infrastructure	60	30	30
Soil and Land Remediation	50	25	55
Strict Enforcement of Environmental Regulations	40	20	75
Use of Oil-Resistant Construction Materials	30	15	90
Community Awareness and Education Programs	20	10	100

The data reveal a clear hierarchy of strategies proposed by respondents to address infrastructure damage. As presented in research question four, regular maintenance is the foremost priority (30%), with land remediation (25%) and stricter regulations (20%) also seen as critical. This highlights a recognized need for immediate physical interventions alongside stronger policy frameworks. Complementary strategies, such as adopting resilient materials (15%) and educating communities (10%), further suggest that long-term sustainability requires both technical innovation and social empowerment.

TEST OF HYPOTHESIS

HYPOTHESIS ONE

H0: Oil spillage does not have a significant impact on the built environment in oil-producing areas of Nigeria.
H1: Oil spillage has a significant impact on the built environment in oil-producing areas of Nigeria.

Table 2. Oil spillage does not have a significant impact on the built environment in oil-producing areas of Nigeria.

Response	Observed N	Expected N	Residual
Strongly Agreed	68	50	18
Agreed	50	50	0
Undecided	47	50	-3
Disagreed	35	50	-15
Total	**200**		

$$X^2 = \frac{\sum(O-E)^2}{E}$$

X^2 tab = X^2 tab x Df

X = 0.05, Df = (n – 1) = 4 – 1 = 3

At 3 d.f. and an assumed 5% (0.05) level of significance, the Chi-square critical/tabulated values X^2 t 0.95 = 7.815

Hypothesis Testing Criterion: For this test, the predetermined decision criterion was as follows: Reject the null hypothesis (H_0) if the computed chi-square statistic (χ^2) is greater than the tabled critical value (χ^2_crit) at the applicable degrees of freedom and an alpha level of .05. Failure to meet this criterion would fail to reject H_0.

Findings: The computed chi-square statistic is 11.16 (χ^2_calc = 11.16), surpassing the critical value of 7.815 (χ^2_crit = 7.815). In accordance with the decision rule, the null hypothesis is rejected. This result provides statistically significant evidence to support the alternative hypothesis that oil spillage has a substantial impact on the built environment within the oil-producing areas of Nigeria.

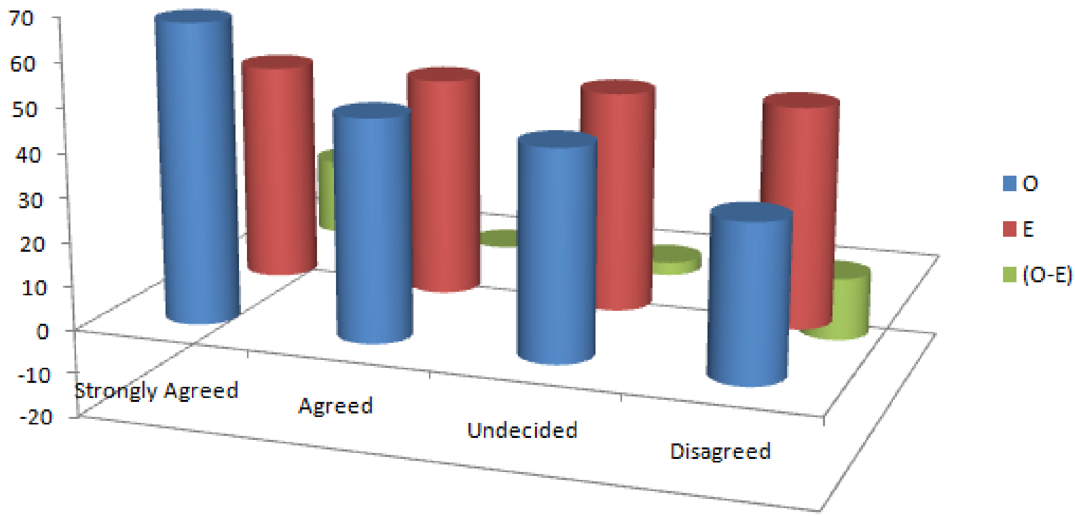


Figure 1. Oil spillage does not have a significant impact on the built environment in oil-producing areas of Nigeria.

DISCUSSION OF FINDINGS

The data reveal a pronounced level of infrastructural degradation attributable to oil spills. A significant majority of respondents, 70% reported measurable damage, categorizing it as moderate (45%) or severe (25%). This scale of impact supports prior research by Eze and Okoye (2021) on the mechanistic weakening of built structures. The remaining 30% who reported minor or no damage indicate that vulnerability is not uniform; however, the dominant pattern is one of clear and widespread structural compromise.

Survey data reveal that oil spills inflict direct economic harm: 40% of respondents experienced moderate losses and 35% significant losses, totaling 75% of the sample. This supports Okoh and Okafor's (2019) assertion that spills devalue property and strain local economies through costly repairs. Consequently, the economic viability of affected areas is compromised, which suppresses investment and stalls long-term community development.

The evaluation of existing environmental governance reveals significant perceived deficiencies. Only 35% of respondents rated current frameworks as moderately effective, with a minority considering them effective (25%) or very effective (10%). In contrast, 30% deemed them ineffective, pointing to systemic failures in enforcement, monitoring, and compliance. This assessment corroborates the earlier observation by Nwilo and Badejo (2005) that inadequate regulatory oversight and poor adherence to preventive protocols are key drivers of persistent oil spills in the Niger Delta. Consequently, there is a compelling need to strengthen regulatory institutions and integrate proactive community-based monitoring to enhance accountability and spill prevention.

To address these systemic and physical challenges, the study identifies a multifaceted strategy for protecting and rehabilitating the built environment. Critical approaches endorsed by respondents include stringent preventive maintenance of pipelines, remediation of contaminated soil and water, adoption of resilient construction materials, and comprehensive community awareness programs.

Specific supportive measures cited were site decontamination, structural reinforcement of vulnerable assets, and improved, risk-informed urban planning. These proposed interventions align with the integrated model advocated by Eze and Okoye (2021), who assert that effective long-term infrastructure sustainability in oil-impacted regions requires the concurrent application of robust regulatory enforcement, technological innovation, and meaningful local stakeholder engagement.

This discussion substantiates the significant and interrelated physical, economic, and regulatory consequences of oil spills on infrastructure. The empirical evidence aligns with and reinforces prior research, illustrating a clear trajectory from environmental contamination to infrastructural failure, economic hardship, and institutional ineffectiveness. The analysis, therefore, highlights that an effective response demands a holistic approach, merging stronger regulations, inclusive stakeholder participation, and innovative engineering practices to build resilience.

CONCLUSION

Oil spills systematically weaken infrastructure, drain local economies, and outpace current regulations. This study documents how contamination directly damages buildings, roads, and drainage systems, imposing heavy costs on communities and governments. Existing environmental management is insufficient, allowing damage to recur. Affected areas face layered crises: unsafe housing, disrupted livelihoods, and disincentives for investment. Effective solutions require integrated action: proactive pipeline integrity programs, contaminated land rehabilitation, use of oil-resistant materials, and empowered local monitoring. Success depends on the coordinated commitment of regulators, oil firms, and residents.

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