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Severity Index of Environmental Factors Associated with Building Construction Process.

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Abstract:- Environmental impact assessment of construction projects is demanded by government of developed nations where the construction industry is regulated. This is however not the case in developing nations where the industry is not regulated. In this research, types and the degree of severity of environmental factors associated with building construction projects in Lagos state of Nigeria was examined. Twenty –eight on-going building projects scattered between Lagos Island and the mainland were randomly selected from each cluster using proportional allocation. Data were collected through a questionnaire survey administered on 3 senior management staff and 7 artisans at each site. The study established raw material consumption and transportation as the most always occurring, most severe construction activity constituting environmental hazard and having the highest impact level on the environment. It was concluded that on-site construction activities have significant impact on the environment across the broad spectrum of, natural resource, ecosystem and public health.

Keywords:- Environmental Factors, Construction, Impact, Nigeria

I. INTRODUCTION

The environment is the totality of the places and surroundings in which we live, work and interact with other people in our cultural, religious, political, socio economic activities; for self-fulfillment and advancement of our communities, societies or nations. It is within the environment that both natural and manmade things are found[1],[2].

Human beings are found in the environment, and according to [3] they are not only dependent on the physical environment for livelihood, but also in a number of ways are capable of controlling and determining what takes place in the environment. Studies and reports have indicated rapid growth in human population globally and its effect on the environment. A report on Nigeria by [4] , revealed that Nigeria population would be 433 million by 2050, which implies that Nigeria would become the third largest country in the world, after India and China. Reference [5], believes that with the revelation that Nigeria population has hit 167million and its projected 433 million by 2050, has raised fears on the adverse effects of such population growth would have on the nation economy, infrastructure and teeming population. The building and construction industry is saddled with the responsibility of providing infrastructure for this ever improving life style of the growing population [6].

Reference [7], revealed that construction process are significant in economic activities contributing approximately 10% to the global domestic product and consume considerable energy and resources compared to other industrial process. Reference [8], observed that the construction industry creates and provides facilities for human activities and social development on one hand, while the impact on the environment is witnessed on the other hand. This impact as observed by[9], is across a broad spectrum of, off site, on site and operational activities. He opined that, on site construction activities relate to the construction of physical facilities, resulting in air pollution, water pollution, traffic problems and generation of construction waste.

Throughout the world economy, many industrial sectors are beginning to recognize the impacts of their activities on the environment and to make significant changes to mitigate their environmental impact [10]. An editorial by [11], pointed out the growing importance of environmental considerations in the design, procurement and management of property across the nations. The construction industry accounts for large consumption of energy, non-renewableresources and also generates a fairly large amount of pollutants, including air emissions, noise, solid waste and water discharge when compared with other industries. Hence there is an urgent need to address the environmental impact of the construction industry, most especially on construction sites because they are directly related to the demanding issues of global warming and the depletion of non-renewable energy [12]. Environmental issues have been seen as important issue affecting the whole earth and this has led to advocacy groups in environmental protection. However advances have been made to respond to international governmental policies and initiatives on environment by the setting of targets for the reduction of environmental impacts through reduced energy use and atmospheric emissions [11].

Sustainable development and performance assessment might have emerged as a means of addressing the adverse impact of the construction industry. However,[7],[13],[12],observed that, they focus mainly on the impacts that arise during the operational stage (lifecycle), which includes energy consumption and its associated Green House Gas (GHG) emissions. But the process to construct the built environment have not drawn much attention to environmental issues, since their environmental impacts have been perceived to be relatively lower in significance when compared to the impacts associated with the building design and management and, the inherent temporality related to the onsite construction processes[12],[14].

Reference [12], observed that several studies have called for the need to mitigate the considerable environment impacts, especially air pollutant emission and energy consumption, generated by construction process. As acknowledged by[15], the awareness knowledge would be the main factors needed to mitigate the environmental impacts. Based on the foregoing the study identified and examined the environmental issues related to on-site construction processes in terms of the frequency, the likelihood of occurrence and the severity of the consequence, in order to determine the environmental impact level of on-site construction.

II. THE CONSTRUCTION INDUSTRY ACTIVITIES AND THE ENVIRONMENT.

The Construction industry has been seen by researchers as a main source of environmental pollution compared with other industries. But to mitigate the environmental impact of on-site construction processes globally, regionally and nationally, identification of the impacts are essential.

Reference [16], conducted a study on the energy and carbon dioxide emission during construction process of a 13 storey office building project in the United Kingdom which revealed that 651 tons carbon dioxide was emitted, with 73% from electricity and 27% from fuel usage. Reference [17], measured carbon emissions from a two storey wood frame building in Pittsburgh; the study revealed that the construction of a typical residence could consume 550,000MJ of energy and produce 43tons of carbon dioxide of Green House Gas (GHG), 200kg of Nitrogen (NO_2), 300kg of Carbon (CO) and 100kg of particle pollution (PM). Similarly [18], conducted a case study on the carbon emitted during construction process of a hotel project in South Wales, the study revealed that, construction activities generate more carbon than expected, it found out that materials delivery, operational activities and plant operations account for more than 90% of the total emissions, activities from management (workers) and visitors while utilities only contributed 10% of the carbon dioxide emissions.

Reference [19], investigated the environmental performance of urban construction projects in China. From their findings they concluded thatthe sources of pollution and/or hazards from construction activities can be divided into seven major types; dusts, harmful gasses, noises, solid and liquid wastes, falling objects, and ground movement. Reference [20], also conducted an investigation on the implementation of environmental management in Hong Kong, the study classified environmental impact of construction as the extraction of environmental resources, extending consumption of generic resources, production of waste that require the consumption of land for disposal and pollution of the environment with noise, odours, dust, vibrations, chemical and particulate emissions.

Reference [13], proposed a methodological framework consisting of nine categories of environmental impact (atmospheric emissions, water emissions, waste generation, soil alteration, resource consumption, local issues, transport issues, effects on biodiversity, and incidents, accidents and potential emergency). The methodological framework included twenty direct and indirect performance indicator developed with the help of a panel of experts to identify the potential environmental impacts at the pre-construction stage of 55 new start construction projects in Spain from the project documents (drawings). They found that, the following had an extremely significant impact at the construction site with the highest environmental impact: greenhouse gas emissions due to construction machinery; and the movement of vehicle; waste generation; and water consumption.

Reference [21], examined the environmental impacts associated with construction sites in Malaysia. The study conducted interviews with an expert panel group which consisted of 15 construction professionals to investigate, and determine, the frequency and severity of environmental impacts encountered during the construction of residential buildings, under three categories (1) natural resources impact (2), ecosystem impact , (3) public impact.Theirfindings showed that, ecosystem impact has the highest total impact level on the environment. The ecosystem impacts include accumulated amount of adverse environmental impacts such as waste, noise, dust and hazardous emissions which cause serious damages to humans and ecosystems [22].

In order to achieve the aim of this study, the study adopted the classification of environmental impacts into three main categories, natural resource, ecosystem and public impact as shown in the table 1.

Table 1: Environmental Impacts

Environmental Impacts	Effects	Causes/Process
Public Impact	Site Hygiene Condition, Public Effects Social Disruption.	Transportation of equipment, bulk material transportation, drilling and blasting, building demolition, hammering works, solid state waste, toilet waste of site staff and workers
Natural Resource Impacts	Raw material (consumption & transportation), Water Consumption On Site, Fuel Consumption, Electricity Consumption	Electric Welding, construction equipment, building materials, site clearing, excavation, burning, chemical usage and ground water released during piling operation.
Ecosystem Impact	Noise Pollution, Dust Generation With Construction Machinery, Land Pollution, , Air Pollution, Operation With Vegetation Removal, Emission Of Volatile Organic Compounds (VOC) And CFC, Generation Of Inert Waste(package waste), Operations With High Potential Soil Erosion, Water Pollution, Dust Generation, Inert Water Chemical Pollution, Landscape Alteration, Toxic Generation, Water pollution, Green Gas Emission, waste generation(materials)	Clearing of site, construction machinery, rubble disposal, material handling and storage, soil excavation, painting ,tile works, cleaning agent(organic solvent),, concrete batching and sand, steel bar handling, surplus adhesive, spent lubrication oil and grease

Source: Adapted and modified from [22],[21]

III. THE RESEARCH METHOD

A. The Study Area

The study area of this research is confined to metropolitan area of Lagos State, in Southwestern Nigeria. It is a typical mega city and Nigeria's commercial capital and former capital city, this elongated state spans the Guinea coast of the Atlantic Ocean for over 180km, from the Republic of Benin on the west to its boundary with Ogun state of Nigeria, in the east. It extends approximately from latitude 6°2' North to 6°4'North, and from longitude 2°45'East to 4°20'East, of its total area of 3,577sq. km., about 787sq. km. or 22 percent is water. Lagos state has a population of 17 million with approximately 85% living in the city of Lagos making it one of the most urbanized regions in Nigeria. The UN estimates that at its present growth rate, Lagos will be the world's third largest city by 2015, after Tokyo in Japan and Mumbai in India [24].Lagos Metropolis is the economic and financial capital of Nigeria with a total of 999.6km^2 in land area, and the metropolis is made up of 16 Local Government Areas [25].

B. Sample Design and Frame

The sample frame for the study was drawn from ongoing building construction sites in Metropolitan area of Lagos State, of not less than two floors manned by relevant registered professionals (RRP) in the built environment. Reconnaissance survey indicated that the study samples could be chosen from construction sites within metropolitan area of Lagos. Thus, multi-stage sampling technique was used to divide metropolitan area of Lagos, into two zones; namely Lagos Island and Lagos Mainland. Each of these zones was further divided to clusters where ongoing building construction projects of not less than two floors could be found. Four of such clusters with 116 construction sites mainly manned by RRP were identified in Lagos Island. These were; Ikoyi (40), Lekki (65), Ajah (07) and Victoria Island (04). In the same vein, while seven clusters having 111 construction sites were purposively identified in the Lagos Mainland. These were; Berger (25), Ogba/Isheri (21), Ikeja G.R.A (30), Omole Phases 1and 2 (12), Magodo Estate (13), Yaba (05) and Opebi (06). Thus, 227 building construction sites formed the sample frame for the study.

Out of the 227 building construction projects identified on Lagos Island and Mainland, byapplying random selection technique on each cluster, using proportional allocation, and making sure that the number of sites selected from a particular cluster is proportional to the cluster's share of the total population, ten percent (28) of all the building projects identified in each of the clusters were sampled.

C. Data Collection and Analysis

Data were collected through the administration of questionnaire on construction workers (senior management staff and artisans). The questionnaire was administered on 3 senior management staff and 7artisans at each site, hence, 84 and 196 questionnaires were administered on senior management staff and artisans respectively. Respondents were asked to rate the frequency and severity of the environmental factors using a five –point Likert scale as in Table 2.

Table 2: Likert Scale Used to Determine the Level of Frequency and Severity of Environmental Factors

Scale	Severity	Description	Frequency
1	Insignificant	Minimal impact	Never
2	Low	Short-term impact	Rarely
3	Moderate	Significant impact	Sometimes
4	High	Major short-term impact	Often
5	Very High	Major long-term impact	Always

Source: Adapted from [21]

The risk matrix was used to determine the probability, frequency or likelihood of an environmental factor occurring for its rows(or columns) and to determine the severity ,consequences or impact of the factors for its columns (orrows) as illustrated in Table 3 [25]. As noted by [21], the risk will increase if either probability or severity rise or both rise simultaneously.

Table 3: Risk Matrix Table

Level of Consequence	Description
1	Insignificant
2	Low
3	Moderate
4	High
5	Very High

x

Level of Frequency	Description
1	Never
2	Rarely
3	Sometimes
4	Often
5	Always

=

Probability					
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	Severity				

This is expressed mathematically as follows:

R= F x S ---------------------- Equation 1

Where R = Impact level Rating for an Environmental Factor

F = Relative Frequency Index for the Environmental Factor

S = Relative Severity Index for the Environmental Factor

Source: Adopted and Modified from [21]

IV. DATA ANALYSIS AND DISCUSSION OF RESULTS

A. Respondents'Profile

A total number of two hundred and eighty questionnaires (280) were administered, 84 on site agents, 196 on site operatives. One hundred seventy (170) were retrieved and eighteen were rejected for the analysis due to inconsistency and errors observed in the data provided. Table 4 shows the profession, academic qualifications and years of experience of respondents. The table 4 reveals that 3.9% of the respondents were Architects, Builders, 7.9%, Engineers, 15.1%, Quantity Surveyors, 3.9% and Artisans 66.4%. About 47% of the respondents were senior secondary school certificate holders, 18.4 % were Ordinary National Diploma (OND) holders, 11.2% were Higher National Diploma (HND) holders, while 12.5%, 4.6% and 6.6% were Bachelor degree, Post graduate degree and Primary school certificate holders respectively. On the years of experience, 16.4% of the respondents had 5 years while37.5% have had 10 years experience, 24.3% had 15 years experience , 14.6% of the respondents had 20 years experience and 5.9% above 20 years experience.

Table 4. Respondents' Profile.

Profession	Frequency	Percent (%)
Architects	6	3.9
Builders	12	7.9
Engineers	23	15.1
Quantity Surveyors	6	3.9
Artisans	101	66.4
Missing	4	2.6
Total	**152**	**100.0**
Academic Qualification		
Senior School Certificate	71	46.7
Ordinary National Diploma	28	18.4
Higher National Diploma	17	11.2
Bachelor Degree	19	12.5
Post Graduate Degree	7	4.6
Primary school certificate	10	6.6
Total	**152**	**100.0**
Years of Experience		
1-5 Years	25	16.4
6-10 Years	57	37.5
11-15 Years	37	24.3
16-20 Years	22	14.6
Above 20 Years	9	5.9
Missing	2	1.3
Total	**152**	**100.0**

Source: Field Survey 2014

B. Rate of Occurrence

Respondents were asked to indicate the rate of occurrence of the environmental factors indicated in Table 1.The rating was done on a Likert scale of 1-5.The Mean Item Score expressed as $\sum W$ ------------Equation 2

N

was used for the analysis, where w is the weighting given to the factor by the respondents and ranges from 1 to 5 where '1' is 'Never' and '5' is 'Always'.

For the purpose of this study, all impacts with MIS value of 3.00 and above were considered to be impacts that often or regularly occur, while those below 3.00 were considered rarely occurring or take place on construction sites. From table 5, 13 out of the 21 impacts associated with construction process, ranked by construction workers had MIS values above 3.00.

The respondents rated the raw material transportation and consumption as regularly occurring because in developing nations as Nigeria most of the infrastructural productions are done on site instead of off-site in developed countries. Water consumption was apparently rated second because most of the raw materials consumed on site must be turned to usable components using water. Hence much water is consumed which could cause environmental hazard.

Waste generation was rated third with MIS of 4.35. The construction industry is known to generate much waste because of the large quantity of raw materials used in construction and the fact that contractors do over-estimate these materials while tendering.

Noise pollution was also rated as almost always occurring because heavy equipment are always used in the course of construction. These equipment are at times not in good condition and obsolete; hence do malfunction leading to noise generation. In Malaysia as reported by [21], transportation resources, noise pollution and dust generation were rated by the respondents as 1^{st}, 2^{nd} and 3^{rd} respectively to regularly occurring on construction sites.

The Nigerian construction industry workers rated water pollution, social disruption and public health as the least factors that could be affected by construction activities. This was not however, the case in Malaysia, because construction experts believe construction activities affect public health and pollute water much more as rated in Nigeria ,though the rating for social disruption seems to be the same.

Hence, there is need to investigate further the extent of the effect of construction activities on the health of residents living within some radius where construction activities are ongoing. This is so because it seems construction workers in Nigeria are not aware of the extent of construction activities on the public health.

Table 5. The Frequency (Rate of Occurrence) of Environmental Factors

Environmental impact	A	O	ST	R	N	TS	MIS	RANK
Natural resource impact								
Raw material (consumption and transportation)	125	17	4	3	2	707	4.65	1
Water consumption	108	33	3	5	3	694	4.56	2
Fuel consumption	18	53	49	30	2	511	3.36	13
Electricity consumption	10	23	45	67	7	418	2.75	15
Ecosystem impact								
Waste generation	85	50	7	6	4	662	4.35	3
Noise pollution/vibration	56	83	8	5	-	646	4.25	4
Dust generation	57	70	16	6	3	628	4.13	5
Landscape alteration	30	74	31	15	2	571	3.76	7
Operation with vegetation removal	24	67	39	17	4	543	3.57	8
Generation of inert waste	21	68	32	26	5	530	3.48	9
Inert water	11	82	32	19	8	525	3.45	10
Land pollution	15	32	49	39	6	520	3.42	11
Dust generation(machinery)	10	68	56	12	6	520	3.42	11
Air pollution	4	40	68	30	10	454	2.99	14
Green house gas emission	2	34	45	58	13	410	2.69	16
Emission of VOC	-	16	64	61	11	389	2.56	17
Toxic generation	6	17	31	60	38	349	2.30	18
Water pollution	1	13	28	81	29	332	2.18	19
Public impact								
Site hygiene condition	70	46	21	12	3	624	4.11	6
Social disruption	5	8	47	70	22	360	2.37	20
Public health effect	1	9	27	67	47	303	1.99	21

Source: Field Survey and Analysis, 2014

Legend: A – Always, O- Often, ST- Sometimes, R-Rarely, N - Never, TS- Total score, MS- Mean item score

C. Severity of Environmental Factors

The severity of the environmental factors as indicated in Table 5 was assessed by the respondents. They were asked to rate the factors on a scale of 1-5. The value '1' represents 'Insignificant', '2' represents 'Minor', '3' represents 'Moderate', '4' represents 'Major' and '5' represents 'Catastrophic'. The ratings were analysed using Mean Item Score (MIS) as in equation 2. For the purpose of this study, all impacts with MIS value of 3.00 and above were considered to have a high severity, while those below 3.00 were considered to have a low severity. From table 6, 10 out of the 21 impacts associated with construction process, ranked by construction workers had MIS values above 3.00 which showed that less than half of the impacts were considered by respondents as high.

Table 6: The Severity of Environmental Impact of Construction Activities.

Environmental impact	VH	H	MD	L	INS	TS	MIS	RANK
Natural resource impact								
Raw material (consumption & transportation)	84	58	4	4	2	674	4.43	1
Water consumption	53	78	10	6	5	624	4.10	4
Fuel consumption	4	20	55	66	7	404	2.66	14
Electricity consumption	4	15	38	75	20	364	2.39	16
Ecosystem impact								
Waste generation (construction material)	70	63	13	5	1	652	4.29	2
Noise pollution/vibration	56	69	20	6	1	629	4.14	3
Dust generation	52	65	23	9	3	610	4.01	6
Landscape alteration	18	67	44	16	7	529	3.48	7
Dust generation (machine)	13	71	43	23	2	526	3.46	8

Generation of inert waste (package waste, nylon and cartons)	18	72	36	12	14	524	3.45	9
Operation with vegetation removal	15	62	41	26	9	507	3.34	10
Inert water	5	64	47	18	18	476	3.13	11
Land pollution	14	33	43	36	26	429	2.82	12
Air pollution	6	23	62	44	17	4.13	2.72	13
Green house gas emission	-	20	55	60	17	382	2.51	15
Emission of Volatile organic compound	1	10	50	59	32	345	2.27	17
Toxic generation	1	6	45	48	52	312	2.05	19
Water pollution	2	10	30	50	60	300	1.97	21
Public impact								
Site hygiene condition	58	58	19	15	2	611	4.02	5
Social disruption	-	14	28	78	32	328	2.15	18
Public health effect	5	12	26	51	58	311	2.05	19

Source: Field Survey and Analysis, 2014

Legend: VH – Very high, H- High, MD- Moderate, L-Low, INS- Insignificant,TS- Total score, MS- Mean item score

Raw material transportation and consumption was rated the 1st amongst those rated with MIS value of 4.43. This indicates that the impact of this factor is worst compared to others. The movements of vehicles and machinery in transporting and converting the construction raw materials to usable components have extreme impact on the environment. Hence there is need for construction managers to reduce the regularity of the movements and usage of the vehicles and machinery to protect the environment.

Waste generation was rated the second most severe environmental factor. In the study conducted in Malaysia by [21], waste generation was rated the 21st on the severity scale. This result indicates that in the Nigerian construction industry much construction materials are wasted on site to constitute environmental hazard.

The construction industry is believed to contribute to noise pollution in most countries [26]. As acknowledged by [27], the noise generated during construction however depends on the nature and status of the equipment used, the nature of the surrounding environment, and consideration of environmental and health regulations. In Nigeria, environmental and health regulations applicable to construction processes are not clearly defined and so applied haphazardly. Therefore, for it to be rated the third most severe by construction workers means it actually constitutes nuisance to the workers. This is likely to be the case because most of the contractors hire old equipment as a result of the fact that they could not afford new ones. That being the case, the old and overused equipment will produce higher level of noise to constitute hazard to workers. As suggested by [28], a protective tool such as earplug or canal cap can be used to control the noise to the receiver since the alternative means of reduction of noise by moving the source away from the receiver is not possible in construction sites.

The Nigerian construction industry workers rated toxic generation, public health effects and water pollution as the least severe. This clearly means the Nigerian construction workers believe their activities on site do not so much constitute hazard to public health.

D. Environmental Impact Level of Construction Projects.

The environmental impact level (IL) of the factors associated with construction projects were assessed using equation 1 and the risk matrix of Table 3. For an illustration in deriving the value for an impact level assessment, a typical value for raw material consumption and transportation was derived as follows:

IL = S x F

Where: **IL** = Severity of raw material consumption and transportation

F is the * Frequency of occurrence (***MIS derived in table*** 5)

S is the severity (***MIS derived in table 6***)

IL= 4.43* 4.65

= 20.59

For the purpose of this study, all impacts with IL value of 10.00 and above were considered to be extremely significant impacts on building construction sites, while those below were considered to be marginally (low) significant impacts on building construction sites. From the table, 11 out of the 21 impacts assessed had IL values above 10.00.

Raw material consumption and transportation had the highest impact level (IL = 20.59), followed by waste generation (IL = 18.79) and water consumption (IL = 18.69) in that order. This reveals that raw material consumption and transportation is the most hazardous project construction activity in Nigeria that severely impact on the environment and the health of Nigerians. This seems to be in agreement with the result of [21]. This is because in Nigeria, most if not all construction materials are transported to sites by heavy duty vehicles or equipment which are mostly old and in the process emit hazardous gases. Some of these materials are wasted either in their raw forms or mixed with other raw materials and left in open spaces constituting environmental hazards. Much water is also consumed in the construction project sites to put these raw materials into useable form and in the process, waste water generated is allowed to seep into the soil or water systems thereby constituting potential hazard to the ecosystem and health of residents.

The least Impact Level factors were toxic generation (IL = 4.72), water pollution (IL = 4.29) and public health effects (IL = 4.08). These results revealed that the Nigerian construction stakeholders do not believe that their activities do generate much toxic waste, do not have effect on water systems and do not affect public health.

The results showed that, "ecosystem impacts" as a sub-category is the most severely (151.62) affected by construction. This is highly significant, accounting for more than 65% of the total impact, followed by "natural resource impact" and "public health impact". These results for sub-category impact level agrees with the result of [21] in Malaysia in that order, while the study by [29] in China had "ecosystem impacts", "public impacts" and natural resources in that order.

Table 7: Impact Level Assessments of Construction Projects

Impact	MIS(SEV)	(MIS)FOC	IL	RANK
Natural resource impact				
Raw material (consumption and transportation)	4.43	4.65	20.59	1
Water consumption	4.10	4.56	18.69	3
Fuel consumption	2.66	3.36	8.94	13
Electricity consumption	2.39	2.75	5.14	17
TIL/AIL			**53.36/13.34**	
Ecosystem impact				
Waste generation(mats)	4.32	4.35	18.79	2
Noise pollution/vibration	4.13	4.25	17.55	4
Dust generation	4.01	4.13	16.56	5
Landscape alteration	3.48	3.76	13.08	7
Dust generation (machinery)	3.46	3.57	12.35	8
Generation of inert waste (package waste, nylon and cartons)	3.41	3.48	11.87	9
Operation with vegetation removal	3.30	3.45	11.38	10
Inert water	3.13	3.42	10.70	11
Land pollution	2.82	3.42	9.64	12
Air pollution	2.72	2.99	8.13	14
Green house gas emission	2.51	2.69	6.75	15
Emission of VOC	2.27	2.56	5.81	16
Toxic generation	2.05	2.30	4.72	19
Water pollution	1.97	2.18	4.29	20
TIL/AIL			**151.62/10.83**	
Public impact				
Site hygiene condition	4.02	4.11	16.52	6
Social disruption	2.15	2.37	5.09	18
Public health effect	2.05	1.99	4.08	21
TIL/AIL			**25.69/8.56**	
Total			**230.71**	

Legend: MIS- Mean item score, SEV-Severity of environmental impacts, FOC- Frequency of occurrence, IL – Impact level, TIL- Total impact level for a category, AIL – Average impact level for each category of impacts

V. CONCLUSIONS AND RECOMMENDATIONS

Environmental factors that could be generated in the course of construction activities were considered in this study. These factors were grouped into sub-categories of natural resource factors, ecosystem and public health.

The study established that on-site construction activities have significant impact on the environment across the broad spectrum of, natural resource, ecosystem and public health. The study established, raw material consumption and transportation as the most frequently occurring construction activity that could constitute environmental hazard. This factor was adjudged by construction workers in Nigeria as the most severe construction activity constituting environmental hazard.

The result of the impact level assessment of impacts by construction workers, established that raw material consumption and transportation, waste generation and water consumption are the most severe environmental impacts. It was concluded that construction activities in Nigeria impact significantly on the ecosystem more than the natural resource and the public health.

Based on the findings of this study, the following recommendations are made to assist construction practitioners and companies improve on their environmental site performance, this will mitigate the effect of environmental impact arising from construction projects processesin Nigeria:

I. Construction companies should adopt an environmental policy/system. Environmental policy as defined by ISO 14001 is a statement by the organization of its intentions and principles in relation to its overall environmental performance which provides a framework for action and for the setting of its environmental objectives and targets.The adoption of Environmental Management Systems will allow construction companies to identify opportunities for reducing the environmental footprint of its day-to-day operations.

II. Government and international organization give out incentives to research bodies/institution so as to aid in the development of new materials and equipment with reduced environmental footprint.

III. Professional and government bodies should embark on enlightenment campaigns periodically to educate construction workers and members of the public on the impacts of construction sites activities, sustainable construction, lean construction concept and resource efficient buildings. This can be achieved by organizing public lectures, workshops and seminars or through the use of the media.

IV. Government agency and bodies monitor/regulate construction activities on construction sites. This might be in the form of timing of activities that might have adverse effect on residents, ensuring proper disposal of waste, submission of environmental management plan before the commencement of work on site, site cleanliness/orderliness and ensuring that construction plants and equipment used are those with a low carbon footprint and noise level.

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