International Journal of Environmental Problems

Has been issued since 2015.
E-ISSN 2413-7561
2018. 4(1). Issued once a year.

Journal is indexed by: **Cross Ref, OAJI, MIAR**

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Founder and Editor: Academic Publishing House Researcher s.r.o.

Release date 02.09.18.
Format 21 × 29,7/4.

Headset Georgia.

Order № EP-06.

International Journal of Environmental Problems

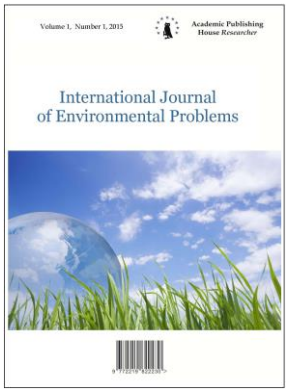
2018

Is. 1

Articles and Statements

Published in the Slovak Republic
International Journal of Environmental Problems
Has been issued since 2015.
E-ISSN: 2413-7561
2018, 4(1): 3-18

DOI: 10.13187/ijep.2018.1.3
www.ejournal33.com



Articles and Statements

Influence of Local Governance on Residents' Environmental Sanitation Behavior in Nigeria: the Ile-Ife Experience

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Abstract

This paper examined the influence of local governance on residents' environmental sanitation behavior in Ile-Ife, Nigeria. This was with a view to suggesting policy response in furtherance of a sustainable environmental behavior among residents in the city and others with similar background. Four residential zones were identified in the study area. A total of 2,881 buildings were identified comprising 739, 154, 357 and 431 respectively in the low income, middle income, high income and post crisis residential area. One out of every 10th residential building was sampled in each residential area. A total of 288 residents were selected for survey using systematically sampling technique. The study revealed that residents' socio-economic characteristics varied significantly across residential areas. The study also found that there is low level of access to environmental sanitation facilities/services in the low income, middle income and post crisis residential areas.

The study established that a relationship exist between residents' environmental sanitation behavior and their place of residence. The study also established a variation in the level of agreement of the functions of the mandated monthly environmental sanitation exercise. In general, the maintenance of dumpsites within the city by government was not satisfactory to the residents across the four identified residential areas. The study recommended a synergy of strategies among environmentally-concerned institutions in the study area in provision of facilities/services, environmental awareness and enforcement of sanitation legislations in the study area.

Keywords: environmental sanitation, governance, legislation, facilities, services, Ile-Ife.

1. Introduction

Many countries especially in the developing world are characterized by poor sanitation conditions, indiscriminate dumping of wastes, open urination and defecation. This situation manifested as a result of poor sanitation behavior of citizens, inadequate environmental amenities, ineffective legislation and governance among others (Daramola, Olowoporoku, 2018; Olukanni et al., 2014; Akpabio, 2012). In Nigeria, issues of environmental sanitation have constituted a major problem to both individuals and government as living environment in urban centres of the country pose serious health risk and affront to human dignity. In order to alleviate these challenges, proper

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environmental sanitation behavior in close involvement with the regulators and facilitators of environmental sanitation especially at the local level must be ensured.

The delivery of environmental sanitation services and facilities which is meant to aid environmental sanitation behaviour in Nigeria is poor. This poor delivery is a reflection of the disjointed nature of local governance of Nigerian cities (Daramola, Olowoporoku, 2017a). Local governance is the formulation and execution of collective action at the local level. It encompasses the direct and indirect roles of formal institutions of local government and other government hierarchies (World Bank, 2005; Wilson, 2000). Local governance is not limited to the relationship between the government and its citizens at the local level rather, it emphasis citizens' interaction and the delivery of local public services (Daramola, Olowoporoku, 2017).

Local governance refers to how government at the local level among other stakeholders decides how to plan, finance and manage urban areas (Avis, 2016). It plays a critical role in shaping the physical, political and social character of cities and influences the quantity and quality of local services and efficiency of delivery (Slack, Côté, 2014). Nigeria as a country operates federalism and has witnessed concerted efforts of federal, state and local governments and other allied institutions on various issues such as environmental sanitation. Various government agencies and non-governmental institutions have been established to manage environmental sanitation in terms of providing interventions, facilities, promulgation and enforcement of legislation. However, the efforts of these agencies and institutions have been a clap with one hand.

Environmental sanitation behavior encompasses the involvement of citizens in the provision, utilisation and maintenance of environmental sanitation facilities and services and adherence to environmental sanitation legislation both in their homes and neighbourhoods (Daramola, 2015). The concern for urban environmental sanitation has been part of Nigerian development. Efforts in these regard include regular inspection of households by sanitary inspectors and the promulgation of environmental sanitation regulations (Olowoporoku, 2016). The legislations were made so as to arrest the sanitation problems and inculcate correct healthy habits, attitude and practices among citizens. Despite these laws, the physical environment in most states are still plagued with worrisome environmental sanitation conditions, gross environmental indiscipline, heaps of refuses on roadsides, rivers, road medians, therefore making issue of sanitation seems incurable (Daramola, Olowoporoku, 2017b). As opined by Daramola, Olowoporoku (2017a) and Olowoporoku (2014) enhancing citizens' environmental sanitation behaviour, involves improved governance of the local administrative system of the city.

Issues related to environmental sanitation have aroused the interest of researchers in Nigeria (Daramola, Olowoporoku, 2017a; Daramola, Olowoporoku, 2016; Olukanni et al., 2014; Oke et al., 2013; Olawuni, Daramola, 2012; Odekunle, 2015; Ojedokun, Balogun 2010). However, they have only focused on environmental sanitation behavior in relation to availability of environmental amenities. Other studies in this regard include Ekong (2015), Afon, Okanlawon, Adigun, Odunola (2008). These studies examined the influence of socioeconomic background on environmental sanitation behavior while Olowoporoku, (2017) and Daramola and Olowoporoku (2017a) examined environmental legislation and service delivery. In all these discussions, little emphasis was placed on the link between institutional policies and people's sanitation behavior. In order to bridge the identified gaps in literature from the previous studies the intent of this study is therefore to examine the influence of local governance on residents' environmental sanitation behavior in Ile-Ife, Nigeria.

2. Materials and Methods

2.1. Object of the Study

The study area is Ile-Ife, Osun State Nigeria. Ile-Ife is known to have been in existence before the advent of colonialism. The city is located in the South-western geopolitical zone of the country. It lies between Latitude 7^{o} 15^{o}N, 7^{o} 31^{o}N and Longitude 4^{o} 43^{o}E, 4^{o} 45^{o}E (see Figure 1). Ile-Ife covers 1,846km^{2} with a population of 214,258 (Federal Government of Nigeria, 2007). Ile-Ife comprises two Local Government Areas (LGAs); Ife Central and Ife East LGAs of Osun state.

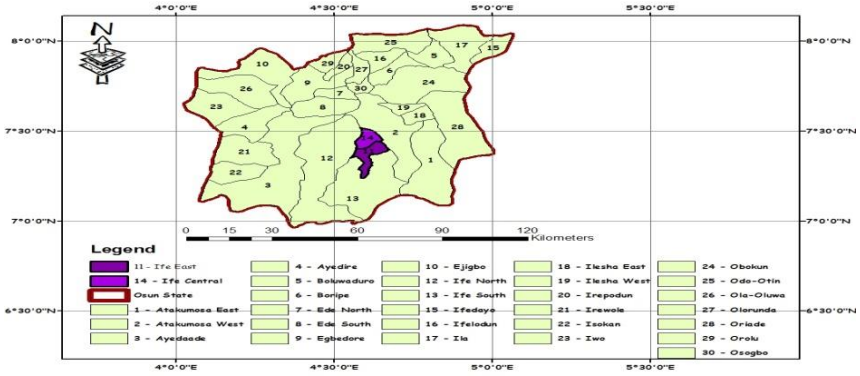

Fig. 1. Ile-Ife Local Government Areas in the context of Osun State

As identified by Afon & Badiora (2013), Ile-Ife is divided into the traditional town centre, middle income, high income and post crisis residential areas. The traditional town centre is mainly occupied by indigenes and the first migrant settlement (Mabogunje, 1962). The area is characterized by low income earners, high levels of poverty, high population density, lack of physical planning, dilapidated buildings, high level of illiteracy and inadequate environmental services both at household and community levels. The houses in the zone are closely built together, mainly of the traditional system, connected together with footpaths in a serpentine manner. Presence of human and animal waste, waste products from food and other consumables litter is obvious in this area (Adedimeji et al., 2005). The most predominant housing types are face-face bungalow buildings.

According to Afon (2011), the middle income residential area evolved to accommodate growing middle-income class in the city. In these areas, ethnic composition of the population is more varied compared with the traditional areas (Mabogunje, 1962). In this area there are evidences of development with layout plans and planning regulations.The area is characterised with higher income status compared to the traditional area, lower population density and higher accessibility to environmental facilities and services than the traditional residential area. It features house types such as flats and face-face storey-buildings.

The high income residential areas are characterised by well-planned layouts and high income earners than all other residential areas (Adedimeji et al., Durotolu, 2005). The ethnic composition and housing types are heterogeneous. Also there improved provision of urban environmental services compared to the middle income areas. Majority of residents in this area engaged in white collar jobs. These areas have high quality of landscape architecture, streets layout with planned distributed structure. It features house types such as flats and duplexes.

The post crisis residential areas were originally parts of the traditional residential areas and middle income residential area. This is because some part of this area developed as transition zone through a layout plan while others organically developed. They are mainly occupied by the indigenes of Ile-Ife. However, its present social and physical conditions emerged as a result of the last Ife-Modakeke crisis. This area consists of freestanding row houses and dilapidated buildings, vacant spaces, unoccupied buildings serving as dump sites, low trees and bushes between the buildings. The local streets inside the area are frequently disserted particularly in the night. The social compositions of the dwellers consist of mostly immigrants, unemployed and low-income families and the areas' spatial layout tend to be spatially segregated with few possibilities for social control and natural surveillance.

2.2. Methodology

In determining the sample size for the study, the two local governments in the city of Ile Ife were stratified into the four identified residential areas. These are the low income, middle income, high income and post crisis residential areas. A total of 287 streets were identified from the identified residential areas comprising 77, 118, 35 and 57 respectively. One out of every five street (20%) in each residential stratum was randomly selected without replacement. From the selected

streets, a total of 2,881 buildings were identified comprising 739, 154, 357 and 431 respectively in the four areas.

Every 10th residential building was sampled sequel to enumeration of buildings based on street numbering system and counting of buildings where houses were not numbered, especially in the low income and post crisis residential areas. Of the 288 questionnaire administered, 270 were retrieved for analyses. In each selected building, the focus was on any adult from age 18 years and above. The benchmark of 18 years is premised on the legal age appointed as legal transition into adulthood in the country. Data collected through the questionnaire survey are socio-economic attributes of the residents, those pertaining to availability of sanitation services/facilities, sanitation and their perception on the mandated monthly environmental sanitation exercise**.** Analysis of the data was done using cross tabulation and Analysis of Variance (ANOVA).

Mean indexes was used to determine residents agreement with the roles of the mandated monthly environmental sanitation exercise in the study area. The views of the residents on agreement with the exercise were expressed using a five-point Likert scale. Residents were provided with a list of functions of environmental sanitation exercise in the literature. The analysis of the responses evolved Residents' Agreement Indexes (RAIs) and mean Residents' Agreement Indexes ($\overline{RAI}$). To obtain a RSI, a weighted value of 5,4,3,2 and 1 were respectively attached to rate each response (Strong Agreement (SA) =5, Just Agreed (JA) =4, Agreed (A) =3, Disagreed (D) =2 and Strongly Disagreed (SD) =1) on any functions of the exercise. The SWV for each item was obtained through the sum of the product of number of responses of each item and the respective weighted value attached to each rating. This is expressed mathematically as:

$$SWV = \sum_{I=1}^{5} X_i Y_i$$

Where:

SWV = summation of weight value, X_i = number of respondents to rating i; Y_i = the weight assigned a value (i = 1, 2, 3, 4, 5).

The RAI for each item on the scale was arrived at by dividing the Summation of Weighted Value (SWV) by the total number of respondents in each residential area, mathematically expressed as:

$$RAI = \frac{SWV = \sum_{I=1}^{5} X_i Y_i}{N}$$

The $\overline{RAI}$ later was computed by summing residents' agreement and dividing by the number of the functions (n = 10), mathematically expressed as:

$$\overline{RAI} = \frac{RAI}{n}$$

Residents' agreement with function of the exercise with the actual values of the $\overline{RAI}$ indicated a moderate level of agreement by residents. Values with positive deviations indicated high level of agreement, while those with negative deviations indicated low level of agreement with functions of the exercise. The ranks of the index values were likewise provided. The views of the residents on satisfaction with the roles of government in the exercise were expressed using a five-point Likert scale of Very Satisfied (VS) =5, Satisfied (S) =4, Fairly Satisfied (FS) =3, Dissatisfied (DS) =2 and Very Satisfied (VD) =1. The views were measured through an index called Residents Satisfaction Index (RSI). The procedure for arriving at this index is similar to the one used to measure resident agreement. The mean indexes were denoted by $\overline{RSI}$.

3. Result and Discussion

This section discusses the profile of the respondents, availability of environmental sanitation facilities/services in residents' homes based on residential characteristics, household sanitation practices and perception of the conduct of the monthly environmental sanitation exercise in the study area.

3.1. Profiles of the Respondents

The profiles of the respondents discussed are gender, age educational attainment, length of stay, income status, household size and type of building all these in relation to their places of residence. As established by Afon and Faniran (2013) and Daramola and Olowoporoku (2016) socio-economic attributes are main features that affect environmental behaviour.

Findings were made on gender distribution of respondents across the four residential areas of Ile-Ife. The proportion of males in the low income, middle income, high income and post crisis residential areas constituted 61.1 %, 48.4 %, 33.3 % and 40.0 % respectively. Also, female respondents in the low income zone were 38.9 %, middle income 51.6 %, high income 66.7 % and post crisis residential zone 60.0 %. In general, 51.1 % of the total respondents across the four residential areas were females. Impliedly, females participated more in the study than their male counterpart. The high level of participation of females could be attributed to their availability at home for family obligations, neighbourhood trading and their key role in environmental sanitation issues (Daramola et al., 2017; Daramola et al., 2017; Afon, Faniran, 2013).

Another important attribute of residents discussed is age**.** As established by Schultz et al, (2005) and Olowoporoku et al. (2017), age plays a significant role in environmental awareness. For a better understanding, the initial qualitative data on age of residents was categorized into four. These are teenagers (≤ 20 years); young adults (21 – 40 years); elderly adults (41 – 60 years) and older people (> 60). In the low income areas, 16.7 % of the respondents were teenagers 44.4 % were young adults, 36.1 % were elderly adults and 2.8 % of the respondents were older people. In the middle income areas, 14.1 % of the respondents were teenagers, 64.1 % young adults, 20.3 % were elderly adults while the remaining 1.6 % older people. Information from the high income areas revealed that the proportion of teenagers, young adults and elderly adults constituted 6.7 %, 66.7 % and 26.7 % respectively. Investigation from the post crisis zone revealed that 40.0 %, 45.0 % and 15.0 % of the respondents were teenagers, young adults and elderly adults respectively. Across the four residential areas majority (80.7 %) were adults. The ANOVA Test result ($F= 13.916$, $p < 0.05$) revealed that the age distribution of respondents varied significantly across the residential areas.

Findings were made on the average monthly income of respondents in the study area. The mean monthly income was grouped into three: low, medium and high. Income below ₦20, 000 categorized as low. This was premised on the fact that the minimum wage at the federal level in Nigeria is ₦18, 000 while it ranges from ₦15, 000 to ₦20, 000 in the states of the federation. The medium monthly income was categorized from ₦20, 000 to ₦70000 while residents earning above ₦70000 were categorized as high income earners. Based on the categorization, variation in average monthly income class existed among the respondents in the study area. Findings revealed that in the low income areas, 50.0 % earned less than ₦20000, 41.2 % earned between ₦20000 and ₦70000 while 8.8 % earned above ₦70000. In the middle income areas, 26.9 % of the respondents earned below ₦20000, 55.8 % earned between ₦20000 and ₦70000, and 17.3 % earned above ₦70000. In the high income areas, 7.7% of the respondents earned below ₦20000, 23.1 % earned between ₦20000 and ₦70000 69.2 % earned above ₦70000. In the post crisis areas, 53.3 %, 33.3 %, and 13.3 % earned below ₦20000, ₦20000 and ₦70000 and above ₦70000 respectively. The ANOVA test result ($F = 9.080$, $p <0.05$) revealed that income distribution varied significantly with residential areas.

Household size was measured by the number of people living together with common eating arrangement. Based on this, the household sizes of the residents were categorized into three. The household sizes of one to five members were categorized as small, those with six to ten members as medium while those with more than ten members was categorized as large (Daramola, Olowoporoku, 2016; Olowoporoku et al., 2017). Thus, in the low income area, 63.6 % respondents had small household, 33.3 % had medium household size and 3.0 % of the respondents had a large household size. In the middle income zone, 75.8 % of the respondents had small household size, 24.2 % had medium household size. In the high income zone, 50.0 % of the respondents had a small household size and the remaining (50.0 %) had medium household size. In the post crisis zone, 75.0 % had a small household size while the remaining (25.0 %) had a medium household size. Further findings revealed that aside from the low income residential areas, other areas have no respondents with large household size.

Table 1. Socio-economic Attributes of the Respondents

Attributes	Low Income	Middle Income	High Income	Post Crisis	Total
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
Gender					
Male	44 (61.1)	62 (48.4)	10 (33.3)	16 (40.0)	132 (48.9)
Female	28 (38.9)	66 (51.6)	20 (66.7)	24 (60.0)	138 (51.1)
Total	**72 (100.0)**	**128 (100.0)**	**30 (100.0)**	**40 (100.0)**	**270 (100.0)**
Age (years)					
≤20	12(16.7)	18 (14.1)	2 (6.7)	16 (40.0)	48 (17.8)
21-40	32(44.4)	82 (64.1)	20 (66.7)	18 (45.0)	152 (56.3)
41-60	26 (36.1)	26 (20.3)	8 (26.7)	6 (15.0)	66 (24.4)
> 60	2 (2.8)	2 (1.6)	0 (0.0)	0 (0.0)	4 (1.5)
Total	**72 (100.0)**	**128 (100.0)**	**30 (100.0)**	**40(100.0)**	**270 (100.0)**
Income					
<₦20000	34 (50.0)	28 (26.9)	2 (7.7)	16 (53.3)	80 (35.1)
₦ 20000-₦70000	28 (41.2)	58 (55.8)	6 (23.1)	10(33.3)	102 (44.7)
>₦70000	6 (8.8)	18 (17.3)	18 (69.2)	4 (13.3)	46 (20.2)
Total	**68 (100.0)	**104 (100.0)	**26 (100.0)	**30 (100.0)	**228 (100.0)
Household size					
≤5	42 (63.6)	94 (75.8)	14 (50.0)	30 (75.0)	180 (69.8)
6-10	22 (33.3)	30 (24.2)	14 (50.0)	10 (25.0)	76 (29.4)
>10	2 (3.0)	0 (100)	0 (100)	0 (100)	2(0.8)
Total	**66 (100.0)	**124 (100.0)	**28 (100.0)	**40 (100.0)	**258 (100.0)
Length of stay					
≤5	20 (41.6)	66 (64.7)	8 (50.0)	14 (50.0)	108 (55.7)
6-10	14 (29.2)	20 (19.6)	6 (37.5)	10 (35.7)	50 (25.8)
>10	14 (29.2)	16(15.7)	2(12.5)	4 (14.3)	36 (18.6)
Total	**48 (100.0)	**102(100.0)	**16(100.0)	**28 (100.0)	**194 (100.0)
Educational Status					
No formal education	6 (8.3)	0 (0.0)	0 (0.0)	2 (5.6)	8 (3.1)
Primary	14 (19.4)	4 (3.3)	4 (13.3)	0 (0.0)	22(8.5)
Senior secondary	14 (19.7)	12 (9.8)	4 (13.3)	6 (16. 7)	36 (13.8)
Tertiary	38 (52.8)	106(86.9)	22 (73.3)	56 (77.8)	194 (74.6)
Total	**72 (100.0)	**122(100.0)	**30(100.0)	**64 (100.0)	**260(100.0)
Type of Houses					
Face to Face (Bungalow)	41 (56.9)	59 (46.1)	0 (0.0)	16 (40.0)	116 (43.0)
Face to Face (Storey)	24 (33.4)	38 (29.7)	0 (0.0)	11 (27.5)	73 (27.0)

Flats	7 (9.7)	27 (21.1)	19 (63.3)	10 (25.0)	63 (23.3)
Duplex	0 (0.0)	4 (3.1)	11 (36.7)	3 (7.5)	18 (6.7)
Total	**72 (100.0)**	**128 (100.0)**	**30 (100.0)**	**40 (100.0)**	**270 (100.0)**

** These were less than the total number of respondents as some respondents did not provide the relevant information

The length of stay of respondents are categorized into three (<5, 6-10, >10 years) (Daramola, Odunsi, Olowoporoku, 2017). In the low income area, 41.6 % of the respondents have been living in the area for up to 5 years, 29.2 % have been living in the area for a span between 6 to 10 years while 29.2 % have dwelled in the area for more than 10 years. Information from the middle income residential area revealed that the proportion of respondents that have lived in the area for less than 5 years, 6-10 years and above 10 years constituted 64.7 %, 19.6 % and 15.7 % respectively. In the high income residential areas, 50.0 %, 37.5 % and 12.5 % of the respondents in this area have respectively spent less than 5 years, 6-10 years and above 10 years in the study area. In the post crisis residential zone, 50.0 % of the respondents claimed to have lived in the area for a maximum of 5 years, 35.7 % had resided in the areas for an interval of 6 to 10 years while the remaining 14.3 % had spent more than 10 years in the area. The volatile nature of the post-crisis residential area might be responsible for the short length of residency of the respondents in the area.

Educational level plays a significant role in environmental awareness. Studies such as Olofsson and Öhman (2006), Daramola and Olowoporoku (2016) and Olowoporoku (2017b) opined that educated people are more concerned and place more emphasis on preserving the environment. Findings on residents' educational qualifications across the residential zones of Ile Ife revealed that 19.4 %, 61.2 % and 19.4 % of the respondents had no formal education, primary and secondary education respectively. In the middle income area, it changed to 9.8 % for no formal education, 37.8 % for primary education holders, 43.4 % for secondary school holders and 11.9 % for tertiary education. There was improved level of education in the high income area, 13.3 % of the respondents had primary education, 23.3 % had secondary education while 63.4 % had tertiary education. In the post crisis zone, 40.0 % had no formal education, 15.0 % of the respondents had primary education, 27.5 % had secondary education, while 17.5 % had tertiary education. Further findings revealed that the average number of years spent in school computed for the low income, middle income and high income area were years, 6years, 11 years and 14 years respectively while the mean number of years spent in school in the post crisis area was 10 years. This indicates that the number of years spent in school increases as distance increases from low income to the high income area of the city. This is further established by ANOVA results ($F= 9.279$; $p < 0.05$) which indicated that educational attainment varied significantly with residential zones. This variation would assist in explaining environmental sanitation activities embarked upon by residents across the three different residential areas of Ile Ife.

The type of house occupied by residents was also considered relevant to this study. This is premised on the fact that type of house is a factor in provision and maintenance of sanitation facilities for households (Daramola, 2015). Type of house in the study area was categorized into four: face-face (bungalow), face-face (storey), Flat (bungalow) and duplex. Findings revealed that in the study area, 70.0 % of the residents sampled lived in multi-habitation buildings (face-face) while the remaining (30.0 %) lived in single-family apartments. Findings revealed that majority of the multi-habitation buildings were found in the low income, middle income and post-crisis residential area. One important fact to note is that multi-habitation buildings may have to do with sharing of water supply and sanitation facilities in the houses.

3.2. Respondent's Access to Environmental Sanitation Facilities/Services

Information on availability of environmental sanitation facilities across the residential areas is presented in Table 2, 3 and 4. It is necessary to consider the environmental sanitation facilities available to residents. This is imperative because availability of facilities may influence resident's environmental sanitation behavior.

Findings on the availability of water in respondents' homes revealed that across the residential areas, majority (91.9 %) of the respondents have water available in their house while 8.1 % do not have water in their homes. On the sources of water available to the respondents household, findings revealed that in the low income area, the proportion of respondents that had

access to well water, bore hole, stream, tap water and water vendors constituted 46.3 %, 30.5 %, 12.2 %, 8.5 % and 2.4 % respectively. In the middle income area, 48.8 %, 16.2 %, 4.3 % and 23.6 % constituted respondents that had access to well water, borehole, stream and tap water while 7.5 % engage the services of water vendors in their homes. Furthermore, findings from the high income zone revealed that respondents who had access to well water constituted 13.8 %, boreholes 60.3 % while those who had accessed to tap water and water vendor respectively represented 8.6 % and 17.3 % of the respondents. In the post crisis area, respondents whose household sources of water were well water, borehole, stream and tap water respectively constituted 38.2 %, 19.0 %, 7.9 % and 28.6 % while respondents who patronized water vendors accounted for 6.3 %. In general, the most predominant source of water in the study area is hand dug well and it is predominant in the low income, middle income and post crisis residential areas.

Investigation was made on the distance between the respondents' house and source of water to household. This is considered necessary as the distance travel in obtaining water could influence peoples' environmental sanitation behavior (Daramola et al., 2017). Findings revealed that in the low income zone, 11.7 % of the respondents live within the distance of 0-50metres from their household water source, 36.7 % live within 51-100metres and majority (51.6 %) travel above 100metres in search of water. In the middle income area, 31.0 %, 50.0 % and 19.0 % of the respondents travel 0-50 metres, 51-100metres and above 100 metres to source for water used in their homes. In the high income area the source of water used by a significant majority (89.3 %) of the household was located within 0-50 metres while the remaining 10.7 % claimed their water source is located within 51-100 metres from their homes. Findings from the post crises area revealed that 44.1 % travel 0-50metres to source for their household water, 35.4 % travel 51-100 metres to source for their household water while 23.5 % travel above 100metres to source for their household water. Across the residential area, majority (61.7 %) travel between 0-50 metres in search of their household water.

Table 2. Availability of Environmental Facilities/Services

Facilities	LI	MI	HI	PC	Total
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
Availability of Water					
Yes	60 (83.3)	126 (98.4)	28 (93.3)	34 (85.0)	248 (91.9)
No	12 (16.7)	2 (1.6)	2 (6.7)	6 (15.0)	22 (8.1)
Total	**72 (100.0)**	**128 (100.0)**	**30 (100.0)**	**40 (100.0)**	**270 (100.0)**
Source of Water Supply					
Well water	38 (46.3)	90 (48.4)	8 (13.8)	24 (38.2)	160 (41.1)
Borehole	25 (30.6)	30 (16.2)	35 (60.3)	12 (19.0)	102 (26.2)
Stream	10 (12.2)	8 (4.3)	0 (0.0)	5 (7.9)	23 (5.9)
Tap water	7 (8.5)	44 (23.6)	5 (8.6)	18 (28.6)	74 (19.0)
Water vendor	2 (2.4)	14 (7.5)	10 (17.3)	4 (6.3)	30 (7.8)
Total	***82(100.0)**	***186 (100.0)**	**58 (100.0)**	***63 (100.0)**	***389(100.0)**
Distance Between House and Nearest Public Water Point (Meters)					
0-50m	7 (11.7)	39 (31.0)	23 (89.3)	15(44.1)	84 (61.7)
51-100m	22 (36.7)	63 (50.0)	5 (10.7)	11 (35.4)	101 (13.3)
>100m	31 (51.6)	24 (19.0)	0 (0.0)	8 (23.5)	63 (25.0)
Total	****60 (100.0)**	****126 (100.0)**	****28 (100.0)**	****34 (100.0)**	****248 (100.0)**
Availability of Toilet					
Yes	32 (44.4)	103 (80.5)	30 (100.0)	21 (52.5)	186 (71.5)
No	40 (55.6)	25 (19.5)	0 (0.0)	19 (37.5)	84 (28.5)

Total	**72 (100.0)**	**128 (100.0)**	**30 (100.0)**	**40 (100.0)**	**270 (100.0)**

** These were less than the total number of respondents as some respondents did not have such facilities in their homes
* These were more than the total number as respondents had the opportunity of selecting multiple responses

The mean distance between respondents' house to their source of water in the low income area was 93metres, in the middle income 67metres, high income 31metres and the post crisis area, it was 58metres. This is further established by the ANOVA results ($F=18.34$; $p < 0.05$) which indicated that the distance from respondents' homes to source of water varies significantly with the residential area. Closely related to the findings on the distance between respondents homes and source of water are investigations on the availability of toilets in respondents home. In the low income, middle income and post crises residential areas, the proportion of respondents that had toilets in their homes respectively constituted 44.4 %, 72.7 % and 52.5 % while all the respondents in the high income areas indicated the availability of toilets in their homes.

Table 3. Availability of Environmental Facilities/Services

Facilities	**Low Income**	**Middle Income**	**High Income**	**Post Crisis**	**Total**
	Count (%)	**Count (%)**	**Count (%)**	**Count (%)**	**Count (%)**
Type of Toilet used in Respondents' House					
Flush toilet	4 (12.5)	52 (50.5)	30 (100.0)	3 (14.3)	89 (47.8)
VIP latrine	6 (18.8)	22 (21.4)	0 (0.0)	6 (28.5)	34 (18.4)
Pit latrine	21 (65.6)	27 (26.2)	0 (0.0)	12 (57.1)	60 (32.2)
Bucket latrine	1 (3.1)	2 (1.9)	0 (0.0)	0 (0.0)	3 (1.6)
Total	**** 32 (100.0)**	****103 (100.0)**	****30 (100.0)**	****21 (100.0)**	****186 (100.0)**
Alternative Toilet Available					
Public toilet	9 (22.5)	6 (24.0)	0 (0.0)	2 (10.5)	17 (20.2)
Nearby Bush	15 (37.5)	9 (36.0)	0 (0.0)	12 (63.2)	36 (42.9)
Nearby Stream	2 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.4)
Uncompleted buildings/Open spaces	14 (35.0)	10 (40.0)	0 (0.0)	5 (26.3)	29 (34.5)
Total	****40 (100.0)**	****25 (100.0)**	****0 (100.0)**	****19 (100.0)**	****84 (100.0)**
Availability of Drains					
Yes	20 (27.8)	60 (46.9)	24 (80.0)	26 (65.0)	130 (48.1)
No	52 (72.2)	68 (53.1)	6 (20.0)	14 (35.0)	140 (51.9)
Total	**72 (100.0)**	**128 (100.0)**	**30 (100.0)**	**40 (100.0)**	**270(100.0)**
Type of Drains Available					
Covered drain	2 (10.0)	8 (13.3)	13 (51.2)	3 (11.5)	26 (20.0)
Open drain	18 (90.0)	52 (86.7)	11 (45.8)	23 (88.5)	104 (80.0)
Total	****20 (100.0)**	****60 (100.0)**	****24 (100.0)**	****26 (100.0)**	****130 (100.0)**

** These were less than the total number of respondents as some respondents did not have such facilities in their homes

Findings on the type of toilet available in respondents' house are contained in Table 3. Findings revealed that in the low income area, 12.5 % of the respondents had flush toilet, 18.8 %

had VIP latrine, 65.5 %, had pit latrine and 3.1 % constituted respondents that had bucket latrine in their homes. In the middle income zone, the proportion of respondents that had flush toilets, VIP latrine, pit latrine and bucket latrine in their homes constituted 50.5 %, 21.4 %, 26.2 % and 1.9 % respectively. In the high income area, all respondents had flush toilets in their homes. Investigation from post crisis residential area revealed that 14.3 %, 28.5 % and 57.1 % of the respondents had flush toilets, VIP latrine and pit latrine respectively. Further findings revealed that availability of flush toilets increases from the low income area to the high income area while availability of pit latrine decreases from the high income to the low income area.

Outcomes of the analysis on the alternative to unavailability of toilet in respondents' homes are contained in Table 3. In the study area, the most predominant means of defecation by respondents who do not have toilet in their house was defecation in the nearby bush constituting 42.9 % of the total aggregates; this was followed by defecation in uncompleted buildings/open spaces 34.5 %, defecation in public toilets which constituted 20.2 % and defecation in nearby streams which accounted for 2.4 %. Information on availability of drains in respondents' homes revealed that 48.1 % of respondents in Ile-Ife had drains to discharge excreta and wastewater in their homes while 51.9 % do not have such in their homes. Waste water and discharge excreta cannot be properly channeled in homes where there are no drains. Findings made on the types of the available drains in the study area revealed that the most common type of drain in the city was open drain and it accounted for 80.0 % of the available drains while 20.0 % of the drains were covered.

Table 4. Availability of Waste Management Facilities/Services

Attribute	LI	MI	HI	PC	Total
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
Availability of Waste Storage Facility					
Yes	13 (18.0)	73(57.0)	22 (73.3)	17 (42.5)	125 (46.3)
No	59 (82.0)	55 (43.0)	8 (26.7)	23 (57.5)	145 (53.7)
Total	**72 (100.0)**	**128 (100.0)**	**30 (100.0)**	**40 (100.0)**	**270(100.0)**
Type of Materials used for Solid Waste Storage					
Plastic container	2 (6.9)	27 (22.6)	18 (54.5)	9 (25.7)	56 (25.8)
Bag/sack	11 (37.9)	31 (25.8)	8 (24.3)	15 (42.9)	65 (30.0)
Metallic container	4 (13.8)	19 (15.8)	4 (12.1)	5 (14.3)	32 (14.7)
Basket	12 (41.4)	43 (35.8)	3 (9.1)	6 (17.1)	64 (29.5)
Total	****29 (100.0)**	****120 (100.0)**	****33 (100.0)**	****35 (100.0)**	****217 (100.0)**
Waste Disposal Method					
Waste Collectors	46 (26.6)	87 (31.2)	24 (40.7)	22 (28.6)	179 (30.4)
Communal Dump Site	56 (32.3)	68 (24.4)	11 (18.6)	19 (24.7)	154 (26.3)
Open Spaces	39 (22.5)	44 (15.8)	6 (10.2)	18 (23.4)	107 (18.2)
Burning	23 (13.3)	59 (21.1)	15 (25.4)	12 (15.5)	109 (18.5)
Composting	9 (5.2)	21 (7.5)	3 (5.1)	6 (7.8)	39 (6.6)
Total	***173 (100.0)**	***279 (100.0)**	***59 (100.0)**	***77 (100.0)**	***588 (100.0)**

** These were less than the total number of respondents as some respondents did not have such facilities in their homes

* These were more than the total number of respondents as some respondents had multiple choices

Findings on waste management practices in the study area are contained in Table 4. Investigation on the availability of waste storage facilities in respondents' homes revealed that

46.3 % of the respondents had waste storage facilities in their houses while 53.7 % constituted respondents that do not have waste storage facilities in their homes. In other words, majority of the residents do not have designated containers for dumping solid wastes in their homes. Further investigation revealed that respondents in the low income, middle income, high income and post crisis residential area who used plastic containers to store waste in their houses accounted for 6.9 %, 22.6 %, 54.5 % and 25.7 % respectively while the proportion of respondents using bag/sack to store waste in the low income, middle income, high income and post crisis residential area stood at 37.9 %, 25.8 %, 24.3 % and 42.9 % respectively. Other prominent waste storage facilities in respondents' homes were baskets and metallic containers. These were used by 29.5 % and 14.7 % of the respondents in the study area.

Information on waste disposal methods as put by the residents is also presented in Table 4. The common waste disposal methods in the study area were engagement of the services of waste collectors, dumping in communal dump sites, dumping outside building premises and others. Findings revealed that 26.6 %, 31.2 %, 40.7 % and 28.6 % of the respondents in the low income, middle income, high income and post crisis residential areas engage the services of waste collectors in collection of waste. This implies that the residents engage the services of waste disposal agencies. From the investigation, the proportion of residents who dump their waste in the communal waste disposal sites in the low income area was 32.3 %; this was 24.4 % in the middle income area, 18.6 % in the high income area and 24.7 % in the post crisis residential area. The high rate of dumping of waste on dumpsites in the low income, middle income and post crisis residential areas can be attributed to the presence of derelict and undeveloped lands which are converted to communal waste dumpsites, within these residential areas in Nigerian traditional cities. However, waste dumpsites in the high income areas are usually designated by the government and are usually distant from residential areas. Also multi-habitation buildings which could lead to increase waste generation are not common in these areas.

The pattern of the rate of dumping of waste in the open spaces outside building premises is explained as 22.5 %, 15.8 %, 10.2 % and 23.4 % of residents in the low income, middle income, high income and post crisis residential areas respectively. Dumping of wastes in pits on open space around building premises in the long run constitute temporary/permanent filth nuisances in the residential areas. Other waste disposal methods were burning and composting as it accounted for 18.5 % and 6.6 % of the methods respectively.

3.3. Residents' Perception of Institutional Polices on Environmental Sanitation

Presented in this section are respondents' perceptions of existing institutional policies and environmental sanitation. It is premised on respondents' agreement and satisfaction with the mandated monthly environmental sanitation exercise

Contained in Table 5 are the residents' views of what the environmental sanitation exercise entails. This is measured in the study by calculating Residents Agreement Indices (RAI). The RAI across the four residential zones were measured by mean and mean deviation.

In the low income area, residents' in these areas predominantly agreed that environmental sanitation exercise restricts peoples movement (4.37), waste time (3.97) and that the exercise has no influence on individual environmental sanitation behavior. In the middle income area, there was change of opinion as respondents agreed that the exercise is capable of achieving a healthy environment (4.69), enhancing citizen involvement in the environmental sanitation (4.13) and that the exercise contributes to hygiene behavior (3.70). Findings from the high income area revealed that respondents agreed that the exercise contributes to respondents' hygiene behavior (3.64), restricts people's movement (3.58) and encourages public participation (3.50). Investigation from the post crisis residential area revealed that respondents agreed that environmental sanitation exercise helps to achieve a healthy environment (4.11), that the exercise enhances citizen involvement in the exercise (4.05) and that it contributes to hygiene behavior (3.45).

Also, in the low income area, respondents disagreed with the view that environmental sanitation exercise has nothing to do with community groups as it ranked the lowest (1.91). In the middle income and high income area residents disagreed with the opinion that environmental sanitation waste time. This received the lowest ratings in the two residential areas with computed means of 1.93 and 3.00 respectively thus forming an accord of opinion in the two residential areas while in the post crisis area, respondents disagreed that the exercise is only observed in the areas of the poor as it rated 2.30. From the foregoing analysis, it can be deduced that the residents in the

four residential areas of Ile- Ife have different views about the ideals of the monthly environmental sanitation exercise.

Table 5. Resident Agreement Index (RAI) with of Environmental Sanitation Exercise

Attribute	Residential Area							
	LI = 72		MI = 128		HI = 30		PC = 40	
	RAI (RAI-$\overline{RAI}$)	Rank	RAI (RAI-$\overline{RAI}$)	Rank	RAI (RAI-$\overline{RAI}$)	Rank	RAI (RAI-$\overline{RAI}$)	Rank
Enhances Citizens Involvement	3.86 (0.77)	3	4.13 (1.11)	2	3.36 (0.06)	5	4.05 (0.90)	2
Achieving a Healthy Environment	2.20 (-0.89)	8	4.69 (1.67)	1	3.43 (0.13)	4	4.11 (0.96)	1
Restriction of People's Movement	4.37 (1.28)	1	3.24 (0.22)	5	3.58 (0.28)	2	3.05 (-0.10)	6
Contribute to Hygiene Behaviour	2.79 (-0.30)	6	3.70 (0.68)	3	3.64 (0.34)	1	3.45 (0.30)	3
A Waste of Time	3.97 (0.88)	2	1.93 (-1.09)	10	3.00 (-0.30)	9	2.63 (-0.52)	8
Encourages Public Participation	3.59 (0.50)	5	3.45 (0.40)	4	3.50 (0.20)	3	3.40 (0.25)	4
No Influence on Individual Sanitation Behaviour	3.96 (0.87)	3	2.48 (-0.54)	6	3.08 (-0.22)	7	3.26 (0.11)	5
Time to Play	2.29 (-0.80)	7	2.29 (-0.73)	8	3.07 (-0.23)	8	2.75 (-0.40)	7
Only observed in the Areas of the Poor	2.00 (-1.09)	9	2.35 (-0.67)	7	3.29 (-0.01)	6	2.30 (-0.85)	10
Influence Community Groups	1.91 (-1.18)	10	2.00 (-1.02)	9	3.07 (-0.23)	8	2.53 (-0.62)	9
$\overline{RAI}$	**3.09**		**3.02**		**3.30**		**3.15**	

Presented in Table 6 are the findings on residents' satisfactions with the various roles of the government in the monthly environmental sanitation exercise. The computed average Resident Satisfaction Index (RSI) in the low income, middle income, high income and post crisis residential areas were respectively 3.20, 3.25, 3.09 and 2.41. Findings revealed that residents in the low income areas were satisfied with enforcement of rules and regulation, attitude of law enforcement agency to residents and cleaning of water drains as they respectively ranked highest 3.60, 3.38 and 3.37 respectively in the zone. In the middle income area, residents were satisfied with prompt collection of waste, cleaning of water drains and enforcement of environmental sanitation rules and regulation as they ranked 3.63, 3.52 and 3.46 respectively. In the high income area, residents indicated their satisfaction with attitude of sanitation officers to their work, politeness of sanitation

officers to residents and the monitoring of environmental sanitation exercise as they ranked 3.43, 3.38 and 3.23 respectively. However, residents' opinion differed in the post crisis residential area as politeness of sanitation officers to residents, prompt collection of wastes and attitude of sanitation officers to works were the most satisfactory role of the government in this area as they ranked 2.76, 2.65 and 2.61 respectively.

Residents of the low income residential area were dissatisfied with the prompt trial of offenders and maintenance of dumpsites as they ranked lowest with mean values of 3.06 and 2.60 respectively. In the middle income area, the residents were unsatisfied with the management of dumpsites and the level of involvement of relevant stakeholders during the conduct of the exercise, as they ranked lowest with mean values of 3.02 and 3.00 respectively. In the high income area, the management of dumpsites and the number of waste collection vehicles provided as they were least ranked with mean values 2.93 in each case. However, residents in the post crisis area were discontented with maintenance of dumpsites and prompt trial of sanitation offenders with mean values of 2.20 and 2.10 respectively. It can be deduced from the foregoing that environmental sanitation exercise and legislation is popular in the city.

Further findings revealed that residents in the post crisis residential area were generally least satisfied with the roles of the government in the conduct of the monthly environmental sanitation exercise. Generally, residents across the city were not satisfied with the management of the dumpsites by the local government agencies within their residential area. Nevertheless, the prompt trial of may scare respondents from participating in the exercise thus defeating its purpose. In the middle income and high income areas were not satisfied with the attitude of law enforcement agency to residents. Also, government waste collection facilities and services does not adequately cover the high income areas. This could prompt environmentally defiant behavior in residents.

Table 6. Residents Satisfaction Indices on Government Roles in Various Aspects of Environmental Sanitation Exercise

Attribute	Residential Area							
	LI = 72		MI = 128		HI = 30		PC = 40	
	RSI (RSI-$\overline{RSI}$)	Rank	RSI (RSI-$\overline{RSI}$)	Rank	RSI (RSI-$\overline{RSI}$)	Rank	RSI (RSI-$\overline{RSI}$)	Rank
Enforcement of rules and regulation	3.60 (0.40)	1	3.46 (0.21)	3	3.00 (-0.09)	7	2.50 (0.09)	4
Prompt trial of offenders	2.60 (-0.06)	11	3.13 (-0.12)	8	3.14 (0.05)	5	2.20 (-0.21)	11
Prompt collection of waste	3.17 (-0.03)	8	3.63 (0.38)	1	3.00 (-0.09)	7	2.65 (0.24)	2
Cleaning of water drains	3.37 (0.17)	3	3.52 (0.27)	2	3.14 (0.05)	5	2.35 (-0.06)	8
Politeness of sanitation officers to residents	3.26 (0.06)	4	3.42 (0.17)	4	3.38 (0.29)	2	2.76 (0.35)	1
Attitude of sanitation officers to their work	3.23 (0.03)	5	3.10 (-0.15)	9	3.43 (0.34)	1	2.61 (0.20)	3
Number of workers provided	3.21 (0.01)	6	3.25 (0.00)	7	3.08 (-0.01)	6	2.30 (-0.11)	10
Monitoring of environmental	3.26 (0.06)	4	3.40 (0.15)	5	3.23 (0.14)	3	2.40 (-0.01)	7

sanitation exercise								
Number of waste collection vehicles provided	3.09 (-0.11)	9	3.27 (0.02)	6	2.93 (-0.16)	8	2.45 (0.04)	5
Involving the relevant stakeholders	3.20 (0.00)	7	3.02 (-0.07)	11	3.15 (0.06)	4	2.33 (-0.08)	9
Maintenance of dump site	3.06 (-0.14)	10	3.00 (-0.25)	12	2.93 (-0.16)	8	2.10 (-0.31)	12
Provision of waste disposal facilities	3.20 (0.00)	7	3.10 (-0.15)	9	3.00 (-0.09)	7	2.30 (-0.11)	10
Attitude of law enforcement agency to residents	3.38 (0.18)	2	3.05 (-0.20)	10	2.80 (-0.29)	9	2.44 (0.03)	6

4. Conclusion and Recommendation

The study examined the influence of local governance on residents' environmental sanitation behavior across the different residential areas of Ile Ife. Findings revealed variation exist in the level of access to adequate environmental facilities/services such as water supply, toilets, drains and solid waste disposal services across the residential areas. The study established that low level of access to these facilities/services is predominant in the low income, middle income and post crisis residential areas. The findings from the study revealed that relationship exist between residents' environmental sanitation behavior and their place of residence. Also, the availability of environmental sanitation facilities/ services is reflections of residents' socio-economic characteristics. These findings are consistent with the results of some earlier studies (Daramola, Olowoporoku, 2016; Daramola, 2015; Hunter et al., 2004) which have indicated that there is a significant statistical association between socio economic characteristics, place of residence, availability of facilities/services and residents' environmental behavior.

On the link between local governance policies and environmental sanitation behavior respondents' perception of the existing legislations were examined. The study established a variation in the level of agreement of the functions of the exercise. This disparity in opinion of residents can be attributed to varying socioeconomic status across the residential areas. On the satisfaction with government roles on the exercise, the study established that in the low income area, residents were dissatisfied with the prompt trial of offenders while across the remaining residential areas, residents were not satisfied with the maintenance of dumpsites. In general, the maintenance of dumpsites by the government agencies was not satisfactory to the residents of the city.

On the background that environmental sanitation is a civic responsibility, the study recommends the following

- The local governing authorities, non-governmental organizations (NGOs), community based organization (CBOs) and landlords should ensure adequate provision of environmental sanitation facilities/services to households for effective observance of sanitation behavior irrespective of socio-economic status and place of residence. Also, an effective cost recovery framework should be devised in order to ensure viability of the facilities/services.
- The government should promulgate laws and enforce existing environmental sanitation regulations in order to sanction house owners without basic environmental sanitation facilities. There should be composition of a team of government official to inspect buildings and ensure house owners adhere to sanitation ethics
- The relevant stakeholders should ensure proper management of dumpsite across the city. This can be achieved by formulating an effective cost recovery framework in order to ensure viability of their maintenance.

• All relevant stakeholders should embark on campaign to raise public awareness on the need for proper environmental sanitation behavior. This can be achieved through recruitment of trained young men and women for constant awareness exercises, use of bill boards, constant media announcements, seminar, workshops etc.

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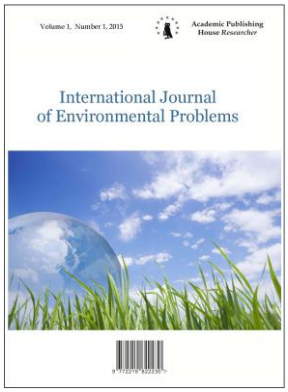
Published in the Slovak Republic
International Journal of Environmental Problems
Has been issued since 2015.
E-ISSN: 2413-7561
2018, 4(1): 19-23

DOI: 10.13187/ijep.2018.1.19
www.ejournal33.com



Biochemical and Antimicrobial Activity of *Prosopisafricana*

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Abstract

Biochemical properties and antimicrobial activities of *Prosopisaricana* were examined in the study. Acetone, ethanol and hexane were the solvents used to extract the phytochemicals. Standard methods were utilised in the extraction of these plant chemicals throughout. Alkaloids, tannins, terpinoids, flavanoids, glycosides, steroids and phenols were detected in varying concentrations depending on the solvent used. Zones of inhibition were determined for the three organisms tested for *S. aureus*, *S. typhi* and *E. coli* with the ethanolic extract showing the highest zone of inhibition.

Keywords: *Prosopisafricana*, Biochemical, Inhibition, Antimicrobial, Metbolites.

1. Introduction

Many herbs are moving from alternatives to main stream use with a good number of the people seeking remedies and health approaches free from the side effects caused by synthetic chemicals (Adebayo, Oladele, 2012). Recently considerable attention has been paid to utilizing eco-friendly and bio friendly plant based products for the prevention and cure of different human diseases (Borokini, 2014). With the present surge of interest in phyto-therapeutics the availability of genuine plant material is becoming imperative, therefore, accurate morphological and anatomical standard of drug plant is very much essential (Adebayo, Oladele, 2012). The microscopic and macroscopic description of a medicinal plant is the first step toward establishing its identity and purity and should be carried out before any test is undertaken. Prosopi**s**are pod bearing trees or shrubs consisting of 44 reported species which are found in arid and semi-arid regions of the world (Barku et al., 2013). *Prosopisafricana* is the only tropical African prosopis species, occurring from Senegal to Ethiopia in the zone between the Sahel and savannah forests. The fact that *Prosopisafricana* has found tremendous use on the local and international scene, it is a good candidate plant for research into its uses, composition and standardization as an attempt to contribute to the health and well-being of humanity (Hamad et al., 2015). There is a long and venerable history of the use of traditional medicine, Agboola stated that Prosopisafricana is used as plant to improve dental health and promote oral hygiene (Omwirhiren et al., 2016). It is used as chewing stick by Yoruba in south western Nigeria and in vast parts of the world where tooth brushing is done with *Prosopisafricana* (Rajeshwar et al., 2016). *Prosopisafricana* is a perennial leguminous tree, the practice of tooth cleaning by chewing subfamily mimosidae and is mostly found growing, it's in sticks has been known since antiquity (Qadir et al., 2015). It is also widely used in the savannah regions of western Africa in many areas,

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its chewing stick persists today among many African and fermented seed are used as food condiments (Gumgumjee, Hajar, 2012). In Southern Asian communities, America and southern United States as well as isolated areas young leaves and shoots are fodder that is highly sought (Iqbal et al., 2015). In many cultures, there is this popular belief that every plant grown on the surface of the earth has medicinal properties or use. However it is impossible to provide a complete list of these uses to which must of these plants may be put (Qadir et al., 2015). Despite all the progress in synthesising chemistry and biochemistry plants are still indispensable sources of medicine in both preventive and curative ways. Hundreds of species of plants are recognized as having medicinal value, and many of them are commonly used to treat or prevent ailments and diseases. The medicinal properties of the plants are often associated barks, leaves flowers, fruits, roots or seeds (Iqbal et al., 2015). The plant belongs to the family mimosaceae, *Prosopisafricana* is a savannah tree of about 12-18m highland up to 1m in width, which may be readily distinguished by its dark rough bark, pale drooping foliage with small pointed leaf lets and sausage-shaped fruits. The flowers which usually appear around December-may are yellowish, fragrant and densely crowded in fat species about 4-6 cm long excluding the shoot stalk. *Prosopisafricana* local names kirya(hausa); Kohi(kulfulde); ayan(yaruba); sanchi(nufe); ubwa(igbo); kpaye(tiv).

2. Materials and Methods

Sample Collection and Preparation

The sample was collected in the area of yunbungavillage Darazo Local Government Area of Bauchi State, Nigeria. The sample was taken to the Biology laboratory of theDepartment of Science Laboratory Technology, School of Science and Technology, AbubakarTatari Ali Polytechnic, Bauchi, Nigeria for authentication by the botanist. The sample was washed with the distilled water and shade dried for about a week the sample was grinded using motor and pistil to obtain it coarse particles then a sieve of diameter 0.02mm was used to sieve the coarse particles so that the fine particle are obtained.

Extraction

50 g of the prepared sample was taking and placed into the clean and dried beaker, 200 ml hexane was added and covered with aluminium foil with polythene bark tied with masking tape, this is to prevent the escape of hexane from the sample. Then the mixture was shaken up and allowed to extract the components for 24h then the hexane extract was separated using filter paper, the filtrate was placed in a clean and dried container covered and kept in a suitable place. The residue was allowed to shade dry and reweighed to get the percentage recovery. The reweighed residue was placed in a fresh and cleaned beaker then 150 ml of acetone was added and allowed for 24h, then the acetone extract was filtered and kept. Then the residue was reweighed and shade dried to obtain the second percentage recovery. The reweighed residue was also placed in a cleaned beaker then 150 ml ethanol was added and allowed for 24 h then the ethanol extract was filtered and the filtrate was shade dried to obtain the third percentage recovery. The three (3) extracts were kept in a suitable place in the laboratory for phytochemical screening and antimicrobial activity.

Phytochemical Screening:

Test for Flavonoids, tannins, terpenoids, cardiac glycosides, steroids and phenols were done using standard methods.

Bioassay

The anti-bacterial susceptibility was determined by using Agar well diffusion method. The entire nutrient agar surface was scaled with the inoculums suspension and allowed to dry for 5 min. The well of 6 mm was created and 7ml of each extract was poured into it, the plates were kept in the refrigerator for about 15 min to allow for proper diffusion. The extract was then incubated at 37 ˚C for 24 h, at the end zone of inhibition was measured in mm. This exercise was done in triplicates to ensure reliability.

Extract Preparation for Bio-Assay

2 ml portion of the each three (3) extracts was kept in a clean and sterile container and was been covered to prevent contamination with microbes and impurities until the time for used for Bioassay.

Preparation of the Media

28 g of nutrient agar powder was suspended in 1 L of distilled water, the mixture was heated in order the suspensions to dissolve completely. The dissolved solution was then covered with

Aluminium foil and placed in the autoclave for sterilization. The solution was then sterilized at 121 ˚C for 15 min, pH7. Agar was poured in 3 sterile petri-dishes and it was allowed to cool in a refrigerator and ready for inoculation.

Bacterial Culture

The antibacterial activity was tested against three (3) clinical isolates; it includes three (3) gram negative bacteria. *Staphylococcusaureous* (*S. aureous*), *Plasmodium species* (*P. species*) and *Salmonella typhi* (*S. typhi*), the isolates were taken from AbubakarTafawaBalewa University Teaching Hospital Laboratories and were identified microscopically and on biochemical basis. Identified isolates were stored in 20 % glycerol at 20 ˚C and sub-cultured on the nutrient agar at 37 ˚C for 24h before use.

Inoculation and Application of Extracts.

Bacterial strains were inoculated into 15 ml of sterile nutrient broth and incubated at 37 ˚C for 24h. After 24h the plate was removed from the oven and 3 different extracts were introduced to the plate and left for 24h.

Minimum Inhibitory Concentration (mic).

This lowest drug concentration prevents visible microorganism growth after overnight incubation. A plate of solid growth media, after a pure culture is isolated was examined and minimum inhibitory concentration was determined.

3. Results

Table 1. Microscopic examination of *Prosopisafricana*stems bark

Test parameters	Observation
Colour	Dark gray with ash coloured patches, reddish brown
Internal colour	Reddish brown
Texture	Hard
Shape	Curved
Ordour	Weak, musty and characteristic
Taste	Characteristic
Fracture	Outer bark is short and rough in the inner bark
Thickness	4 – 7 mm
Internal surface	Longitudinally striated
Powder colour	Reddish brown

Table 2. Phytochemical screening of Prosopisafricana stem bark

Extracted	Secondary Metabolite							
	Alka-loids	Flavo-noids	Tannins	Sapo-nins	Terpe-noids	Glyc-side	Steroid	Phenoliccompound
Hex E	+	-	+ +	-	+ + +	+ +	+ +	+
A C E	-	-	+ +	-	+ +	+	+	+
E E	+ +	-	+ + +	+ +	+ +	+ +	+ +	+ +

Hex E = Hexane Extracted
A C E = Acetone Extracted
E E = Ethanol Extracted

Table 3. The zone of inhibition (mm) of the antibacterial activity of hexane extracted bark of *Prosopisafricana*

TEST	Conc, mg/ml	Hexane
Staphylococcus aureus	10^{-4}	8.00
	10^{-4}	6.00
Escherechia coli	10^{-4}	3.00
	10^{-4}	3.00
Salminellatyphi	10^{-4}	12.00
	10^{-4}	10.00

Table 4. The zone of inhibition (mm) of the antibacterial activity of acetone extracted bark of *Prosopisafrican*a

Test	Conc, mg/ml	Acetone
Staphylococcus aureus	10^{-4}	10.00
	10^{-4}	9.00
Escherechia coli	10^{-4}	11.00
	10^{-4}	11.00
Selmonellatyphi	10^{-4}	14.00
	10^{-4}	12.00

Table 5. The zone of inhibition (mm) of the antibacterial activity of ethanol extracted bark of Prosopisafricana

Test	Conc, mg/ml	Ethanol
Staphylococcus aureus	10^{-4}	15.00
	10^{-4}	13.00
Escherechia coli	10^{-4}	16.00
	10^{-4}	15.00
Salmonellatyphi	10^{-4}	18.00
	10^{-4}	17.00

4. Conclusion

Accuracy morphological and anatomical standardization of medicinal plants is very essential. In this study, physico-chemical evaluation of the stem bark of *Prosopisafricana* were under taken. The results of this study can be used as diagnostic tool for the standardization of *Prosopisafricana* and will be help full in the characterization of the fruit drug. According to the world health organization. The macroscopic and microscopic description of a medicinal plant is the first step toward establishing its identity and purity and should be carried out before any test and undertaking.

The results obtained in (Table 2) shows that the ethanol extract also played more significance role in the bacteriocidal and/or bacteriostatic activity than the acetone and hexane extract and this is because ethanol usually extracts about 90 % of the components. Tables 3, 4 and 5 depict the zones of inhibition of the three solvents showing varying levels of inhibition. The bactericidal and/or bacteriostatic activity for the stem bark of *Prosopisafricana*is established in the study and this data could be used as a tool for the standardization of this medicinal plant and will be helpful in the characterization of the crude drug. This parameter could be useful in properties of its monograph Africa pharmacopeia. Any crude drug which is similar to the *Prosopisafricana* but whose characters significantly differ from the accepted standard will then be rejected as contaminated adulterated or done right fake.

The result of the research provides parameters for the proper identification of the stem bark of *Prosopis Africana*. The crude extract shows significant antibacterial activity. The results of the Phytochemical analysis indicates the presence of active components on the stem bark of *Prosopisafricana.*

5. Recommendations

It is recommended that

- Further toxicity studies using different microorganism;
- Sub-acute test is planned in other to determine the long-term effect of the extract;
- Isolation of other pharmacological active compound is carried out from the plant;
- Further studies to ascertain the actual bactericidal and/or bacteriostatic mechanism of the action of the plant extraction and fraction;
- Further studies on the plant crude extract antiviral antifungal and anti-inflammatory activity.

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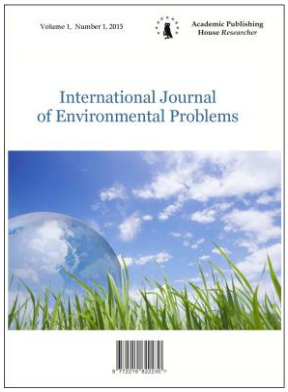
Published in the Slovak Republic
International Journal of Environmental Problems
Has been issued since 2015.
E-ISSN: 2413-7561
2018, 4(1): 24-28

DOI: 10.13187/ijep.2018.1.24
www.ejournal33.com



Bioactivity of Crude Extracts of Stem Bark of *Vetillariaparadoxa*

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Abstract

This research aimed to study the bioactivity of crude extracts of stem bark of *Vetillariaparadoxa* "Shea-nut tree" as used in traditional medicine for treatment of stomach ache and control of diarrhea, using hexane, acetone and ethanol as the extraction solvents. Phytochemical screening of stem bark of extracts of *Vitellariaparadoxa* revealed the presence of alkaloids, steroids, phenolic compounds, flavonoids, saponins, tannins, and cardiac glycosides. Ethanol, acetone, and hexane extracts inhibited the growth of pathogenic *Escherichia coli, salmonella typhi,* and *staphilycoccusaureus* with varying degrees of activity with the ethanol extract demonstrating the highest activity against all the tested bacterial organisms.

Keywords: phytochemicals, antimicrobial, secondary metabolites, bioactivity, inhibition.

1. Introduction

Vitellariaparadoxa (Sapotaceae) is a plant that is locally abundant in Nigeria in the derived Savannah zones, particularly near towns and villages. It is rich in oil and replaces the oil palm as a source of edible oil in Northern Nigeria (Njoku, 2011; Borokini, 2014). The plant species *(Vitellaria)* is easily distinguished by its very long leaf stalks, more widely spaced nerves and abundant white latex when slashed and in the petiole. Shea-butter is the fat extracted from the kernel of this plant. It is becoming increasingly popular as a component of cosmetic formulation in addition to its long standing use as a cocoa butter substitute in the chocolate industry (Omwirhiren et al., 2016).

Shea butter contains high level of UV-absorbing triterpenes esters which include cinnamic acid, tocopherols (vitamin A), and phytosterols (Leke, 2015). Research have confirmed that she a butter contains a high level of unsaponifiables (5 – 15 %) which include: campesterol, stigmasterol, sitosterol, spinosterol and triterpenes such as cinnamic acid ester and amyrin, parkeol, butyrospermol. lupeoland and a hydrocarbon called karitene. Analysis of the kernel reveals the presence of phenolic compounds such asgallic acid, catechin, epicatechin, epicateachingallate, gallocatechin, epigallocatechin, epigallocatehingallate, as well as quercetin and trans-cinnamic acid (Borokini, 2014; Leke, 2015).

V. paradoxa (formally *Butryspermumparadoxum*), *(Sa-potaceae)* is an immensely popular tree with many applications in folkloric medicine. It is commonly called Shea butter (English), Kareje (Fulfulde, Nigeria), Kadanya (Hausa, Nigeria) Koita (Gbagi, Nigeria), mameng (Cham, Nigeria). The tree grows naturally in the wild of the dry savanna belt of West Africa, from Senegal

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in the West to Sudan in the East and onto the foothills of the Ethiopian mountains. V. paradoxais considered a sacred tree by many communities and ethnic groups and plays important roles in religious and cultural ceremonies. It is also believed to have some spiritual protective powers (Eleazu et al., 2012; Rajeshwar et al., 2016). Different parts of the plant including leaves, roots, seeds, fruit and stem bark have been used in the treatment of enteric infections such as diarrhea, dysentery, helminthes and other gastrointestinal tract infections, skin diseases and wound infections (Rajeshwar et al., 2016; Eltayeb et al., 2018). The bark is used to suppress cough and also to treat leprosy (Patil, Gaikwad, 2011; Eltayeb et al., 2016).

The research aims to assess the phytochemicals and antibacterial activities of the plant using three solvents and to compare same.

2. Materials and Methods

Preparation of reagents

Mayer's Reagent

Dissolve 1.36 g of$HgCl_2$ and 5 g of KI in distilled water separately, mix both solutions and make it up to 100 ml with distilled water.

Wagner's test (Iodo-potassium iodide)

Dissolve 2 g of iodine and 6 g of KI in 100 mL of distilled water.

Dragendorff's reagent

Stock solution-Bismuth carbonate (5.2 g) and sodium iodide (4 g) were boiled for a few min with 50 ml glacial acetic acid. After 12h, the precipitated sodium acetate crystals were filtered off using a sintered glass funnel. To the clear, reddish brown filtrate (40 ml) 160 ml ethyl acetate and 1 ml distilled water was added and stored in amber–colored bottle.

Working Solution-To the 910 ml of stock solution, 20 ml of acetic acid was added and made up to 100 ml with distilled water.

Sample collection and preparation

Fresh stem bark of *Vitellariaparadoxa* (2.5 Kg) were collected from Janligo village of Yana, Shira L.G.A in Bauchi State, Nigeria. The plant was identified by a local medical practitioner Mr.KabiruAdamu (Dan-Chakwati) from Shira L.G.A Bauchi State and authenticated by a Botanist. The Sample was dried under (shade) room temperature for over 21 days and grinded using mortar and pestle, sieved in order to obtain a pure powdery form. The powdered material was stored in polythene bags at room temperature until needed.

Extraction

50 g of the dried and pulverized fiber-free stem bark of *Vitellariaparadoxa* was extracted exhaustively via maceration with 3·300cm^3 of hexane (HE), acetone(ACE) and ethanol(EE), each at room temperature for 24 h. Excess solvent was removed to give crude extracts of HE, ACE, and EE, from hexane, acetone and ethanol respectively.

Phytochemical Screening

Crude hexane extract (HE) was screened for phytochemicals using standard procedures (Harborne, 1973; Sofowora, 1993).

Phytochemicals screening methods

Detection for Alkaloids, flavonoids, tannins, phenolic compounds, tannins, saponins, terpenoids, sterols and glycosides were done using standard procedures.

Thin layer chromatography of *V. paradoxa Crude* Extract

Three chromatography papers of the same length were used. Three different mixtures of solvent system varying polarities were also used to enhance ideal separation in different chromatography tanks: hexane/chloroform (1:1), chloroform, chloroform/ethyl acetate (1:1) and ethyl acetate/ethanol (1:1).

The solvent front and the separation were later calculated and the relation factor was obtained using the formula.

$R_f = m^1/m$

Were R_f – relation factor. m^1 – separations (cm). m – solvent front (cm).

The disc diffusion method

The paper disc diffusion assay technique (Akpuaka et al., 2003) was done.

Preparation of the medium

The nutrient agar medium was prepared by dissolving 7.0 g of agar in 250 ml of distilled water in a conical flask and heated to dissolve. The solution was sterilized in an autoclave at 121°C for 15 min, cooled and poured into Petri dishes to set.

Preparation of culture media and inoculation

Culture of *Staphylococcus aureus*, *Salmonella typhi*, and *Escherichia coli*were obtained from the microbiology laboratory of Abubakar Tafawa Balewa University, Bauchi, Nigeria. Pure isolates were obtained by sub-culturing unto fresh nutrient agar plates. The bacteria were separately used to inoculate the Petri dishes. The plates were incubated at 37 ± 2°C for 24 h.

Assay of extracts

Two different concentrations of each extract were obtained by suspending 250 mg of each extract in 6.0 ml of absolute ethanol and the volume was made up to 10.0 ml using sterile distilled water to give a concentration of 25 mg/ml. These also served as stock solutions. The second concentrations were obtained by diluting 2.0 ml each of the stock solutions with 2.0 ml of sterile distilled water giving a concentration of 12.5 mg/ml. Sterile 6 mm Whatman's filter paper discs were soaked in the extracts and placed on the plates and incubated for 24 h at 37 ± 2°C. The plates were examined for clear zones of activity. The zones of inhibition were measured using a transparent plastic meter ruler

Broth diffusion method

Equal volumes (1.0 ml) each of the extract solutions were mixed with same volume (1.0 ml) of an overnight broth culture of *S. aureus* and *E. coli* to give solutions of final concentrations of 12.5 and 6.25 mg/ml, respectively, in a test tube. These were then incubated at 37 ± 2°C for 24 h and observed for the presence of bacterial growth using a compound microscope

Inoculation and application of extracts

Bacterial strains were inoculated in 15 ml of sterile nutrient broth an inoculated at 37°C for 24 h then the 3 different extracts 0.5ml was introduced to the plates and left for 24 h.

Minimum Inhibitory Concentration (MIC)

This is the lowest drug concentration that prevents visible microorganisms' growth after overnight incubation, a plate of solid growth media. After a pure culture is isolated was examined and minimum inhibitory concentration was determined.

3. Results

Table 1. Weight of various macerated fractions of *Vetillariaparadoxa*

Fraction	Observation	Weight (g)
V. paradoxa + Ethanol	Reddish brown	2.60
V. paradoxa + Acetone	Dark brown	3.70
V. paradoxa + N-hexane	Yellow brown	1.70

Table 2. Result of phytochemical screening

Phytocompounds	Regents	Extracts		
		ACE	HE	EE
Alkaloid	Dragendroff's Mayer's	+ +	+ +	- -
Flavonoids	1% ammonia, 2m NaOH, + HCl	++ ++	+ +	- -
Tannins	5% $FeCl_3$	+	-	+
Saponins	Olive Oil	+	+	-
Terpenoids	Salkowski	++	+	-

Glycosides	Legal's Kelarkillani	+ +	- -	+ +
Steroids	Salkowski	+	-	+
Phenols	1% gelatin solution 10% NaCl	+	+	+

+ Slightly Present; ++ Moderately Present; +++ Highly Present; – Absent

Table 3. Antibacterial activity and zone of inhibition (mm) of *V. paradoxa* disc diffusion

Extracts	Concentration, mg/ml	*E. Coli*	*S. Typhi*	*S. Aureous*
EE	25.0 12.5	6 -	8 -	10 -
ACE	25.0 12.5	7 -	7 -	2 -
HE	25.0 12.5	1 -	2 -	3 -
Streptomycin		25	NT	NT

NT – not tested/done; – no inhibition

Table 4. Various fractions from thin layer chromatography of stem bark of *V. paradoxa*

Extracts	Solvent System	Retention Faction (R.F)
HE	hexane/chloroform chloroform/ethyl acetate ethyl acetate/ethanol	0.6 0.3 0.5
ACE	hexane/chloroform chloroform/ethyl acetate ethyl acetate/ethanol	0.7 0.8 0.8
EE	hexane/chloroform chloroform/ethyl acetate ethyl acetate/ethanol	0.5 0.4 0.3

4. Conclusion

Phytochemical screening of hexane, acetone, and ethanol, extracts revealed the presence of flavonoids, tannins, terpenoids, saponins, sterols, alkaloids and cardiac glycosides by positive reaction with the respective test reagents. Phytochemical screening showed that maximum presence of secondary metabolites was in acetone extract than in the hexane, and ethanol, where almost all the phytocompounds appeared in the acetone extract (Table 1), whereas tannins, glycosides, and steroids where absent in hexane extract; alkaloids, flavonoids and saponins were absent in the ethanol extract. Antimicrobial susceptibility of the extracts (50 mg/ml) against the test organisms showed that in all the three solvents used, the ethanol extracts demonstrated the highest activity, followed by acetone, whereas hexane demonstrated the least activity on the tested bacteria as seen in (Table 3).

Preliminary phytochemical investigations of stem bark of *Vitellariaparadoxa* revealed the presence of some/many secondary metabolites. These secondary metabolites are linked to microbial activity of the plant material and the extracts of this plant has antimicrobial effects on the tested enteric bacteria, hence serve as potential therapeutic agents against diarrhea and other microbial afflictions.

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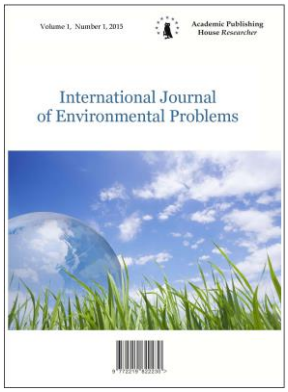
Published in the Slovak Republic
International Journal of Environmental Problems
Has been issued since 2015.
E-ISSN: 2413-7561
2018, 4(1): 29-36

DOI: 10.13187/ijep.2018.1.29
www.ejournal33.com



Appraisal of Waste Minimization and Management in the Context of Malaysian Construction Industry

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Abstract

These days, the building and construction industry is a main provider to the source of national economy in most countries. Though, incorrect construction waste management lead to numerous difficulties such as prohibited dumping along the roadsides, demolition waste and disposal of construction at landfills as Malaysia is facing severe deficiency of landfill space and lately the matter has developed more serious through the country, which these have caused major government sources and environmental problem. Sustainable waste management aids construction key players to diminish and making better use of material on their construction project. The waste minimization strategy is not only implemented during the construction stage, but it record and estimates the use materials through whole project delivery process. This paper will discuss and elaborate on waste minimization and management in the context of Malaysian construction sector. Waste minimization plan is necessary to reduce present and future risks to human health and the environment which presents guidelines that can be used by professional personnel and organizations to decrease the amount and perniciousness of wastes generated.

Keywords: waste management, waste minimization, construction industry, project delivery.

1. Introduction

It should be pointed out that the construction industry is a major contributor to the source of national economy in most countries all over the world. However, inappropriate construction waste management lead to various problems such as illegal dumping along the roadsides, demolition waste and disposal of construction at landfills that Malaysia is facing serious shortage of landfill space and recently the issue has become more serious throughout the country, which these have caused major government sources and environmental issue (CIDB, 2015). Waste minimization plan is an effective and efficient method to assists clients, developers, designers, practitioners, contractors, sub-contractors and competent authorities achieve zero waste on construction projects. The collaboration of waste minimization and management practitioners involved with appropriate skill or method used that it is necessary required to achieve the sustainable waste management (Tey et al., 2013).

Waste minimization is necessary implemented by all developed countries. During construction and remodeling, the recoverable waste materials generated could be converted to recycled contents (Ismam, Ismail, 2014). The waste issue and problem had to be managing through various solutions. For example, the local companies can choose using technology such as

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incinerators, composting, sanitary landfill and etc. or using management method (Waste Minimization Plan) depending on their own requirements. The proposed waste minimization plan is determined through which it can function properly on the projects and the identification of the sources of construction waste is important to solve the current problem. Researchers found that eight waste sources were deemed to be sufficiently significant. These were waiting due to staff interference; insufficient equipment, and setup of equipment; waiting for instruction and inspection; rework due to design efficient; waiting due to stock problem and material supply delay (Nagapan, et al, 2012). The related information will help to carry out waste minimization and management practice successfully.

Sustainable waste management helps construction key players to reduce and making better use of material on their construction project. The waste minimization strategy is not only implemented during the construction stage, but it record and estimates the use materials through whole project delivery process (Mahayuddin, Wan Zaharuddin, 2013), in order to decrease the amount of waste requiring disposal at landfill and as a consequence, fully mitigate the interrelated cost, strengthen competitive advantage and environmental benefits. The implementation of waste minimizing plan method is an opportunity to increase profit of construction company through identification of valuable waste and invaluable waste to gain profit (Augustine, 2011). Businesses can create value through the return of construction wastes back to recycling and manufacturing processes into new products.

1.1 Waste Minimization Plan

Waste minimization plan is necessary to reduce present and future risks to human health and the environment which presents guidelines that can be used by professional personnel and organizations to decrease the amount and perniciousness of wastes generated. They defined that every members of the community to be conscious of the environment and financial impacts related to the disposal of construction wastes and materials and also to help minimize the waste generated quantity.

1.2 Construction Waste

Construction waste is defined as wastes generated by the construction, refitting, and repairing of individual residences, commercial buildings, infrastructural, facility and other structures. They point out that the building material can be divided into four categories during construction process which are material used, surplus, use again and material wasted (Johari et al., 2014). However, surplus material can also be considered as construction waste because contractors always think that the selling and storage of these materials are not required due to less profit. In the construction industry, the waste is not only concentrated on the building material but also focus on several activities such as storage, time and etc. For example, the waste also can be defined as any losses produced by activities that generate direct or indirect costs but do not add any value to the product from the point of view of the client (Mallak et al., 2014). As research indicates, various activities during construction process that can produce direct or indirect cost in these activities are required human resources, need more time, more facility or equipment but do not generate interest to the product.

However, the waste can also be the investment opportunity for the construction industry through proper management. McDonald and Smithers (1998) suggest that the local contractors should reassess the value of construction waste as a new source of profit which the waste should be control and manage with appropriate ways such as recycled, reused or disposed. This is because the construction waste may turn into resource through process of add-value to the waste which it creates use-value for another project.

Management is defined as cooperate with team members or other people to complete the mission and vision of a project within organization. The “management” concept can be adopted and employed in the construction industry which explained as the necessity of construction waste management. It is necessary required to plan and monitor the process work on site with participation of construction professional whether government or private in order to minimize the waste generation and stabilization of building material used (Saadi, Ismail, 2015).

Through the above viewpoints, any substances is abandoned due to they cannot increase the quality of the product and add the value to the project which can be classified as construction waste. Poor waste management may cause the negative impact on our environment.

2. Types of construction waste

In construction industry, the construction waste can be divided into two types which are material waste and time waste

2.1 Material waste

Waste in material can be defined as any physical material that required to be shipped somewhere else from the construction site or operate within the construction site. The material waste is defined when the material is damage, broken, over ordering or not compliance the requirement and specification during the construction process, and departing from the intended specific objective of the project. The cost saving of building material transported somewhere else is deducted due to the difference in between the price of materials transferred and established on construction site, these building material is used as specified and exactly measured in the process which may indirectly increase cost or extension of time by the material wastage.

2.2 Time waste

Time of construction process measured by value adding activity due to the duration of construction projects which consists of various tasks such as redesign, reconstruct, inspection work, transportation time, waiting time. The research explained any activity that exchanges materials and information that is required by the client which it is always defined as value adding activity. When the company activity that takes cost, human resources, equipment and time but does not add value to the product, it is known as time waste or non-value adding activity. Non value adding activity can be divided into contributory activities and unproductive activities such as redesign, work carried out using the wrong equipment or the wrong procedures, correct mistakes and so on.

Contributory activities are work elements that do not directly add to product but are generally required and sometimes essential in implementing an operation. However, unproductive activities are those that are not required such as being unwanted or doing something that is unrelated to the process being carried out or that is in no way necessary to carry out the operation

3. Classification of Waste

As been mentioned by As Memon (2013), there are six types of construction waste material have been produced in 30 construction site which are concrete (12.32 %), metals (9.62 %), bricks (6.54 %), plastics (0.43 %), woods (69.10 %) and others waste. These waste materials are disposed to landfill or few of them are sent to recycling which indirectly increase the construction cost of contractors. Construction wastes on site can be divided into two categories which are direct waste and indirect waste. The indirect waste is more related to cost increased and time delay. When the building material is damaged, broken or cannot be used, it can be defined as direct/physical waste. There are focused on five primary physical waste on the sites which are concrete waste, timber waste, packaging waste, steel waste and brick waste.

In New Zealand, a standard set of categories is prepared by Waste Analysis Protocol which the process of breakdown of different material waste can be carried out easily. Recently, the government is started to focus on how to reduce the quantity of construction waste on site such as encourages the usage of Industrialized Building System (Memon, 2013). Malaysia still do not have strong enough enforcement policy, standard and guidelines to effectively deal with the classification of construction waste.

4. Construction Waste Generation

There are several factors for the generation of the physical and nan-physical waste in the construction project (Taha, 2015). They have identified that most of the causes contributed to the wastes are due to mechanical problem and human resources during the life cycle of construction activities. Many researchers made the same points of view with above. For example, In Hong Kong,

the reasons of construction waste on site can be divided into two parts which are delivery of materials and onsite management (Poon et al., 2001).

Construction site waste always created during design, operational, procurement and material handling problems to influence the effectiveness of project. Besides that, the causes of waste as design, procurement, handling of materials, operational, residual waste and others. They have observed that it occurs a lot of extravagant activities within the construction process, especially during design and procurement, due to lack of systematic of waste management plan.

Taha (2015) identify that "Design" is related error in drawing and specification, "Procurement" includes incorrect detail information and unclear procurement process, "Material handling" and "Operational" are always related to human error and lack of awareness such as incomplete record and careless attitude of workers.

Mallak et al. (2014) emphasis same opinion which different construction stages; design, procurement, materials handling, construction and demolition that contributes to the site wastes. However, project manager cannot really determined the reasons of waste due to the construction process and its activities varies according to the that projects that differ in size, amount, degree, or nature from something else of the same general class based on the client's requirement and financial capability.

5. Waste Management Hierarchy

In 1997, The European Commission's Program is proposed concept that using the options of waste management hierarchy which is the integration of sustainable and integrated waste management in order to take advantage of management's principle. The construction waste should be carefully processing through various steps rather than take discarded or cremation.

According to Taha (2015), the construction waste should be treated through six stages, which are reduce, reuse, recycle, compost, incinerate and landfill, the hierarchy is take aim to help reduce the impact on environment. So, these components are arranged from least beneficial to most beneficial action to the surrounding. Figure 1 shows the hierarchy which is introduced by Peng et.al. However, Ismam, Ismail (2014) defines an effective waste management should include avoid, reuse, recycle, waste to energy and dispose of waste. as shown in Figure 2. He believes that "avoid" should be adopted within the management plan in order to strengthen the process of waste minimization, through avoiding all unnecessary waste and the quantities should be reduced during construction project.

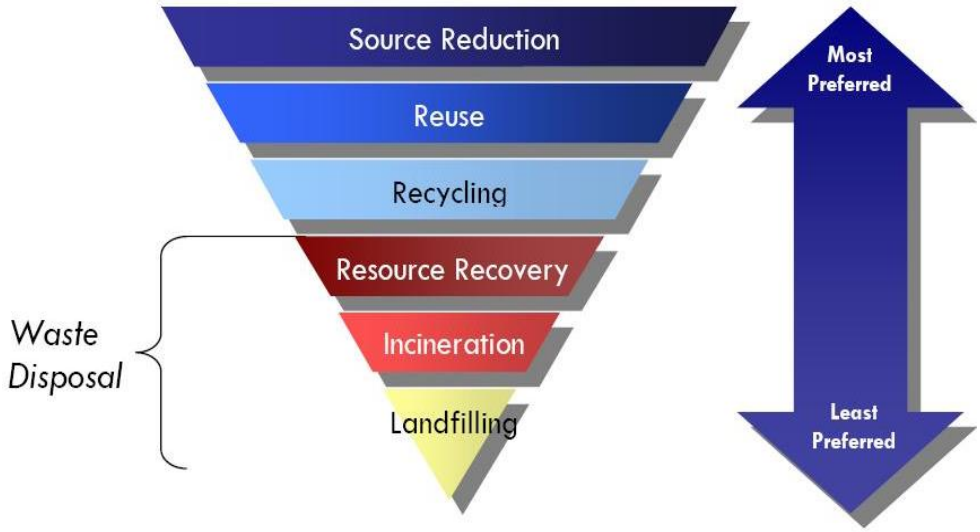

Fig. 1. Solid waste management hierarchy (Ismam, Ismail, 2014)

Fig. 2. Waste management hierarchy (Taha, 2015)

Utilization of 3R concept; reuse, recycle and reduction and these component can effectively minimized construction waste which was created onsite. It required the cooperation of all parties during design and construction stages. Thus, the components of different hierarchy may be different, but the 3R concept is necessary. However, Malaysia is still ineffective in the implementing of the construction waste management hierarchy which led to land disposal site.

6. Waste Management in Construction Industry in Malaysia

The construction industry in Malaysia continues to grow to achieve approximately 10.3 % in 2015 compared to 11.8 % in 2014. It grew 18.1 % in 2012 and 10.6 % in 2013; the number of project has achieved double-digit growth for three consecutive years. The Department of Statistics Malaysia reported the contribution of the construction industry to the GDP has increased dramatically as shown in Figure 3. From Figure 3, GDP from construction industry in Malaysia increased to 13398 MYR Million in the first quarter of 2017 from 12582 MYR Million in the fourth quarter of 2016. GDP From Construction in Malaysia averaged 9808.72 MYR Million from 2010 until 2017, reaching an all-time high of 13398 MYR Million in the first quarter of 2017 and a record low of 6464 MYR Million in the first quarter of 2010.

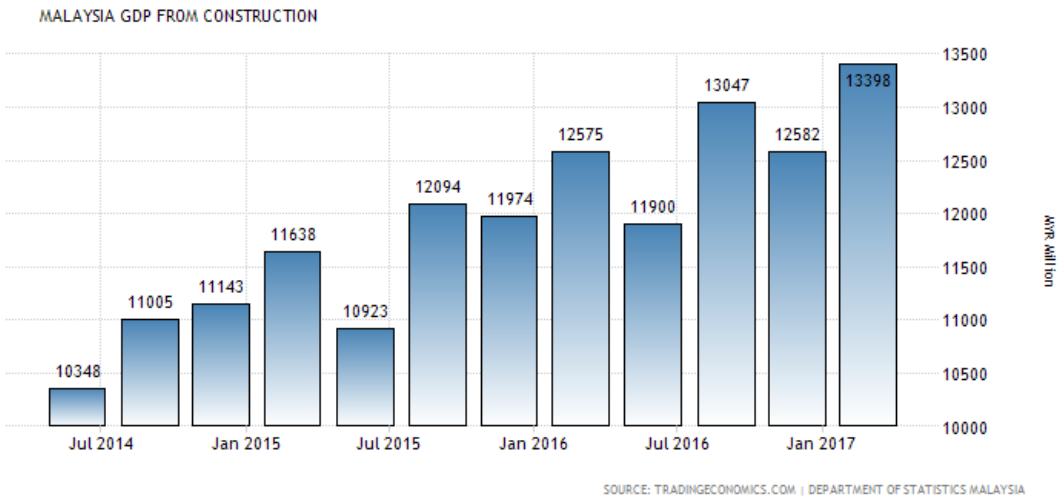

Fig. 3. The Contribution of the Construction Industry to the GDP

However, rapid development in local construction industry lead to higher generation to construction waste which end up in the landfill that it may occurs land shortage in Malaysia. The problems occurred increasingly was illegal disposal waste and illegal dumping site. So, the

government has proposed several related policy to address waste issues in order to improve the condition of environment, economic and social (Tey et al., 2013).

There are few regulations and policy for managing waste generation in Malaysia, which most of them focuses on solid waste. For example, there are four consortiums responsible for processing waste management which are Urban Solid Waste Management, Funded Public information campaigns, Action Plan for a Beautiful and Clean Malaysia and Recycling campaigns. According to the Solid Waste and Public Cleansing Management Act 2007 (Act 672), which is the federal agency; Solid Waste Management and Public Cleansing Corporation will cooperate with others department. They have the power to control and manage the solid waste and public cleansing from the Local Authorities throughout Peninsular Malaysia and the Federal Territories of Kuala Lumpur, Putrajaya and Labuan. However, Construction Industry Development Board (CIDB) is concerned on the impact of construction waste management on the environment pollution, it is responsible to execute the Pembinaan Malaysia Act 1994 (Tey et al., 2013). The Construction Industry Master Plan also introduced by CIDB to local construction industries in order to increase the awareness of contractors of environmental protection through effective waste management.

The Ministry of work is liable to govern and administer the Standard Specification for Building Works (SBW) that is applied into all construction projects. The SBW produced a standard to local contractors consist of guidelines on the materials, equipments, transport, lighting and others necessary items from the construction to the completion.

Today, the government is actively promoting the utilization of effective waste management such as the introduction of the 3R concept- reduce, reuse and recycle to sort and collect the solid waste (Tey et al. 2013). They also recommended the use of new technology, Industrialized Building Construction (IBS) to replace the traditional construction method in order to minimize the waste of construction project (Begum et al., 2006).

7. Waste Minimization Strategy

3R Program as the suitable and economical option that understands the concept of “cause and effect relationship”. It is three essential waste minimization strategies which are reduce, recycle and reuse. However, the waste reduction is the most desired plan by many countries due to its efficient and effective solution that decrease most problems related to waste generated. Based on Taha (2015), it is possible to manage 90 % of the construction and demolition waste with using recycles. Nowadays, 3R Programs always considered as the best waste minimization strategies due to its effectiveness in developing countries in the aspect of environment. For example, an advantage of 2.5 % of total construction cost is produced by reuse and recycled activity.

Just-in-time strategy is one of the reduction options that transport and manage storage levels to apart from over ordering. It required controlling the design to avoid wrong specification in order to enhance off site prefabrication quality through offer supplier agility in bring about reduction quantity of materials (Dainty, Brooke, 2004). This strategy is included how to manage the supply chain and material controlling practices, it is one of the most attractive planning methods. Also, workers training and developing waste awareness among professional can be calculated.

Global Positioning System and Geographical Information System technology can orbit the flow of building material to the construction site, and these is considered as bar code system applications. Based on the quantity of materials onsite needed, the application can measure the performance of the workers. As they indicated, the Global Positioning System and Geographical Information System technology can operate combine with bar code system to quantify the materials used and get the latest information about its delivery time. There are six waste minimization strategies which are recycle, reuse, avoid, compost, burn and dispose at landfills. They are more focuses on the three types for reduction of construction and demolition waste which are avoiding waste; re-using materials; and recycling waste. This is because avoiding waste refers to any fulfilling that avoids or decrease amount waste at source.

The re-using and recycling of waste materials, and thus, minimizing the volume of waste needed to be disposed to the landfills considered as re-using and recycling waste due to composting construction and demolition waste requires widespread use of land. Many type of construction and demolition waste are not combustible, composting waste also cause to the emission of toxic gases. In Malaysia, the land supply is too hard to found, thus it is not feasible in Malaysia, so compositing

waste would cause the emission of toxic gases and many type of construction and demolition waste are not combustible.

8. Waste Minimisation Technique

Waste minimisation techniques are plays an important role in decreasing the quantity of hazardous waste generated at the construction industry. The waste generators are encouraged to actively look into waste minimisation techniques and include these techniques as an essential component of the education and investigation procedures, as shown in Figure 4.

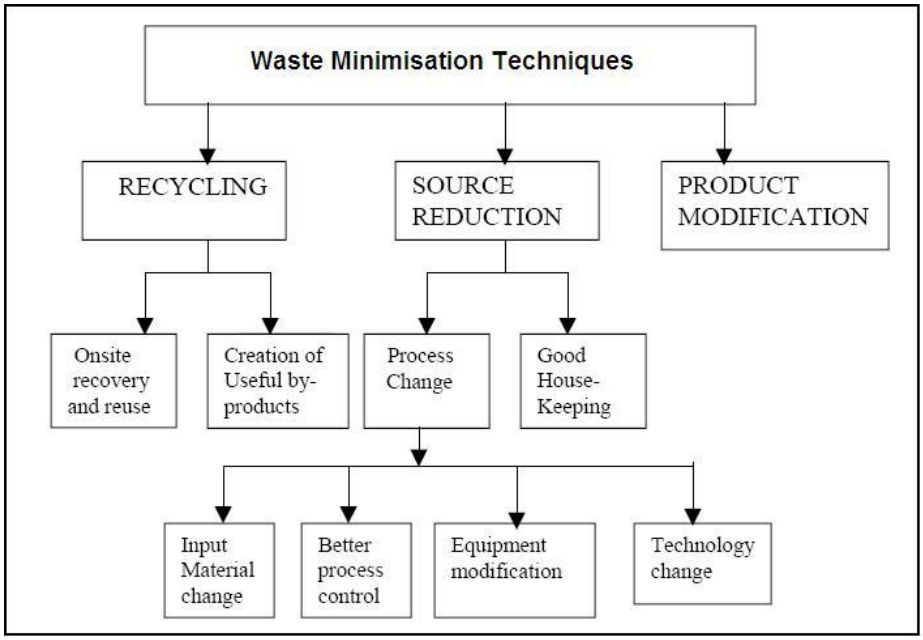

Fig. 4. Waste minimisation techniques

9. Waste Management Plan

9.1. Issues Addressed by Waste Management System

According to Ismam, Ismail (2014), there are various issues should be addressed during the development of the initial stages of the waste management plan. This is because they have many options for waste minimization or reduction such as salvaging, land filling and waste technology, so it is very important to resolve the options of alternatives for waste minimization. External issues to addressed different factors such as worker cost to gather and process the building waste material, delivery cost, tool and equipment cost and waste disposal cost, all of these must be analysed during planning the management.

9.2. Educating Labour about Waste Management System

When investigating the waste management resources, educated human resources involved in the construction process is very important. This is because the worker must be able to analysis which type of materials can be reuse or recycled, which technique of gathering are used on a project for onsite or off site. The field labours need be actively taking part for nearly any kind of waste management plan to be achieve the outcome, so the education and knowledge about construction and demolition wastes and others alternatives to manage and disposal waste is necessary. For example, the strategy plan allows the workers on site necessary to view the types and amount of building waste being thrown away

9.3. Waste Management Plan Overview

Waste management plan is obtained to protecting the social, environment and economics. Construction waste always arise various conflict due to the environmental problems which are troublesome to quantify, while problems of the economic can be measured with mathematic and several decimal places. Construction industry develop waste management plan for these aspects and

reasons, but the plan in all probability, it will be operate by economics. A closed loop system always consider within the waste management process which there are various flexible inputs. These input need analysis with accurate information due to these input that need be to periodically updated.

10. Conclusion

The construction industry has its trends and developments that required to be systematized for the purpose of environment and bonanza. Therefore, materials waste management is an essential part of construction project, which contribute a primary portion of time and cost related activities. The functions of material waste management plan need to be determined in more detail and particular. The management plan will comprehend how the system operates in construction projects due to it is increase the value to company. It will also be advantageous to relate materials management system to supply chain management and waste management systems. It is probable to state the following provision in general as major functions of materials management.

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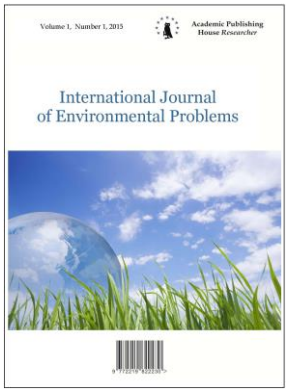
Published in the Slovak Republic
International Journal of Environmental Problems
Has been issued since 2015.
E-ISSN: 2413-7561
2018, 4(1): 37-44

DOI: 10.13187/ijep.2018.1.37
www.ejournal33.com



Analysis of Factors Responsible for Poor Urban Environmental Health among Vulnerable Residents of Ondo, Nigeria

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Abstract

Background. This study examines factors responsible for poor environmental health among vulnerable residents of Ondo, Nigeria. This was with a view to suggesting policy response capable of enhancing healthy environment in the city and others with similar background.

Materials and Methods. Systematic sampling was used to collect data from a total of 196 households having stratified the study area into the high, medium and low densities residential neighbourhoods. Both descriptive and inferential statistics were utilized.

Results. Findings showed that low government intervention was the most important factor responsible for poor urban environmental health in the study area. Results showed that environmental factors are significantly related to health situation of vulnerable people in the study area.

Conclusion. The study concluded that poverty tends to breed poor environmental and unhygienic conditions that have great impact on human health. The study therefore suggests some policy guidelines, including redevelopment (in some parts of the study area), upgrading and provision of basic infrastructural amenities and facilities.

Keywords: urban, environmental, health, vulnerable groups, city.

1. Introduction

The urban environment is a living organism; people react with it, and in turn it reacts with the people. It is the mirror with which we reflect our beings. Therefore, to look at our cities is to see into our future (UNDP, 2000). What the present and the future of our cities hold for us differ from place to place and time to time. Urban cities attest to rapid urbanization particularly in the developing countries. Available statistics evidenced that 43.1 % of the population was urban in 1991. It is forecast to be 63.0 % in 2030. The urban growth rate is 4.5 % while the rural rate is 0.9 %. Already some 50.0 % of the world's population lives in cities, within 25 years it will be 75.0 %. Africa, currently the least urbanized continent, will have a majority of its population living in cities within 20 years. It is clear that the future of the world lies in cities. This is where the battle for sustainable development will be won or lost (WHO, 2010). Urbanization and its sustainable management are not without externalities (World Bank and World Resources Institute, 2015).

WHO (1989), conversely, an unhealthy population produces less and may be forced into practices that which will damage the environment. Inadequate or lack of access to regular supply of food and uncontaminated water, indiscriminate sewage and refuse disposal, laissez-faire attitude of

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the people and lack of government funding bring about unhygienic environment that culminate in ill health (UN-Habitat, 2006). Furthermore, plants and animals of the natural ecosystem sometimes constitute health hazards that threaten the life and well-being of man in the environment. For instance, rats spread diseases alongside with other animals like rodents which cause damage to vast quantities of cereal crops annually. Locusts too do a lot of havoc to crops while mosquitoes and tsetse-fly are carriers of diseases like malaria and sleeping sickness. Pollen and other plants emissions as well can cause uncomfortable or painful allergies (Owoeye, Omole, 2012). The necessity for quality water supply complicates the issue in most of developing nations of the world, particularly, Nigeria. Drinking and using untreated water lead to the spread of diarrhea and other water-borne diseases (Okafor, 2008).

The environment is a composite of behavioral settings which greatly affects the health of vulnerable persons. Environmental factors that affect health are in turn linked to underlying pressures on the environment. These pressures are a result of intense urbanization witnessed by most developing countries (Omole, 2008). In a recent United Nations Development Programme (UNDP) Ondo is presently estimated to be 3,441,024 and is expected to hit the 5.5 million population mark and thus be among the ten most populous cities in Nigeria by the year 2025. This is indeed frightening, considering the small size of the state put at 300sqkm and the type of density just stated the weak infrastructural base to support such a huge population and, the current economic growth rate which is below 13 %. Omole (2009), exposure prevalence study which concluded that, overall, 99.8 % of deaths associated with risk factors are in developing countries, and 90 % are deaths of children.

Also, these hazards have changed from the traditional factors often caused by poverty and insufficient development, and include lack of safe drinking water, inadequate sanitation and waste disposal methods to more modern hazards which are more global. These include; lack of coordinated health and environmental safeguards, air pollution, over-consumption of natural resources, widespread water pollution, population sprawl, intensive industrial development, climate change, and stratospheric ozone depletion. Each of these environmental hazards is associated with a variety of economic and social determinants of health (Adelekan, 2006).

In addition, protecting and improving the quality of the environment is fast becoming a necessity rather than a luxury. Rapid urbanization in the developing world is threatening health, the environment and urban productivity (Afon, 1998). Owoeye (2009) asserted that problems of environmental deterioration emanate from poor environmental sanitation. Thus, practicing good and efficient management of the environment can best provide a permanent solution. This has drawn attention of many scholars, to the effect of urban environmental health on vulnerable groups within and outside Nigeria: (Agbola, 2007; Yoade et. al., 2003; Yoade, 2016).

However, it could be seen that there are a lot of studies on urban environmental health on vulnerable groups both within and outside Nigeria. It could be asserted that information on study of urban environment on vulnerable groups in cities of Southwestern Nigeria is scanty, particularly in Ondo as there little or no literatures in relation to urban environmental health on vulnerable groups. Yet the effect of urban environmental health on vulnerable is important so as to guarantee a sustainable and healthy environment for its inhabitants. It is on this note that this study therefore examined factors responsible for poor urban environmental health among the vulnerable groups with particular reference to Ondo, Nigeria.

2. The Literature

Vulnerability is a multi-dimensional concept that comprises physical, social, economic, environmental, political, cultural and institutional factors. The perception of hazards, disaster, urbanization and vulnerability is increasing both in developing and developed countries of the world. The additional billion people added to the world's population in every 12 to 13 years are mortally taxing the earth and its resources. Each individual person has a unique impact on the planet's environment and no living individual is without an ecological footprint (WHO, 2010).

The term 'vulnerable groups' however, is used just as a convenient (but misleading) shorthand for showing concern for a long list of groups considered more at risk, without a need to ask why they are vulnerable and what needs to change. An individual or household is said to be vulnerable to a risk (such as malaria-spreading mosquitoes, contaminated water or a flood) if they are more susceptible to being harmed or killed by it, or less able to cope or adapt to the poor

environment (to lessen the risk). The lives of infants and young children are generally more at risk from malaria and contaminated water than the lives of adults. The vulnerable groups includes; Children, pregnant women, elderly people, malnourished people, and people who are ill or immune compromised, are particularly vulnerable when a disaster strikes, and take a relatively high share of the disease burden associated with emergencies (Wilson, 2002).

Available statistics show that more than half of the world's 7 billion people live in urban area, crowded into three per cent of the earth's land area. The proportion of the world's population living in urban, which was less than five per cent in 1800, increased to 47 per cent in 2000 and it is expected to reach 65 per cent in 2030 (Tomori, 2008). From this global view, however, more than 90 per cent of the future population growth will be concentrated in developing countries' cities and a large percentage of this population will be poor, living in marginal land (Oriye, 2009).

Vulnerability is dynamic; varying across temporal and spatial scales, and depends on economic, social, geographic, cultural, institutional, governance, and environmental factors (Oyeshola, 1995). Individuals and communities are differently exposed and vulnerable and this is based on factors such as wealth, education, race/ethnicity/religion, gender, age, class/caste, disability, and health status. Lack of resilience and capacity to anticipate, cope with, and adapt to extremes and change are important causal factors of vulnerability (Egunjobi, 1999).

Many factors contribute to vulnerability. These factors act to undermine capacity for self-protection, blocks or diminish access to social protection, delays or complicate recovery, or expose some groups to greater or more frequent hazards than other groups (Damas, Israt, 2004). They include rapid population growth, poverty and hunger, poor health, low level of education, gender inequality, fragile and hazardous location, and lack of access to resources and services, including knowledge and technological means, disintegration of social patters (social vulnerability). Other causes includes; lack of access to information and knowledge, lack of public awareness, limited access to political power and representation (political vulnerability) (Birkmann, 2006). When people are socially disadvantaged or lack political voice, their vulnerability is exacerbated further (29; 30). The economic vulnerability is related to a number of interesting elements, including its importance in the overall national economy, trade and foreign-exchange earnings, aid and investment, international prices of commodities and inputs, and production and consumption patterns (Ibem, 2010). Environmental vulnerability concerns land degradation, earthquake, flood, hurricane, drought, storms, water scarcity, deforestation, and the other threats to biodiversity (Egbunjobi, 2016).

Therefore, vulnerability could be seen as a multifaceted phenomenon. As such, solutions, too, must be multifaceted, addressing the range of social, cultural, demographic and economic conditions – often interacting in complex ways – that culminate in population vulnerability. Population changes also require the frequent and thoughtful revision of existing policies, plan, urban and disaster management options. Therefore, emergency managers, planners, and other policy's fingers, as noted by (Owoeye, Sogbon, 2012), should center on socio-economic and demographic characteristic (social inclusiveness) of the communities that require policy interventions (Owoeye, Obayemi, 2015).

3. The Study Area

Ondo city one of the major urban center in Ondo State and the city is located on latitude 06°30'N and longitude 04°45'E. The city is bounded on the north by Oluji/Okeigbo local government, on the east by Idanre local government, on the west and south by Odigbo local government. The population of the town stood at 113,900 during the 1991 population census. Ondo falls within the 'tropical wet and dry climate' with a relatively small dry season. Currently, there are 12 political wards in Ondo city. Consequently, rainfall in Ondo is seasonal in character with well-marked wet and dry seasons. The dry period comes between November and February, while the wet season lasts for 8 months from March to October; the mean annual rainfall is about 1615mm. the annual mean temperature is 27°C, with a maximum of 30°C.

Ondo landscape is made up of generally undulating hills of granite outcrop of igneous origin, and is marked by few dome-shaped hills. The hills are found to be developed over the basement complex of metamorphic rocks and their summits ranging between 250 and 500 metres above sea level (Akintola, 1982). The town has no major river; rather it is drained by several streams with fairly wide flood plains. The important of these streams are Luwa, Lisaluwa and Mode. The town

falls within the moist/wet lowland forest i.e. it has thick forested vegetation, but due to human activities most of these original forest has been replaced with secondary re-growth. Currently, there are 12 political wards in Ondo city (Figure 1).

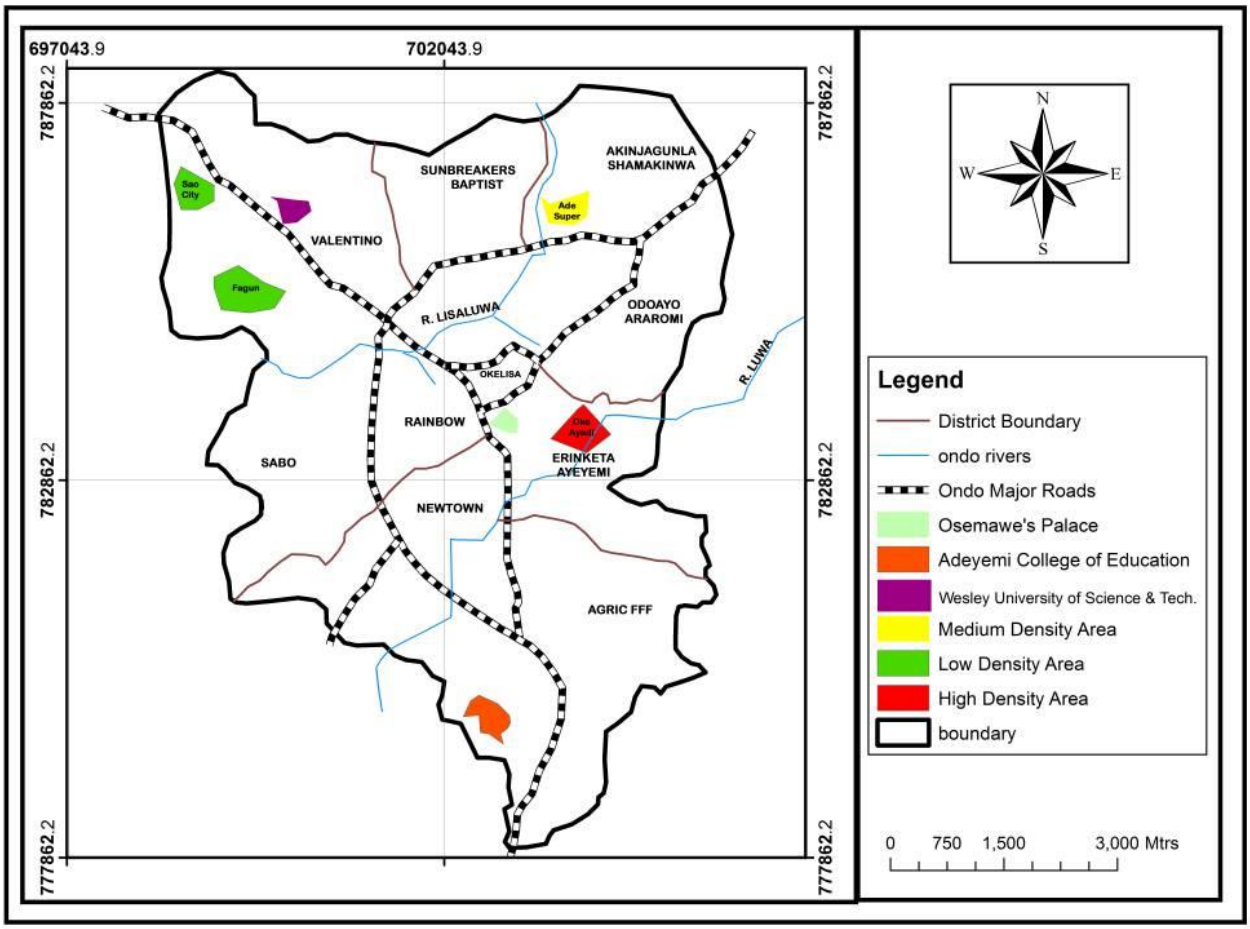

Fig. 1. Map of the Study Area
Source: Ondo west Town Planning Office

4. Methodology

For collection of primary data, questionnaires were administered using systematic sampling method. There are twelve political wards in the study area; out of five (5) political wards fall under the core area (high density); four (4) wards fall under (medium density) while the remaining three (3) fall under low density area and these become the sample frame. Simple random sampling was used to select a ward randomly from each density. Systematic sampling technique was used in selecting residents to be sampled. The first building was chosen randomly. Subsequent unit of investigation was every 10th residential building in each ward. Therefore, a total of 196 households were selected for questionnaire administration. Information elicited included the following: socio-economic characteristic of the respondents, factors that responsible for poor urban environmental health. Data collected were analyzed using Statistical Package for the Social Sciences version 23. Also, descriptive (tables, pictures, cross tabulation) were used to analyze the data collected.

5. Findings and Discussions

Socio-Economic Characteristics of the Respondents'

Findings revealed that 36.7 % of respondents in high density were within 31-40 years of age bracket; in medium density 39.1 % of the respondents' falls within 41-50 years while in low density, 34.8 % of respondents were within 41-50 years of age.

Findings established that 30.6 % of respondents in high density had only secondary school education; in medium density, 56.3 % of the respondents were graduates of tertiary institutions

while in low density, 78.3 % of respondents attended tertiary institutions. It was revealed that there was a significant association between the densities and the educational attainment of residents, there is every tendency to believe that a well-educated person may perceive and take good care his immediate environment differently from a less fellow.

Findings showed that 65.3 % of respondents in high density earned between 20,001 to 50,000; in medium density, 37.5 % of the respondents earned between 150,000 to 200,000 while in low density, 34.8 % of respondents earned between 200,001 and above. There is the tendency that respondents' with higher income may live better and ensure sustainability of the environment and also afford a good accommodation whereas, respondents' with lower income may not be able to, due to financial constraint (Table 1).

Table 1. Socio-Economic Characteristics of the Respondents'

Socio-Economic			
Respondents' Age			
	High	Medium	Low
Less than 20	9 (12.0 %)	4 (6.3 %)	0 (0.0 %)
21-30	18 (24.0 %)	9 (14.1 %)	6 (13.0 %)
31-40	26 (36.7 %)	14 (21.9 %)	12 (26.1 %)
41-50	7 (9.3 %)	25(39.1 %)	16(34.8 %)
51-60	5 (6.7 %)	12(18.8 %)	8(17.4 %)
60 and above	10 (13.3 %)	0(0 %)	4(8.7 %)
Total	75 (100.0 %)	64 (100.0 %)	46 (100.0 %)
Educational Attainment			
No Education	19 (25.3 %)	7 (10.9 %)	0 (0 %)
Primary	21 (28 %)	13 (20.3 %)	10 (21.7 %)
Secondary	23 (30.6 %)	8 (12.5 %)	0 (0 %)
Tertiary	12 (16.0 %)	36 (56.3 %)	36 (78.3 %)
Total	75 (100.0 %)	64 (100.0 %)	46 (100.0%)
Respondents' Income			
Less than 20,000	16 (21.3 %)	0 (0 %)	0 (0%)
20,001-50,000	49 (65.3 %)	10 (15.6 %)	0 (0 %)
50,001-100,000	10 (13.3 %)	18 (28.1 %)	6 (13.0 %)
100,001-150,000	0 (0 %)	24 (37.5 %)	10 (21.7 %)
150,001-200,000	0 (0 %)	12 (18.8 %)	14 (30.4 %)
200,001 and above	0 (0 %)	0 (0 %)	16 (34.8 %)
Total	75 (100.0 %)	64 (100.0 %)	46 (100.0 %)

Source: Yoade (2017)

Factors Responsible For Poor Urban Environmental Health

This section analyses and interprets data collected on the factors responsible for poor urban environmental health in the study area, with respect to the following; poverty and unemployment, lack of health facilities, inadequate sanitation, pollution, exposure to hazard sites among others.

Findings showed that in the high density area, low government intervention had the highest percentage with 18.66 %; next is poverty and unemployment (18.16 %); lack of health facilities (13.93 %); inadequate waste disposal (13.43 %); poor quality and overcrowded housing with (10.20 %); pollution (7.21 %); violation of planning rules (6.72 %); inadequate sanitation (5.47 %); exposure to hazard sites (4.23 %) and lack of safe drinking water (1.99 %) is the lowest in hierarchy.

Findings established that in the medium density area, low government intervention had the highest percentage (17.88 %); next is violation of planning rules (17.60 %); poverty and unemployment (16.76 %); inadequate waste disposal (12.57 %); lack of health facilities (12.01 %);

poor quality and overcrowded housing (9.78 %), exposure to hazard sites (6.15 %), inadequate sanitation (2.79 %); pollution with (2.79 %) and lack of safe drinking water (2.51 %) is the lowest in hierarchy.

Findings established that in the low density area, low government intervention had the highest percentage with 45.54 %; poor quality and overcrowded housing (19.80 %); inadequate waste disposal (10.89 %); poverty and unemployment (9.90 %); exposure to hazard sites (7.92 %); safe drinking water (3.96 %) and inadequate sanitation (1.98 %) (Table 2).

Table 2. Factors Responsible For Poor Urban Environmental Health

Factors	High Density			Medium Density			Low Density		
	Yes	Percentage %	Rank	Yes	Percentage %	Rank	Yes	Percentage %	Rank
F1	73	18.16 %	2	60	16.76 %	3	10	9.90 %	4
F2	56	13.93 %	3	43	12.01 %	5	0	0 %	8
F3	22	5.47 %	8	10	2.79 %	8	2	1.98 %	7
F4	54	13.43 %	4	45	12.57 %	4	11	10.89 %	3
F5	29	7.21 %	6	10	2.79 %	8	0	0 %	8
F6	8	1.99 %	10	9	2.51 %	9	4	3.96 %	6
F7	17	4.23 %	9	22	6.15 %	7	8	7.92 %	5
F8	41	10.20 %	5	35	9.78 %	6	0	0 %	8
F9	27	6.72 %	7	63	17.60 %	2	20	19.80 %	2
F10	75	18.66 %	1	64	17.88 %	1	46	45.54 %	1
Total	**402**	**100.0 %**		**358**	**100.0%**		**101**	**100.0%**	

Source: Field Survey, 2017
Note: *F* is variable used to represent each factor.
F1= Poverty and unemployment, F2= Lack of health facilities
F3= Inadequate sanitation, F4= Inadequate waste disposal
F5= Pollution, F6= Lack of safe drinking water
F7= Exposure to hazards sites, F8= Poor quality and overcrowded housing
F9= Violation of planning rules, F10= Low government intervention

6. Conclusion and Implication of Study for Policy Formulation

Generally, poverty tends to breed poor environmental and unhygienic conditions that have great impact on human health. This is because the poor are incapable of paying for the required amenities for a healthy living, most especially, quality housing thus they become vulnerable to health hazards. To avert this situation and ensure good environmental standard, the ongoing national policy of sustainable minimum wage should be extended to all and sundry. Besides, public enlightenment and environmental education would be necessary to keep the people well informed about the importance of healthy and hygienic environment.

There is only one choice to make and that is preservation and proper management of our environment in such a way that it can be useful for the future generation. It is often said that health is wealth. The most promising area where the greatest impact can be made in combating the disease burden in our environments and ensure a stable healthier and longer lifespan for people surely lies on investment in environmental sanitation, good housing condition and sound health. Adequate plans should be made therefore to involve stakeholders, individuals and government to redeeming the image of deplorable parts of our cities and rescue the lives of the poor residents.

This study has identified environmental health factors experienced by the residents of the three residential density communities, the high-density communities as epitomized in a residential core area of Ondo. However, the followings are some of the conclusions drawn from the findings. The first to be considered is the need for quality housing and hygienic environment. To achieve this, extensive redevelopment and upgrading programmes through the provision of urban basic services are essential in the area priority should be given to provision of more portable water, disposal facilities, and proper maintenance of drainages. Sanitary inspections

showed are regularly carried out on provision of household facilities with the enforcement of environmental sanitary laws. Adequate funding should be given to Waste Management Authority for effective service as well as improved health facilities in the Area.

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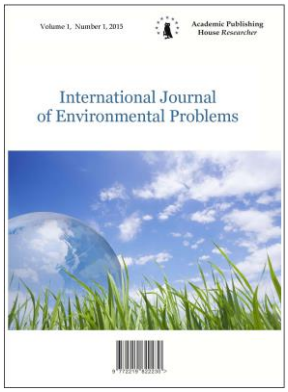
Published in the Slovak Republic
International Journal of Environmental Problems
Has been issued since 2015.
E-ISSN: 2413-7561
2018, 4(1): 45-55

DOI: 10.13187/ijep.2018.1.45
www.ejournal33.com



Toward the Biophysical, Biochemical, Biocenotic and Biogeographic Systematics of Model Experimental Aquarium Plants Based on Complex Descriptors of Plant Cell/Tissue Response to Hydrochemical Factors in the Framework of Physical Chemistry

Brief communication.

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Abstract

We propose a novel technique for complex multidescriptor measurements and control for the experimental biotopic aquarium based on hybridized measurements of biophysical, biohemical and biocenotic-biogeographic descriptors in the framework of hydrochemistry and physical chemistry using specialized device for correlational measurements of such parameters.

Keywords: hydrochemistry, bioindication, biotopic aquarium, hydrophytes, algae, pH, pK.

1. Введение

Практически каждый биоэколог в общих чертах представляет себе зависимость роста и состояния аквариумных растений от условий среды: освещения, температуры, жесткости и pH воды, содержания кислорода и углекислого газа. Каждому, особенно начинающему, хотелось бы иметь такое устройство, которое, если не само собой «меняло показатели в нужную сторону», то хотя бы указывало на сдвиги в гидрохимии и биологическом состоянии аквариума. Это особенно важно для тех, кто выращивает виды, чувствительные, например, к диапазону температур или pH. Так, например, согласно базе данных HYDRO_GEN_ICPRAS, общеизвестно, что *Hedyotis salzmannii* способен расти в воде с pH до 8, *Eleocharis viviparag* чувствителен к значениям pH 7-7.5, *Hemianthus micranthemoides* не способен существовать при pH < 6, а некоторые представители *Rotala* поддерживают физиологически-нормальное функционирование и при pH, много меньшем 5.5 (Градов, 2014, 2015). Иными словами, диапазоны резистентности растений к pH существенно различаются, в ряде случаев являясь видоспецифичным признаком. Аналогично обстоит дело с концентрацией CO_2 и отдельных ионов. Например для вида *Bolbitis heudelotii* достаточна концентрация 3-5 мг/л, *Eleocharis parvula* требует поддержания CO_2 на уровне от 10 до 15 мг/л, *Rotala macrandra* оптимально развивается при 15-25 мг/л, а *Peplis diandra* или *Didiplis diandra* необходимо завышенное значение в 20-30 мг/л. Во множестве случаев результаты вегетации и формообразования (морфогенеза) растения определяется, в существенной части, содержанием CO_2 и отдельных ионов. Так, например, у *Heteranthera zosterifolia*, способной развиваться и при 3-5 мг/л CO_2, при удобрении и доведении уровня

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CO_2 до 20-30 мг/л, наблюдается увеличение линейных размеров до двух раз, а для *Rotala wallichii* характерна зависимость окраски (пигментации) от концентрации CO_2 и ионов железа. У того же вида наблюдается при этом зависимость колористической гаммы от концентрации фосфатов и нитратов, а у ряда других видов, таких как *Limnophila aromatica* и *Echinodorus tenellus,* она качественно зависит от pH. Помимо *Rotala wallichii*, из относительно распространенных в частной практике и количественном тестировании аквариумных растений, очень чувствительными к железу является *Utricularia graminifolia*, *Eleocharis vivipara* (этиолируется и желтеет без него), *Heteranthera zosterifolia* (чернеет) и ряд других. Все эти данные общедоступны, расположены в открытом доступе на ряде зарубежных и отечественных ресурсов. Одним из наиболее хорошо структурированных примеров данных русскоязычных ресурсов является сайт http://aquascape-promotion.com/, с которого осуществлено цитирование ряда вышеприведенных видоспецифичных данных. На сухопутную флору также существуют подобные базы данных, однако в них дескрипторами и предикторами являются, зачастую, другие величины (Орехов и др., 2017).

На молекекулярном уровне подобные зависимости зачастую обусловлены каналомной машинерией – ионными каналами, регулирующими отклик растений на химизм контактно взаимодействующей с их поверхностью среды (Александров, Градов, 2017). Поэтому целый ряд методов индикации этого взаимодействия (таких, как методы с использованием многих ионоселективных электродов, а также патч-кламп) может рассматриваться как возможность для перехода от чисто-химической индикации этого взаимодействия к анализу активности и эффективности этого взаимодействия на сетях Кауфмана в системно-биологическом плане и определения биохимических целей (targets) подобных ионов посредством анализа подобия, в частности – методами QSAR / QSPR (Орехов, Градов, 2014; Orehov, Gradov, 2015, 2016). На множествах неводных видов растений принципиально возможно оценить реактивность как функцию фенологических метеоклиматически-детерминированных параметров и развития растений как многостадийного процесса (путем специализированных методов совмещенной с химическим анализом и анализом ионных каналов в реальном времени немеханической ауксанометрии (Градов, 2016), ранее применявшейся и без комплексирования с патч-кламп- анализом в чистом виде (Gradow, 2014)). С химических и эколого-биохимических позиций, анализ функции ионных каналов в сопряжении со спектроскопическими данными даёт нам возможность говорить о механизмах воздействия ионов (например, вышеупомянутого нами железа) с использованием методов обработки данных спектроскопии ионных каналов как координационных (комплексно координирующих данные ионы) структур (Градов, Орехов, 2016), определяя сигнализацию и регуляцию клеточных функций ионными каналами того или иного типа через петли обратной связи в циклической кинетике фиксации и переноса ионов (Александров, Градов, 2014). Роль диссоциированных / ионизированных агентов для водных растений в некоторых аспектах может быть сопоставлена роли аэроионов для видов сухопутных (Градов, Адамович. 2015). Одним из экологических проявлений обратной связи на уровне каналома является участие подобных процессов в биологически-опосредованном метаморфизме, формировании биокосного вещества и обогащении естественных частично упорядоченных сред ионами определенных типов (Градов, 2017). Это сказывается не только в естественных условиях, но и в термодинамически открытых, но отделенных от нормальной среды системах, таких как опытные аквариумы, где обратные связи формируют изменения в акваскейпе и комплексную реакцию системы в целом, а не только, например, растений (т.е. аквафлоры данного акваскейпа).

Вполне очевидно, что большинству любителей и специалистов, поддерживающих на акваскейпе многовидовое сообщество, хотелось бы приложить все усилия, чтобы в нем не возникало физико-химических противоречий и конкурентных антагонизмов разных видов растений, связанных с их отличными предпочтениями по химизму аквариумной экосреды. Для этого необходимо измерять и контролировать, а в идеале – производить мониторинг среды с целью установления её внутренних взаимоотношений и оптимальной регуляции с учетом потребностей видов. С другой стороны, известно, что факторы среды комплексно, а не по одиночке, воздействуют на аквариумные растения и, кроме того, взаимодействуют между собой, что приводит к невозможности однонаправленного изменения параметрики аквариума, так как

это, как правило, приводит к компенсирующему или модифицирующему результат воздействия отклику, что особо характерно для аквариумов, содержащих также микрофауну.

Имеет смысл проиллюстрировать эту цепочку связей простейшим примером: pH и жесткость воды связаны, так как кислотно-основные свойства в доступной аквариумистам воде складываются из баланса концентраций карбонатов, ответственных за карбонатную жесткость и играющих роль основания, и CO_2, играющей роль кислоты. Однако CO_2 есть, как известно, субстрат фотосинтеза, от концентрации которого зависят рост, развитие растений, вырабатывающих кислород. Следовательно, чем больше концентрация CO_2, тем больше впоследствии будет концентрация кислорода. Но, в то же время, увеличение CO_2 в среде влечет понижение pH, которое замедляет метаболизм базисных микроорганизмов, в частности – ответственных за нитрификацию, что влечет к ускоренному старению среды аквариума по окислительно-восстановительному критерию и по скорости гумификации – отложения гуминовых кислот и фульвокислот. По отношению к последним применяется, в частности, термин «окислительное кислотообразование», говорящий о взаимосвязи этих процессов с изменением pH и редокс-потенциала Eh (аквариумисты часто используют rH). Именно поэтому, в частности, фильтр с торфяным наполнителем служит для подкисления воды – общеизвестно, что гуминовые кислоты входят в состав органической массы торфа. Однако торф, равно как и многие другие используемые в подобных целях органические и природные материалы, выделяет CO_2, потребляемый аквариумной растительностью. Она, в свою очередь, осуществляет своего рода «биологическую оксигенацию», что приводит к окислению откладывающегося органического вещества. Диссоциация этих органических кислот, в свою очередь приводит к изменению pH, что замыкает круг рассуждений и цикл биологического равновесия.

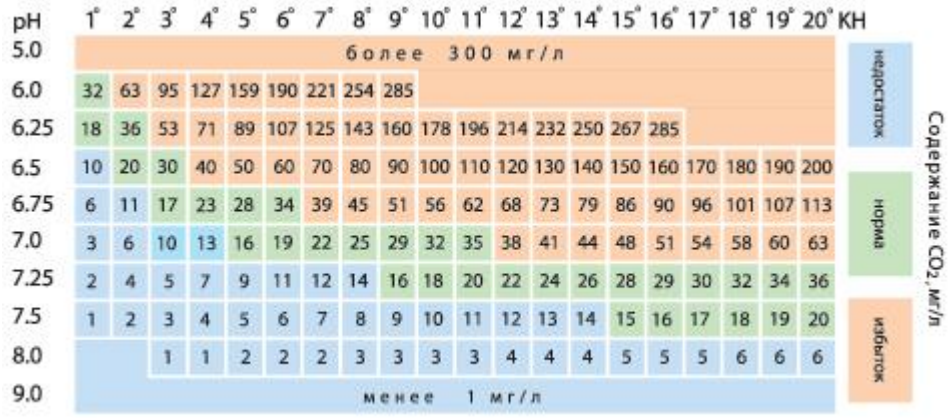

Рис. 1. Индикация оптимума содержания углекислого газа в воде

Вышерассмотренная система относится к наиболее простому варианту аутэкологии растений (вне связей с животным), хорошо известной читателю по популярным изданиям, начиная с 1970-х гг. (Rataj, Horeman , 1977) и до наших дней (Walstad, 2013). В то же время, проблема взаимоотношений в подобной искусственной аквариумной экосистеме не исчерпывается этой упрощенной схематикой. Существуют принципиальные отличия в физико-химических основах функционирования, определяющих режимы биологического равновесия, у аквариумов с пресной (Ruff, 2009) и морской (Brightwell, 2007) водой, особо существенные при наличии своеобразной ихтиофауны. Раньше они часто игнорировались, в силу отсутствия технических возможностей широкого распространения сложных «морских» аквариумов, и не учитывались в ранней литературе по аквариумной химии (Geisler, 1963). В общих чертах, речь идет об учете концентрации солей, их осмотических характеристик в водном растворе по отношению к биологическим тканям, удельной электропроводности среды, влияющей на свойства биологических мембран. Однако это существенно сдвигает параметрику среды, то есть «физико-химические ареалы обитания» – определяемые pH / Eh, pCO_2 возможные диапазоны существования аквариумных растений, которые, по сути, моделируют соответствующие (географически-обусловленные) природные

условия. Этим путем можно выявлять географию происхождения и «климатический паттерн» растения, в том числе – по отношению к минерализации водной среды.

Рис. 2. Простейший цветной pH-тест, используемый аквариумистами

Так как все целевые параметры обозначены и, как оказалось, взаимосвязаны, вполне логична потребность в системе, которая бы осуществляла взаимно-скомпенсированный и коррелированный мониторинг в этой области, одновременно автоматически осуществляла классификацию регистрируемых значений по шкале пригодности к жизни определенного растения или неантагонистического растительного сообщества. Иначе говоря, аппаратура подобного рода должна, подобно аквариумному термометру, относить регистрируемые с её помощью значения в их неразрывной совокупности к «зеленой зоне», оптимальной для обитателей фитоаквариума, либо нет. Это особенно важно для так называемых «биотопных» аквариумов.

Общеизвестно, что большинство аквариумистов для контроля жесткости и pH воды используют как раз комплекты реагентов-индикаторов с визуальной цветовой шкалой (см. Рис. 2, 3). Но, в то же время, невозможно провести синхронный тест, в частности, pH и жесткости воды, на этом принципе, так как химико-аналитические процессы будут накладываться друг на друга и смещать результат. В то же время, часто бывает так, что вода, оптимальная по pH или содержанию CO_2 все же не является оптимальной по жесткости для данного вида или сообщества. Таким образом, для полной взаимно-коррелированной оптимизации водной среды аквариума, в котором содержатся Ваши растения, необходим синхронный анализ с использованием нескольких юстируемых друг относительно друга химических величин. В силу сложности взаимодействия этих величин, рассмотренной выше, этот процесс должен осуществляться в режиме мониторинга, а не единичных измерений. Отсюда следует, что в данном случае обычные цветовые реакции не подходят, но можно, использовать датчики, воспроизводящие аналитический результат данных реакций: pH-метрические электроды, датчики на содержание газов, например – CO_2 в среде, датчики жесткости воды TDS, или кондуктометрические электроды для измерения удельной электропроводности по солям в

выносной колбе и т.д., визуализируя результат измерений на измерительном индикаторе с «зеленой зоной», положение которой пользователь может видоспецифично юстировать по всем важным параметрам сразу с учетом взаимодействия последних.

Рис. 3. Колориметрически-различные тесты на разные дескрипторы состояния воды

2. Материалы и методы

В связи с этим целесообразно рассказать об одной работе, выполненной российской инициативной группой под кураторством автора несколько лет назад по просьбе коллег из Латвии, специализировавшихся на выращивании водных растений. Требовалось создание аквариумной мониторинговой системы для взаимно-коррелированного измерения четырех параметров: pH, растворенного кислорода/углекислого газа, температуры и жесткости. В связи с целевой аудиторией читателей этой статьи здесь не приводятся технологические и схемотехнические подробности, но делается акцент на интуитивно-понятных принципах и операциях управления подобными конструкциями. В настоящее время доступны намного более продвинутые платформы типа «Arduino» и т.п., на базе которых желающие могут на модульной основе создать аналогичную конструкцию удовлетворительной для аквариума точности. Общий вид блока контроля нашей разработки приведен на Рис. 4.

Рис. 4. Блок контроля комплексной «зеленой зоны»

Микроэлектронная часть системы мониторинга предусматривает два калибровочных уровня – химической калибровки и биологической калибровки. Химическая калибровка с учетом температуры по четырем датчикам (тумблеры инициализации которых обозначены буквами А, Б, В, Г) осуществляется модулем, показанным на рис. 5. Учет температуры (в т.н. режиме термокомпенсации) производится с помощью рукоятки со шкалой температур Т с двумя шкалами. Взаимная калибровка осуществляется с использованием процентного регулятора (потенциометра, переменного резистора, агометра), обозначенного стрелкой с процентами. Грубое определение пользователем результата переключения осуществляется по красному и зеленому светодиодным индикаторам, расположенным ниже. Превышение индицируется красным индикатором, заниженное соотношение зеленым, причем уровень свечения зависит от уровня отклонения показателя. После химической калибровки нужно осуществить биологическую привязку, которая осуществляется с помощью специального программируемого (цифро-аналогового / аналого-цифрового модуля) по зеленой шкале на миллиамперметре. В память прибора введены оптимальные значения диапазонов и нормы реакции для тех растений, которые выращивались латвийскими коллегами (по выданным ими же данным). Эти шаблоны калибровки вызываются с помощью клавиатуры рядом с микроамперметром, индицирующим «зеленую зону», как это показано на Рис. 6.

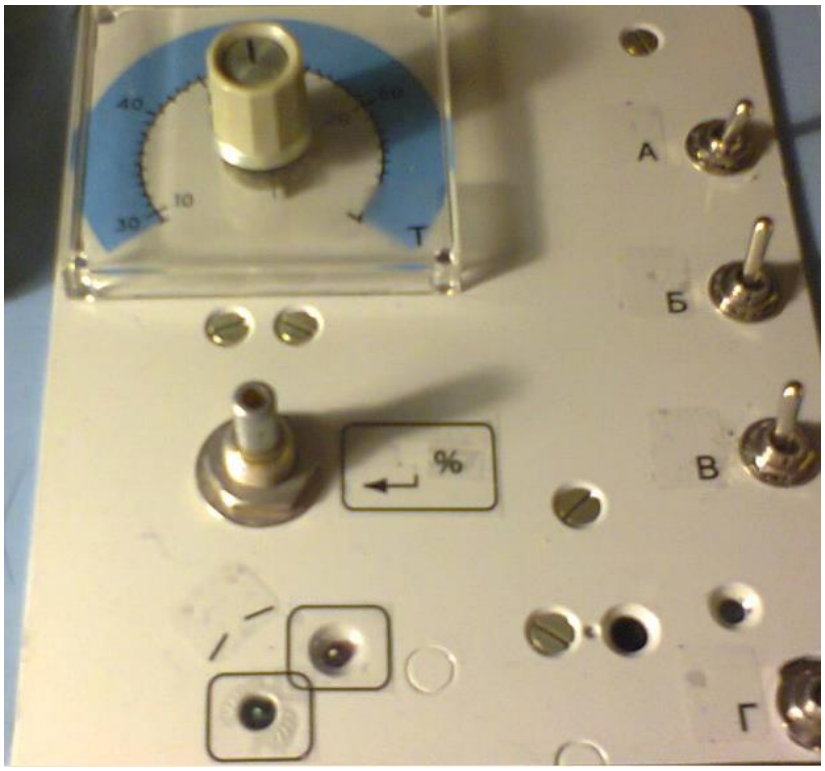

Рис. 5. Модуль корреляционной химической калибровки

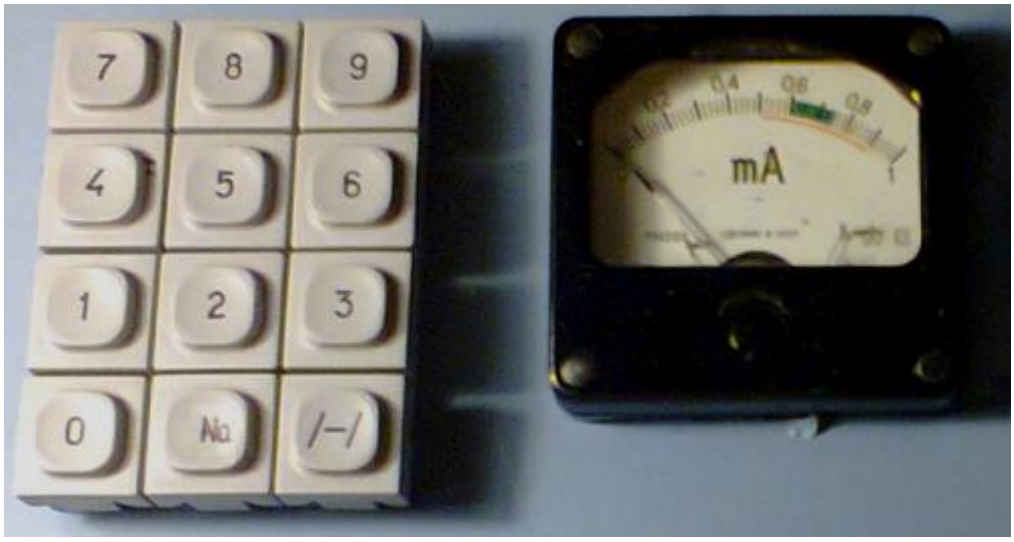

Рис. 6. Модуль выбора программ и индикации биологического диапазона

3. Результаты

Прибор в составе программно-аппаратного комплекса с HYDRO_GEN_ICPRAS (более поздняя разработка) управляется от компьютера и может передавать данные мониторинга с указанием величин отклонения от видоспецифичных диапазонов на компьютер через USB порт (например, на ноутбук, как это показано на рис. 4). Для выбора программы по номеру с клавиатуры на корпусе (см. рис. 6) при удерживаемой клавише No. Набирается комбинация цифр для данной программы. При этом появляется возможность наблюдать соответствие и / или несоответствие на шкале миллиамперметра. Следует подчеркнуть, что прибор носит специализированный для экспериментального аквариумного растениеводства характер, то есть результат выдается не в физических или химических величинах (которые возможно и нужно измерять уже существующей специализированной откалиброванной техникой), а в

комплексно-биологических корреляционных величинах (точнее, диапазонах), ранг которых определяется цифровой логикой на основе сопоставления величин с датчиков. Их число, в принципе, может быть увеличено путем увеличения разнообразия датчиков, что позволит внести в список автоматизированного принятия решений, например, фосфаты и нитраты либо ионы железа или иные важные для растений параметры. К сожалению, из-за заказного характера описанных работ, автор статьи не может предоставить полную схемотехническую документацию и программное обеспечение под ОС Windows для желающих. Кроме того, ввиду утери связи с заказчиком, не может привести отзывы о результатах использования данной системы в длительной практике (на данный момент прошло около 7-8 лет). Однако тестирование, произведенное перед отправкой экспериментального образца, показало как метрологическое, так и фактическое соответствие (с использованием в качестве поверочных приборов «Mettler Toledo» и «Hanna»), так и биологическую правдоподобность получаемых результатов. За две перых недели использования любые критические сдвиги «параметрики» аквариума индицировались без существенной задержки и качественной ошибки. И, кроме того, на случай дрейфа показаний во времени (либо механического сбоя показаний – при падении прибора) на корпусе прибора предусмотрен двухуровневый (на случай физико-химической и обратной – биологической калибровки либо общей калибровки к условному нулю) механизм тонкой регулировки «ноля» стрелки индикатора. Помимо винта на корпусе миллиамперметра в область кнопки включения (см. Рис. 7) выведен электромеханический регулятор.

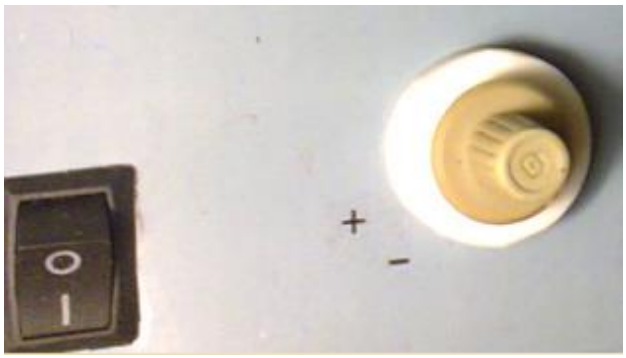

Рис. 7. Электромеханический регулятор

Уровень системотехники, надежности (робастности) предложенной системы позволяет работать в экстремальных условиях по механическим воздействиям – что важно, например, для аквариумистов, часто меняющих объекты хардскейпинга в аквариуме и иным образом манипулирующими с аквариумной средой. Автор был бы рад повторению подобной работы и просит обращаться за комментариями по электронной почте.

4. Благодарности

Тренд данной работы был продолжен в рамках инициативных (неоплачиваемых) НИР «Феноспектр» («Разработка принципов корреляционных феноспектральных измерений с использованием комплементарных аэрохимических / газохимических и гидрохимических дескрипторов и их использования для систематической реконструкции фенограмм и построения многомерных корреляционных биогеографических и биоклиматических карт») в 2014 году, основанных на бартерном обмене оборудованием и предоставлении приборов в безвозмездное пользование между сотрудниками химико-физических институтов (номер по списку проектов 53159363 [https://istina.msu.ru/projects/53159363/]), за что лабораториям и отдельных сотрудникам лабораторий данных институтов выражается особая благодарность. Работа не была поддержана государственными или частными фондами, поэтому автором и участниками проекта декларируется отсутствие конфликта интересов.

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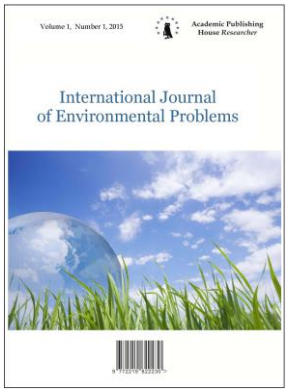
Published in the Slovak Republic
International Journal of Environmental Problems
Has been issued since 2015.
E-ISSN: 2413-7561
2018, 4(1): 56-75

DOI: 10.13187/ijep.2018.1.56
www.ejournal33.com



Assessment on the Barriers to Application of Lean Principles at the Construction Stage in Bauchi Metropolis

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Abstract

Material waste has been a great nuisance in the construction industry. It is the major cause of the high cost, low value and poor service delivery in the construction industry. The purpose of this study is to provide data that will increase knowledge on waste minimization in construction sites by identifying sources and causes of avoidable waste on construction sites and valuation of level of knowledge of the lean concepts among construction specialists and recognizing obstacles to effective application of the lean concept in construction. Data for the study were obtained through site visitations, interviews and the administration of 1000 questionnaires. Respondents included all the major professionals in the construction industry. Ratios and Simple percentages were used to analyze the data. Data from the analyses indicated about 10 % to 33 % of total construction materials are wasted on site. Results also revealed that method of operation, storage and handling of construction materials, procurement methods, record keeping and design were the major sources of waste on construction sites. It also revealed the presence of some degree in knowledge of lean construction among the construction experts.

Keywords: construction, waste, lean construction, manufacturing, operation.

1. Introduction

The manufacturing industry has experienced tremendous improvements and significant performance which can be equated with increasing productivity. The most significant feature in this accomplishment was the implementation of the novel philosophy of production, known as "Lean Production" By the removal of myriad types of waste; this approach has provided a continuous improvement in the production process (Ward, Sobek II, 2014).

Despite the fact that manufacturing had attained enormous results, the construction industry still encounters stern problems resulting from massive amounts of waste (Womack, Jones, 2010) hence, the need for lean construction to help curb the wastage issue. Past research into the causes of waste in construction projects indicate that waste can arise at any stage of the construction process from inception, right through the design, construction and operation of the built facility (OJEBA, L. G. T. P. O.).

Waste in the construction industry has been the subject of several research projects around the world in recent years (Pacheco-Torgal, Labrincha, 2013; Ashworth, Hogg, 2014; Ball, 2014;

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Bhasin, 2015; Gandaa, 2015; Gandaa, 2015). According to Ball, M. (2014), it is commonly acknowledged that a very high level of waste exists in construction. Since construction has a major and direct influence on many other industries by means of both purchasing inputs and providing the products to all other industries, eliminating or reducing waste in the construction industry could yield great cost savings to the society.

According to Agyekum, (2012), waste can be defined as "any inefficiency that results in the use of equipment, materials, labour or capital in larger quantities than those considered as necessary in the construction of a building". Waste can be classified as *unavoidable waste* (or natural waste), in which the investment necessary for its reduction is higher than the economy produced, and *avoidable waste,* in which the cost of waste is higher than the cost to prevent it.

Lean construction considers construction materials wastes as potential wastes that hinder flow of value to the client and should be eliminated (Gregory, 2010). The creation of this waste can be prevented by applying lean construction principles. The question now arises as to whether professionals in the building industry in Nigeria are aware of the amount of materials waste generated on site. What measures have they put in place to deal with the situation?

The study covered only the construction stage of building projects with the assumption that lean design has already been considered at the design stage. Construction stage refers particularly to the building or construction of sub-structures, super-structures and architectural elements such as finishes. Surveys carried out at these phases enabled on-site observations to be conducted simultaneously. The materials considered were timber, cement/mortar, concrete and blocks. The research focused on the flow activities of these materials (storage and handling). Surveys in the forms of questionnaires and personal interviews were conducted with the proponents who were undertaking referenced projects. Proponents mentioned refer precisely to the site managerial staffs concerned such as project managers, quantity surveyors and architects. The study focused on construction sites in and around Bauchi metropolis due to site accessibility and availability of contacts. These sites were mainly made up of construction of lecture theatres, offices, student hostels and residential buildings.

2. Relevance

Agyekum (2012) describes waste as "any inefficiency that results in the use of equipment, materials, labour or capital in larger quantities than those considered as necessary in the construction of a building". Waste can be classified as *unavoidable waste* (or natural waste), in which the investment necessary for its reduction is higher than the economy produced, and *avoidable waste,* in which the cost of waste is higher than the cost to prevent it (Bhasin, 2015). The percentage of unavoidable waste depends on the technological development level of the company (Bhasin, 2015). Ramos (2010) stated that waste can also be categorized according to its source; namely the stage in which the root causes of waste occurs. Waste may result from the processes preceding construction, such as materials manufacturing, design, materials supply, and planning, as well as the construction stage (Harris, 2013) classified the main waste causes in construction into: Design; Procurement; Materials Handling; Operation; Residual.

However, for the sake of this study, only materials wasted at the construction stage of projects would be considered. This is due to two main reasons:

1. Materials account for the largest input into construction activities in the range of 50-60 % of the total cost of a project (Ramos, 2010) and because

2. The raw materials from which construction inputs are derived come from non-renewable resources. Hence, rarely would these materials be replaced once they are wasted (Udeaja et al., 2013).

3. Materials and Methods

In this study, data was collected through interviews using structured questionnaire on a site visit. The questionnaire was self-administered to respondent and information gathered at the spot to collect detailed information about respondents‟ experiences and impressions about materials wastage and lean construction. It was also used to collect preliminary information to help in structuring the questionnaires. The questionnaire survey was also adapted to get feedback on opinions of respondents‟ about wastage of building materials and the implementation of lean

principles in the Nigerian construction industry. The site visits also involved observations where the researcher sought to find out how materials are stored and handled and also provide a compendium on high waste generating building materials are used in the construction industry. The researcher spent 4 months on building construction sites and observed the flow of activities of materials (handling and storage). Only handling and storage was considered on the questionnaire survey.

Sources of Data

The study depended on both primary and secondary data. Primary data was developed from first-hand data collected through the use of questionnaires, interviews and site visits (observation). The secondary source of data was obtained using relevant books, journals, magazines and research papers.

Questionnaire *Design*

The questionnaire consisted of 6 major sets of closed-ended questions designed to obtain data on the sources and causes of materials waste and waste minimization measures, the questionnaire further sought to obtain information on the level of knowledge of construction professionals on the concept and benefits of lean construction and barriers to the implementation of lean construction in the Nigerian building industry. Interviews were also used to obtain more specific information about material waste and lean construction.

The question was constructed using the Linkert scale. The respondents were asked to rank on a scale of 1-5 factors that cause materials waste on construction sites where 1= „Highly unimportant", 2= „Unimportant", 3= „Neutral", 4= „Important" and 5= „Highly important".

For each waste minimization measure, the respondents were asked to score the level of contribution to waste minimization on the Likert scale of 1 to 5 where 1= „very low", 2= „low", 3= "Medium", 4= „High" and 5= „Very high".

The respondents were further asked to score each measure according to the level of practice in their organization on a scale of 1 to 5 where 1= „Not practiced at all", 2= „Not practiced", 3= „Practiced", 4= „Frequently practiced" and 5= „Most frequently practiced".

Concerning the principles of lean construction, the respondents were asked to indicate their level of agreement to the application of the principles to project delivery in the construction industry on a five- point Likert scale (from 1= „highly disagree" to 5 = „highly agree"). For the achievability of customer values, respondents will be asked to rank from 1 = „highly unachievable" to 5= „highly achievable".

For the benefits of lean construction, the respondents were asked to rank from 1 = „highly unbeneficial" to 5 „highly beneficial" and for measures to bridge the knowledge gap, respondents were asked to rank from 1 „highly unimportant" to 5 „highly important".

On the issues of barriers to the implementation of lean construction, the respondents were asked to score the severity of the potential barriers out of the forty which were pre-tested to the implementation of lean construction on the Likert scale of 1-5 where 1= „Not very severe" and 5= „Very severe". The 17 measures to overcome potential barriers to implementation of LC were also scored on a scale of 1-5, where 1= „Highly Unimportant", 2= „Unimportant", 3= „Neutral", 4= „Important" and 5= „highly important.

The target population for the data collection using the questionnaires consisted of consultancy firms (architectural and quantity surveying) and construction organizations. Building construction organizations operating within Bauchi metropolis registered with the Ministry of Water Resource, Works and Housing (MWRWH): based on the nature of work the organizations engage in – building, civil engineering construction, electrical and plumbing works as classified respectively.

4. Discussion

The report of the findings the survey after the questionnaire survey was carried out is presented here. Statistical analysis of the responses using ratios and percentages was carried out. Describes the characteristics of the respondents in terms of profession (Figure 1); level of education (Figure 2); experience (Figure 3).

Unnecessary delays in materials delivery, inefficient use of quality standards, long implementation period, waste accepted as inevitable, inconsistency in government policies, high

dependency of design specifications on in-situ components and materials, extensive use of subcontractors, lack of long term commitment to change and innovation, lack of long term relationship with suppliers, delays in decision making and materials scarcity(Figure 4); fragmented nature of the construction industry, lack of interest from clients, poorly defined individual responsibilities and less involvement of contractors and specialists in design process(Figure 5); poor project definition, lack of equipment, lack of buildable designs, incomplete designs and lack of standardization, lack of agreed implementation methodology and unsuitable organizational structures (Figures 6, 7 and 8); Figures 9 and 10 show the level of material wastage on site and measures that aid in waste minimization respectively. Figures 11, 12 and 13, 15-19 depicts understanding, level of adoption and hindrance on applicability of lean principles, while Figure 14 shows the level of achievability of consumer values in company operations.

The report of the findings the survey after the questionnaire survey was carried out is presented here. Statistical analysis of the responses using ratios and percentages was carried out. Describes the characteristics of the respondents in terms of profession (Figure 1); level of education (Figure 2); experience (Figure 3).

Unnecessary delays in materials delivery, inefficient use of quality standards, long implementation period, waste accepted as inevitable, inconsistency in government policies, high dependency of design specifications on in-situ components and materials, extensive use of subcontractors, lack of long term commitment to change and innovation, lack of long term relationship with suppliers, delays in decision making and materials scarcity(Figure 4); fragmented nature of the construction industry, lack of interest from clients, poorly defined individual responsibilities and less involvement of contractors and specialists in design process(Figure 5); poor project definition, lack of equipment, lack of buildable designs, incomplete designs and lack of standardization, lack of agreed implementation methodology and unsuitable organizational structures (Figures 6, 7 and 8); Figures 9 and 10 show the level of material wastage on site and measures that aid in waste minimization respectively. Figures 11, 12 and 13, 15-19 depicts understanding, level of adoption and hindrance on applicability of lean principles, while Figure 14 shows the level of achievability of consumer values in company operations.

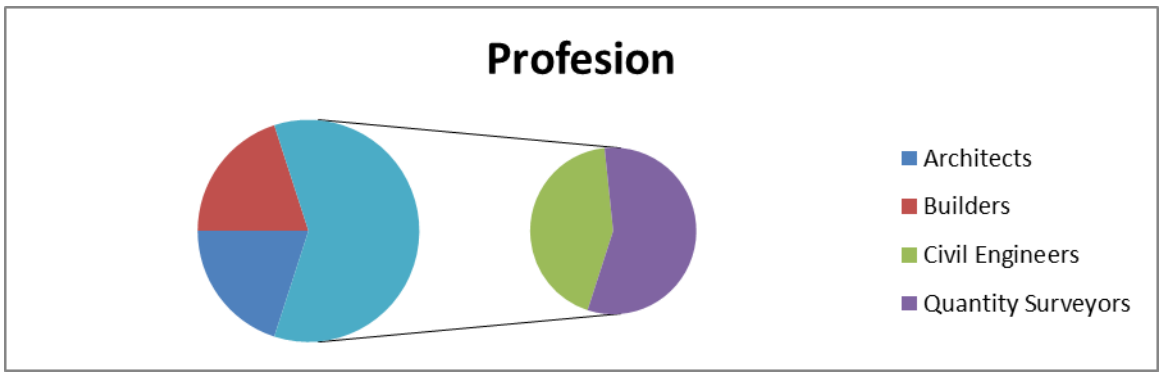

Fig. 1. Characteristics of the sample (% Profession)

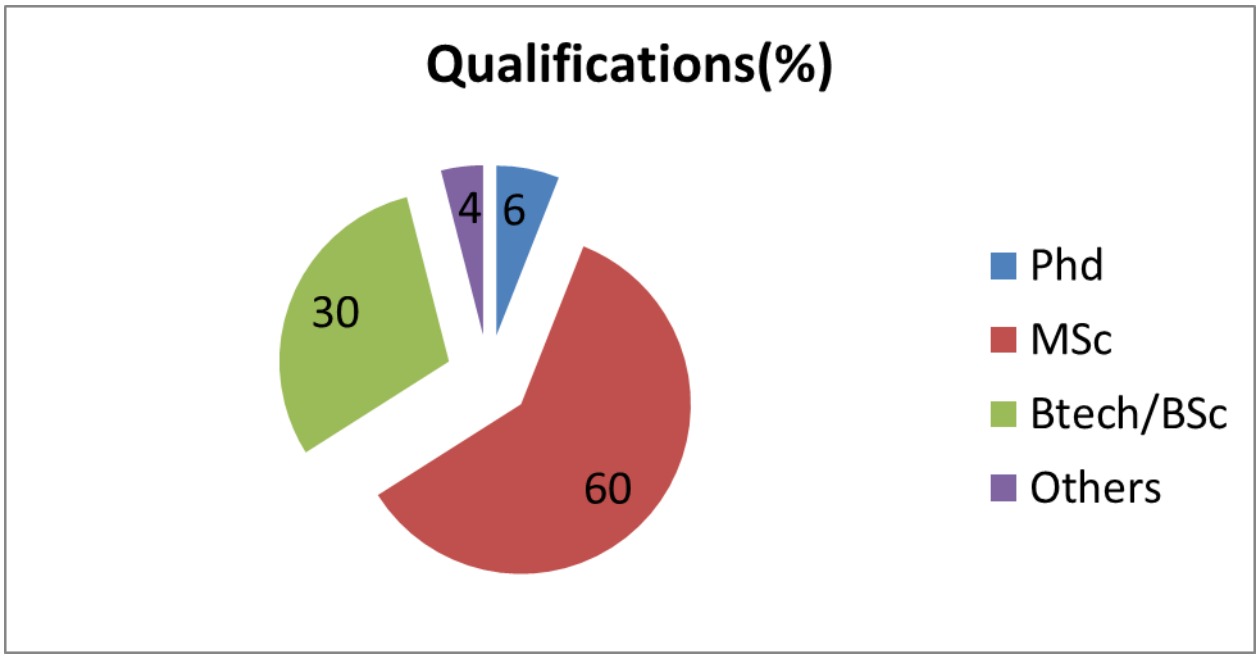

Fig 2. Characteristics of the sample (%)

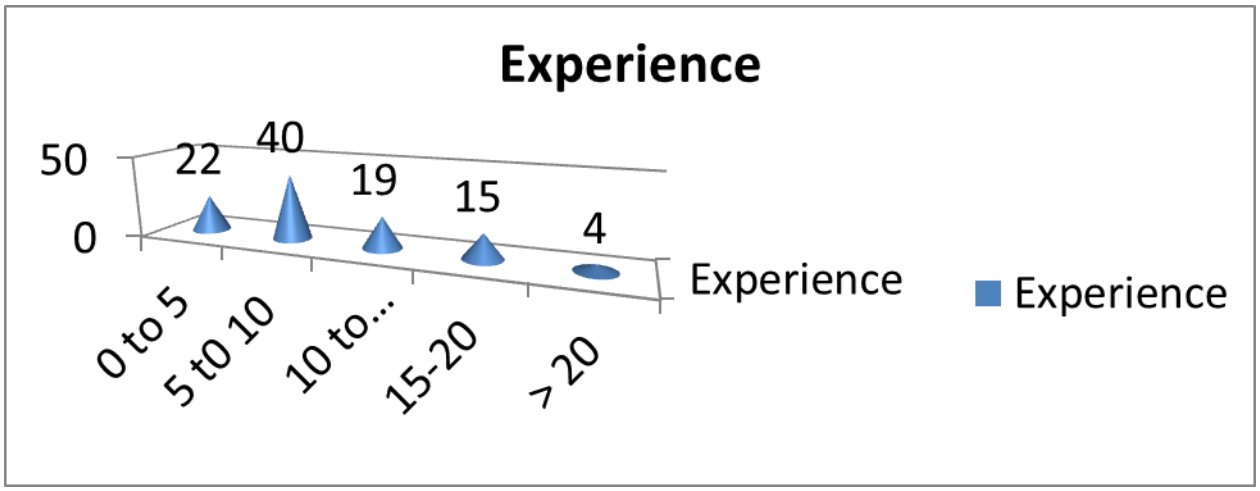

Fig. 3. Characteristics of the Sample (experience, %)

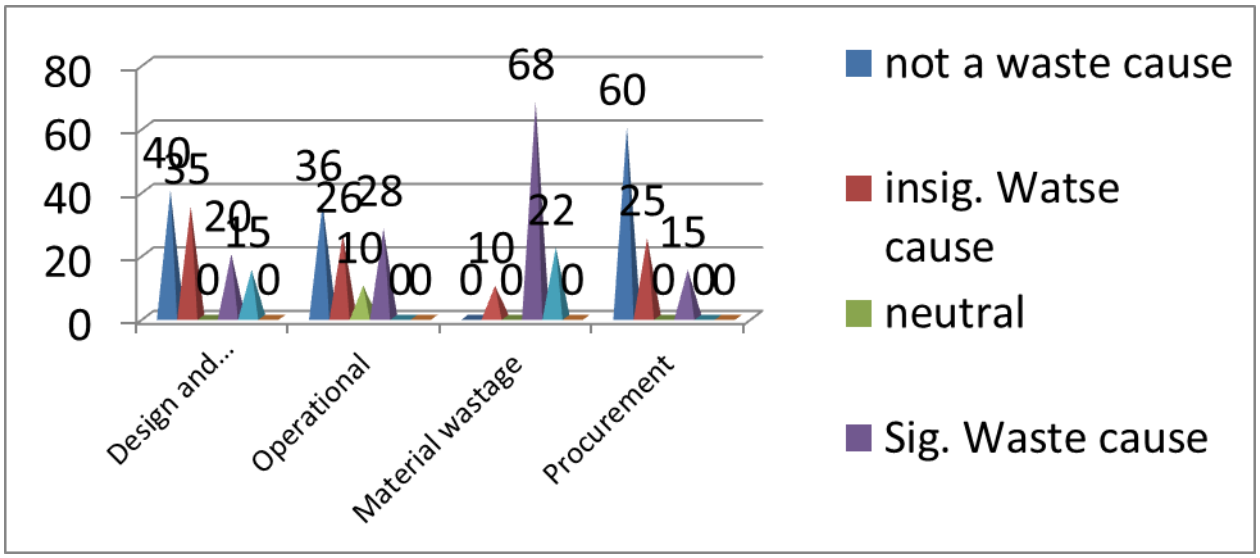

Fig. 4. Possible Sources of Construction Waste

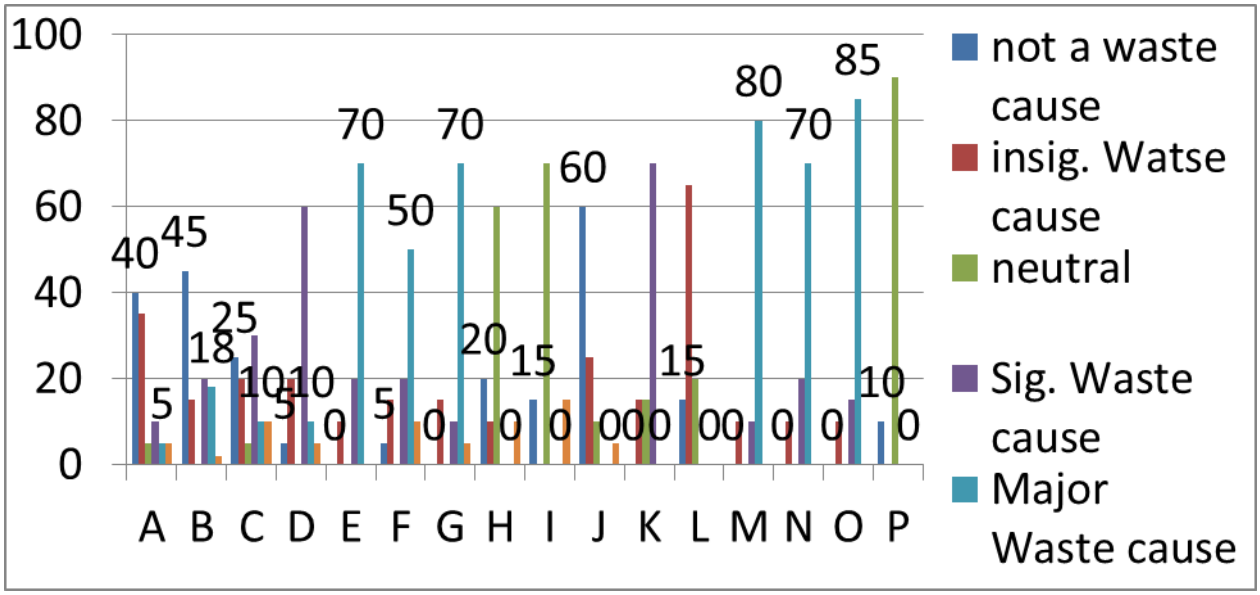

Fig 5. Possible sources of construction waste (design and documentation)

Key

A	Lack of attention paid to dimensional consideration of products
B	Variations in the design during construction
C	Designer inexperience in method and sequence of construction
D	Lack of attention paid to standard sizes available in the market
E	Designers unfamiliarity with alternative products
F	Complexity of detailing in drawings
G	Lack of information in drawing
H	Poor/wrong specifications
I	Incomplete contract documents at commencement of project
J	Selection of low quality products
K	Last minute client requirement
L	Poor communication leading to mistakes and errors
M	Overlapping of design and construction

N Lack of knowledge about construction techniques during design
P Poor site layout

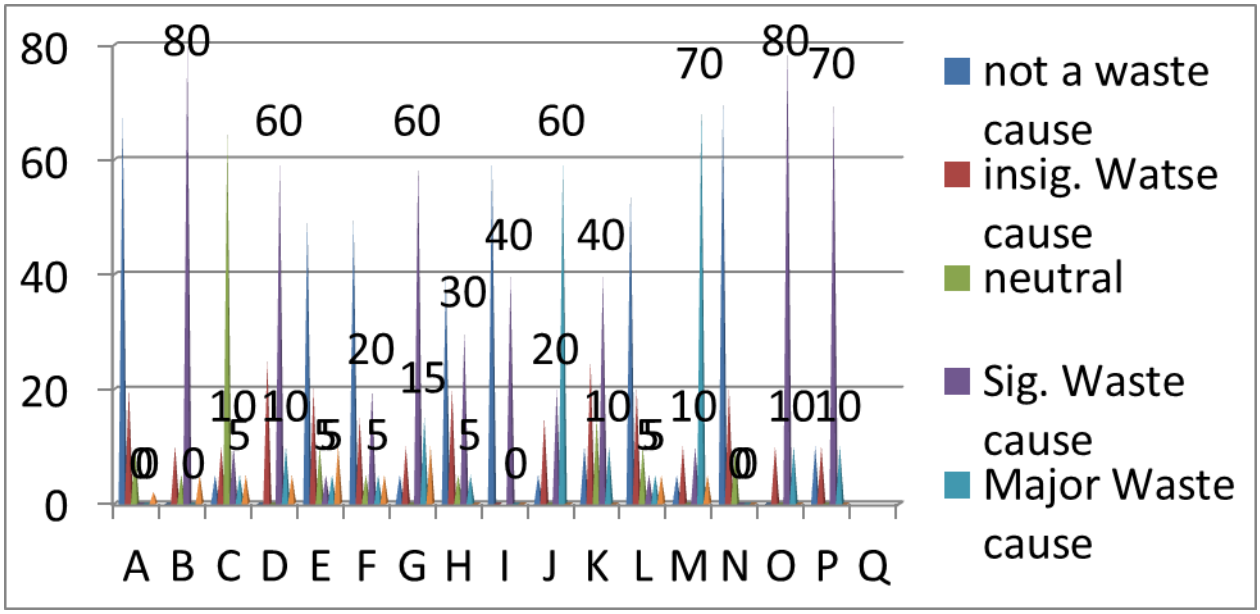

Fig. 6. Possible Sources and sources of Construction Waste (Operational, %)

KEY
- A ERRORS BY TRADES MEN OR OPERATIVES
- B ACCIDENTS DUE TO NEGLIGENCE
- C DAMAGE TO WORK DONE CAUSED BY SUBSEQUENT TRADES
- D USE OF INCORRECT MATERIALS THUS REQUIRING REPLACEMENT
- E REQUIRED QUALITY UNCLEAR DUE TO IMPROPER PLANNING
- F DELAYS IN PASSING OF INFORMATION TO THE CONTRACTOR ON TYPES AND SIZES OF PRODUCTS TO BE USED
- G EQUIPMENT MALFUNCTIONING
- H INCLEMENT WEATHER
- I INAPPROPRIATE PLACEMENT OF THE MATERIAL
- J POOR INTERACTION BETWEEN VARIOUS SPECIALISTS
- K CHOICE OF WRONG CONSTRUCTION METHOD
- L UNFRIENDLY ATTITUDES OF PROJECT TEAM AND LABORS
- M EFFECTS OF POLITICAL AND SOCIAL CONDITIONS
- N DIFFICULTIES IN OBTAINING WORK PERMITS
- O FREQUENT BREAKDOWN OF EQUIPMENT
- P POOR TECHNOLOGY OF EQUIPMENT
- Q SHORTAGE OF TOOLS AND EQUIPMENT REQUIRED

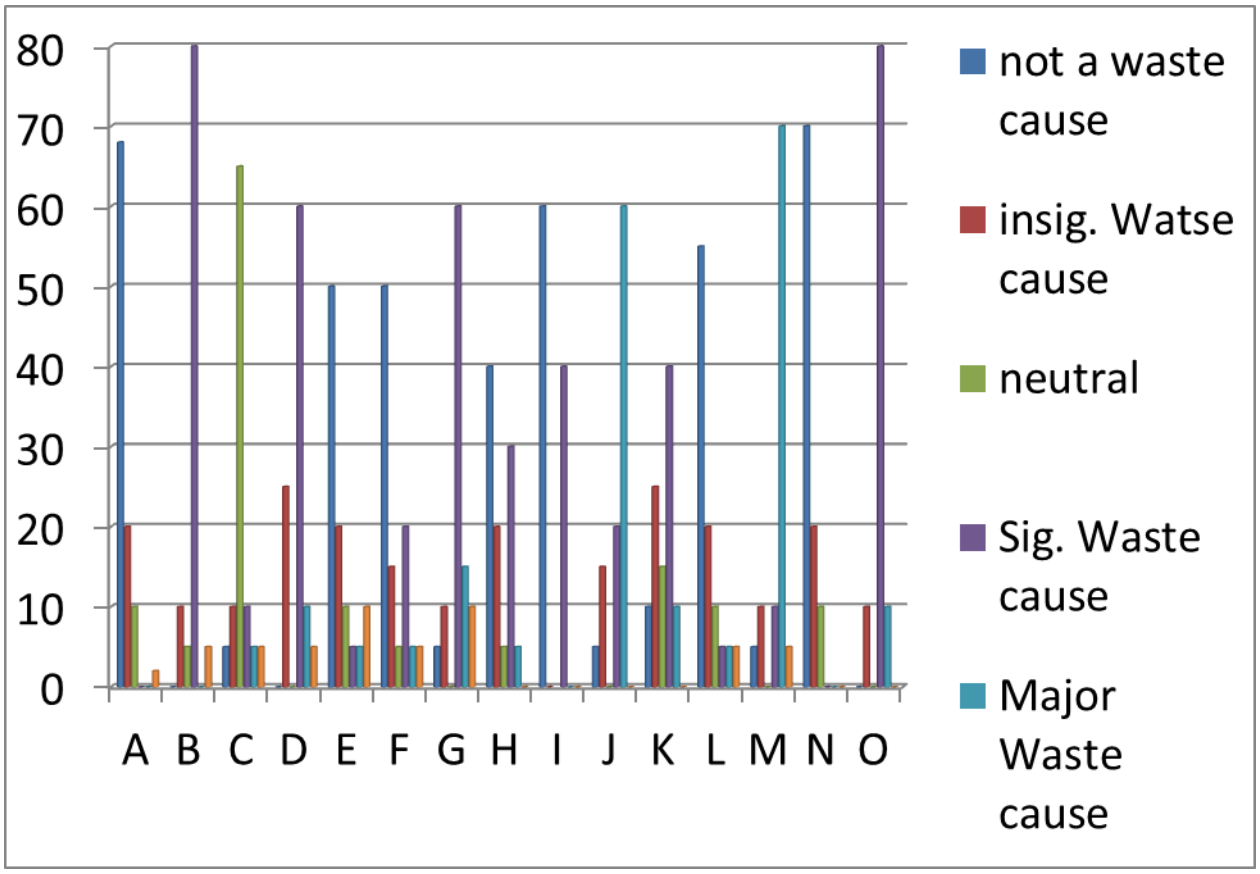

Fig. 7. Possible Source and sources of Construction Waste (Material Wastage)

KEY

- A OVERLOADING OF TRANSPORT EQUIPMENT
- B USE OF WRONG METHOD OF TRANSPORT
- C POOR METHOD OF STORAGE ON SITE
- D POOR HANDLING. E USE OF WHATEVER MATERIAL CLOSE TO WORKING PLACE
- F THEFT. G DAMAGE TO MATERIAL ON SITE
- H WASTE RESULTING FROM CUTTING UNECONOMICAL SHAPES
- I UNNECESSARY INVENTORIES ON SITE LEADING TO WASTE
- J OVERPRODUCTION/PRODUCTION OF A QUANTITY GREATER REQUIRED OR EARLIER THAN NECESSARY
- K MANUFACTURING DEFECTS
- L LACK OF ONSITE MATERIALS CONTROL
- M USING EXCESSIVE QUANTITIES OF MATERIALS THAN REQUIRED
- N INSUFFICIENT INSTRUCTIONS ABOUT HANDLING

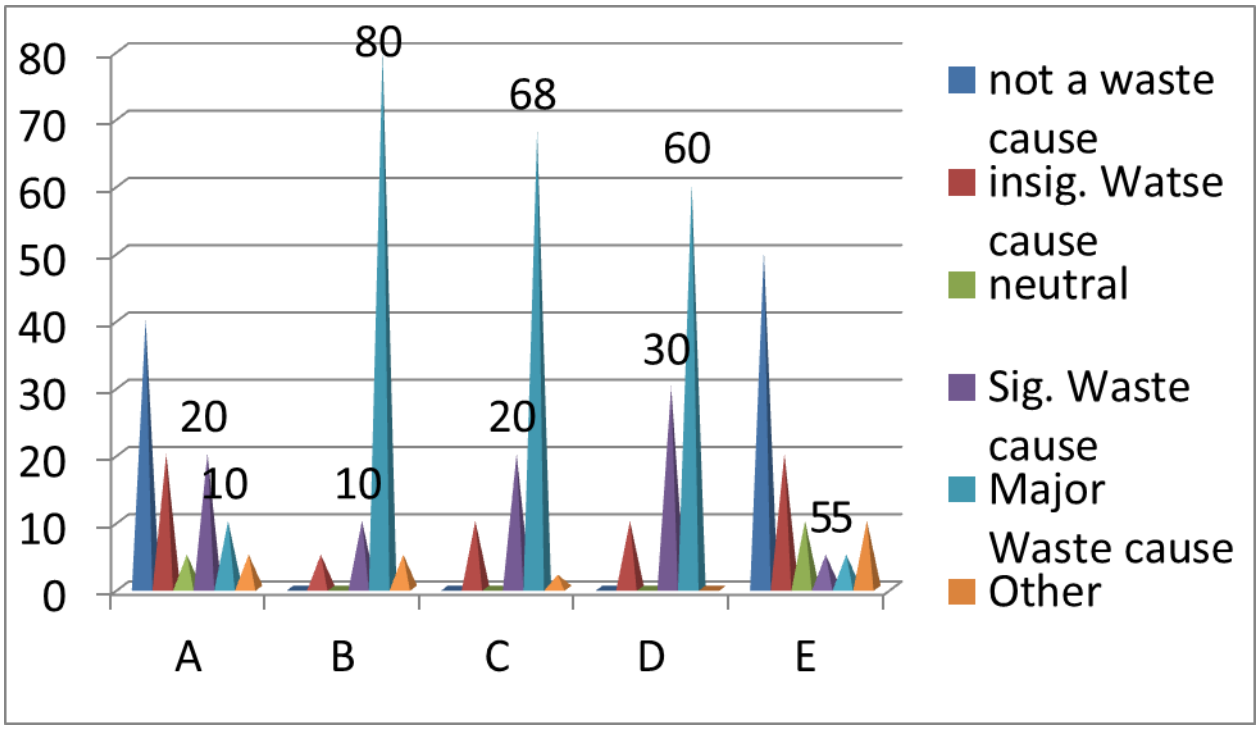

Fig. 8. Possible sources construction waste (Procurement) (%)

KEY

- A ORDERING ERRORS (EXAMPLE, ORDERING SIGNIFICANTLY MORE OR LESS)
- B PURCHASED PRODUCTS THAT DO NOT COMPLY WITH SPECIFICATION
- C UNSUITABILITY OF MATERIALS SUPPLIED TO SITE
- D SUBSTITUTION OF A MATERIALS BY A MORE EXPENSIVE ONE(WITH AN UNNECESSARY BETTER PERFORMANCE)
- E CHANGES IN MATERIAL PRICES

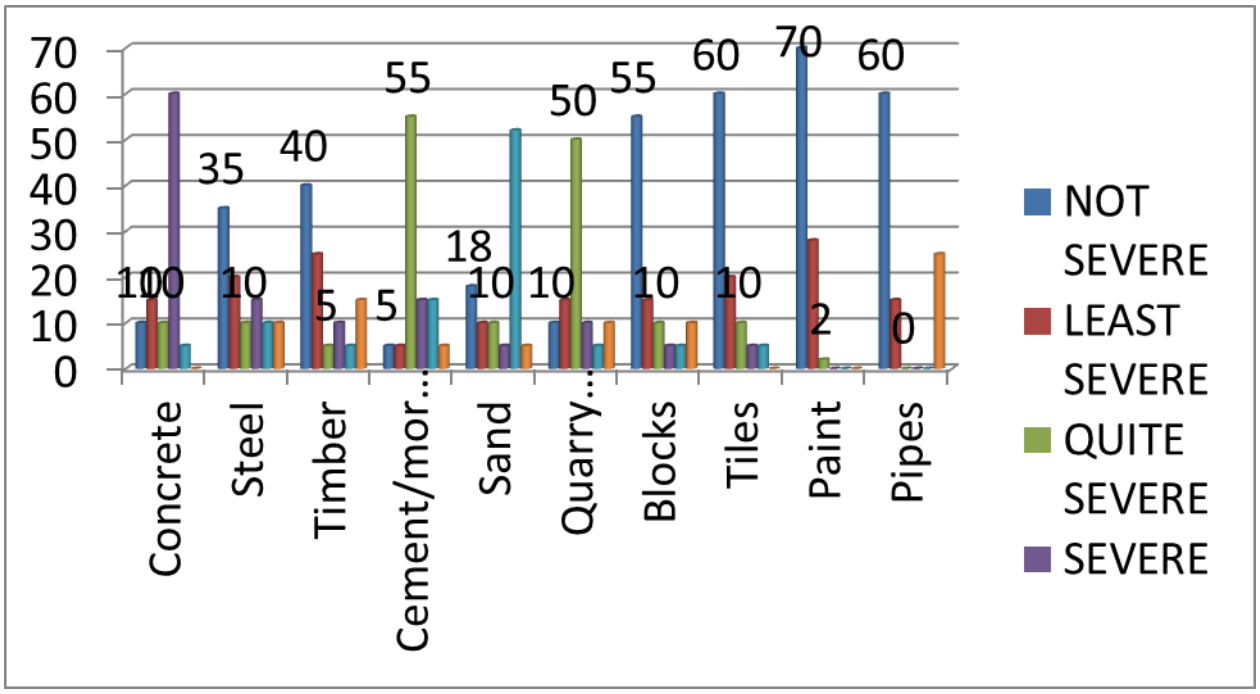

Fig. 9. Material wastage on site (%)

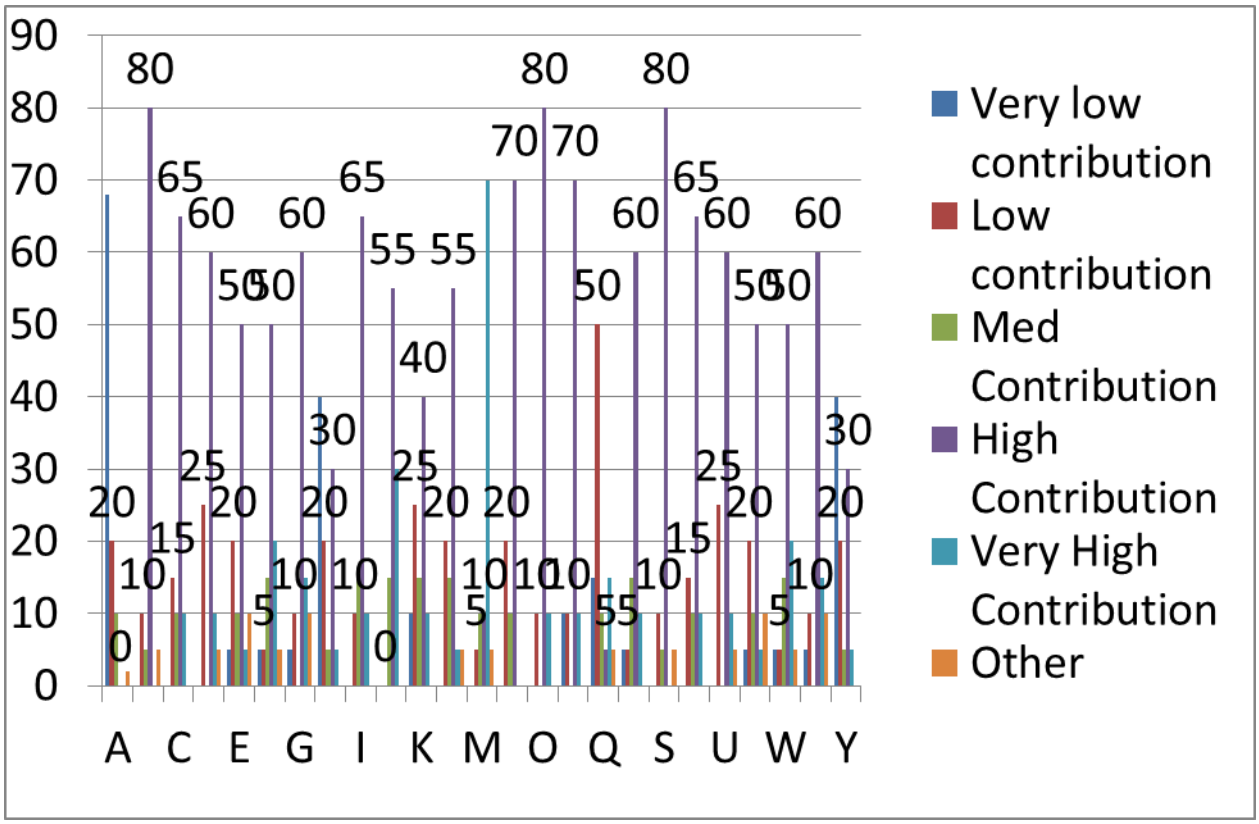

Fig. 10. Measures that contribute to minimization of waste (%)

KEY

- A RECYCLING OF SOME WASTE MATERIALS ON SITE
- B GOOD CONSTRUCTION MANAGEMENT PRACTICES
- C TRAINING OF CONSTRUCTION PERSONNEL

D GOOD COORDINATION BETWEEN STORE AND CONSTRUCTION PERSONNEL TO AVOID OVER-ORDERING

- E USE OF MORE EFFICIENT CONSTRUCTION EQUIPMENT
- F VIGILANCE OF SUPERVISORS
- G PROPER STORAGE OF MATERIALS ON SITE
- H JUST IN TIME OPERATIONS
- I EARLY AND PROMPT SCHEDULING OF DELIVERIES
- J ADHERENCE TO STANDARDIZED DIMENSIONS
- K CHANGE OF ATTITUDE OF WORKERS TOWARDS THE HANDLING OF MATERIALS
- L REGULAR EDUCATION AND TRAINING OF PERSONNEL ON HOW TO HANDLE
- M CHECKING MATERIALS SUPPLIED FOR RIGHT QUALITIES AND VOLUMES
- N EMPLOYMENT OF SKILLED WORKMEN
- O ACCURATE AND GOOD SPECIFICATIONS OF MATERIALS TO AVOID WRONG ORDERING
- P ENCOURAGE RE-USE OF WASTE MATERIALS IN PROJECTS
- Q CAREFUL HANDLING OF TOOLS AND EQUIPMENT ON SITE
- R WEEKLY PROGRAMMING OF WORKS
- S MIXING, TRANSPORTING AND PLACING CONCRETE AT THE APPROPRIATE TIME
- T WASTE MANAGEMENT OFFICER OR PERSONNEL EMPLOYED TO HANDLE WASTE ISSUES
- U ADOPTION OF PROPER SITE MANAGEMENT TECHNIQUES

- V ACCESS TO LATEST INFORMATION ABOUT TYPES OF MATERIALS ON THE MARKET
- W MINIMIZING DESIGN CHANGES
- X PURCHASING RAW MATERIALS THAT ARE JUST SUFFICIENT
- Y USING MATERIALS BEFORE EXPIRY DATES

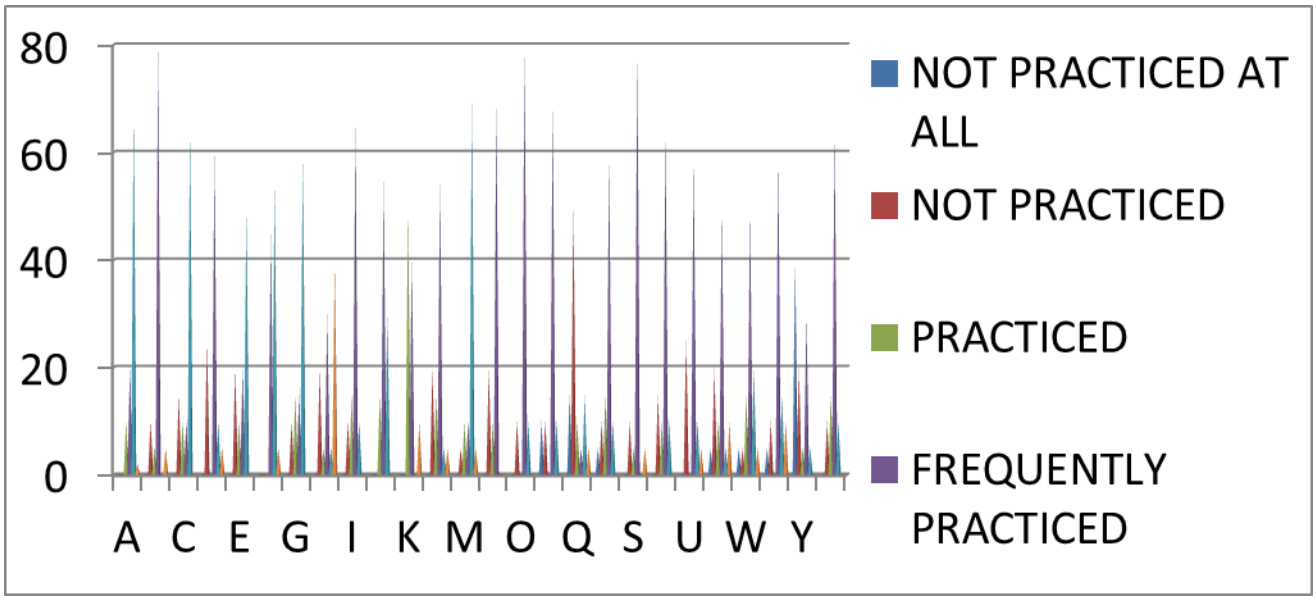

Fig 11. Frequency of use of minimization of waste measures

KEY

- A RECYCLING OF SOME WASTE MATERIALS ON SITE
- B GOOD CONSTRUCTION MANAGEMENT PRACTICES
- C TRAINING OF CONSTRUCTION PERSONNEL

D GOOD COORDINATION BETWEEN STORE AND CONSTRUCTION PERSONNEL TO AVOID OVER-ORDERING

- E USE OF MORE EFFICIENT CONSTRUCTION EQUIPMENT
- F VIGILANCE OF SUPERVISORS
- G PROPER STORAGE OF MATERIALS ON SITE
- H JUST IN TIME OPERATIONS
- I EARLY AND PROMPT SCHEDULING OF DELIVERIES
- J ADHERENCE TO STANDARDIZED DIMENSIONS
- K CHANGE OF ATTITUDE OF WORKERS TOWARDS THE HANDLING OF MATERIALS
- L REGULAR EDUCATION AND TRAINING OF PERSONNEL ON HOW TO HANDLE
- M CHECKING MATERIALS SUPPLIED FOR RIGHT QUALITIES AND VOLUMES
- N EMPLOYMENT OF SKILLED WORKMEN
- O ACCURATE AND GOOD SPECIFICATIONS OF MATERIALS TO AVOID WRONG ORDERING
- P ENCOURAGE RE-USE OF WASTE MATERIALS IN PROJECTS
- Q CAREFUL HANDLING OF TOOLS AND EQUIPMENT ON SITE
- R WEEKLY PROGRAMMING OF WORKS
- S MIXING, TRANSPORTING AND PLACING CONCRETE AT THE APPROPRIATE TIME
- T WASTE MANAGEMENT OFFICER OR PERSONNEL EMPLOYED TO HANDLE WASTE ISSUES
- U ADOPTION OF PROPER SITE MANAGEMENT TECHNIQUES

• V ACCESS TO LATEST INFORMATION ABOUT TYPES OF MATERIALS ON THE MARKET
• W MINIMIZING DESIGN CHANGES
• X PURCHASING RAW MATERIALS THAT ARE JUST SUFFICIENT
• Y USING MATERIALS BEFORE EXPIRY DATES

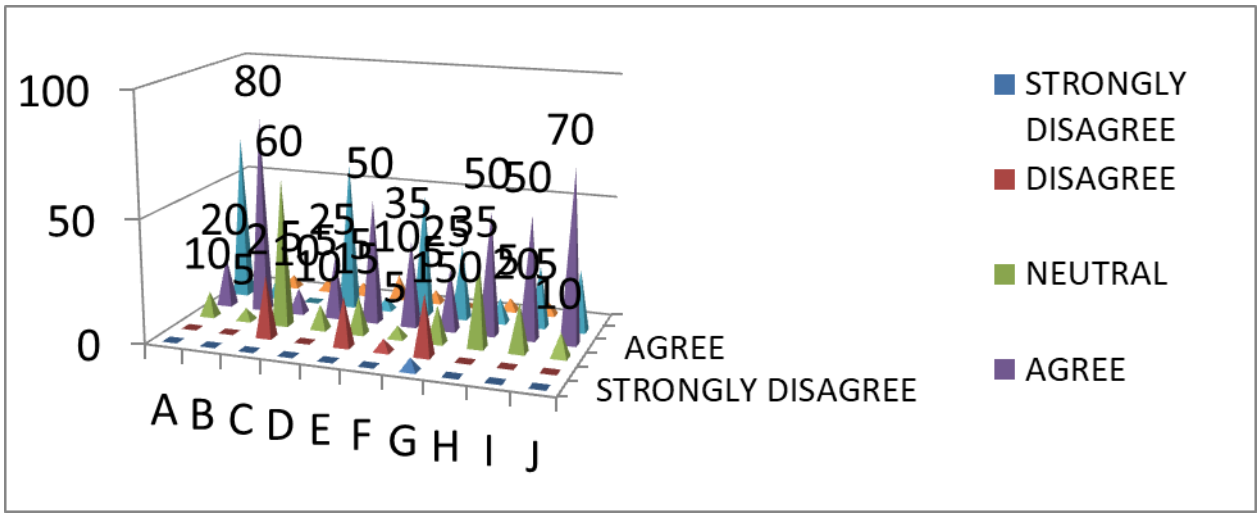

Fig. 12. Application of Lean Principles in Projects

KEY
• A DELIVERING WHAT THE CLIENT WANTS
• B ESTABLISHING CONTINUOUS IMPROVEMENT: THUS, REDUCTION OF COSTS, INCREASE IN QUALITY AND PRODUCTIVITY
• C DOING THE RIGHT THINGS AT THE FIRST TIME: THUS ACHIEVE ZERO DEFECTS, REVEALING AND SOLVING PROBLEMS AT THE SOURCE
• D AVOIDING DEFECTS IN THE WORKS DONE THAT CAN RESULT IN FOR EXAMPLE, WASTE, UNNECESSARY REWORK, LOSS OF CUSTOMERS AND CORPORATE REPUTATION
• E INVOLVING THE WHOLE PROJECT TEAM THROUGH THE DESIGN TO CONSTRUCTION
• F CONSTANTLY SEEKING BETTER WAYS TO DO THINGS
• G INCREASING OUTPUT VALUE THROUGH SYSTEMATIC CONSIDERATION OF CUSTOMER REQUIREMENTS
• H INCREASING OUTPUT FLEXIBILITY: THUS THE PRODUCTION OF DIFFERENT MIXES AND/ OR GREATER DIVERSITY OF PRODUCTS, WITHOUT COMPROMISING EFFICIENCY
• I WASTE MINIMIZATION: THUS, ELIMINATING ALL NON-VALUE ADDING ACTIVITIES AND MAXIMIZING THE USE OF ALL RESOURCES
• J BUILDING AND MAINTAINING LONG-TERM RELATIONSHIPS WITH SUPPLIERS

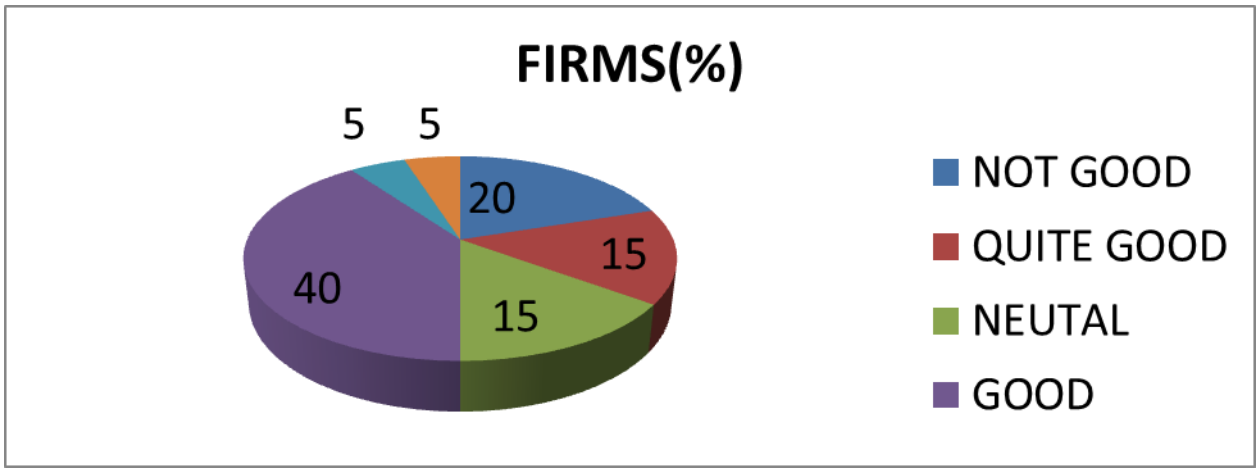

Fig 13. Transferability of Lean Principles to Construction

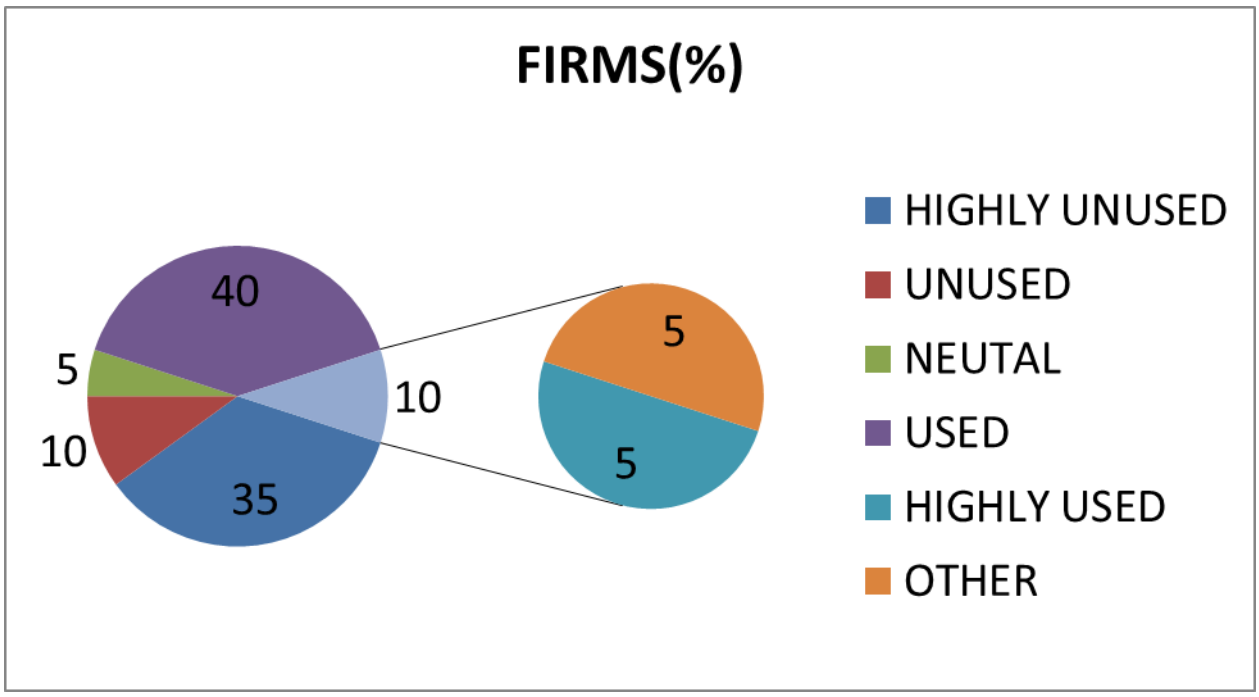

Fig 14. Extent of use of Lean Principles

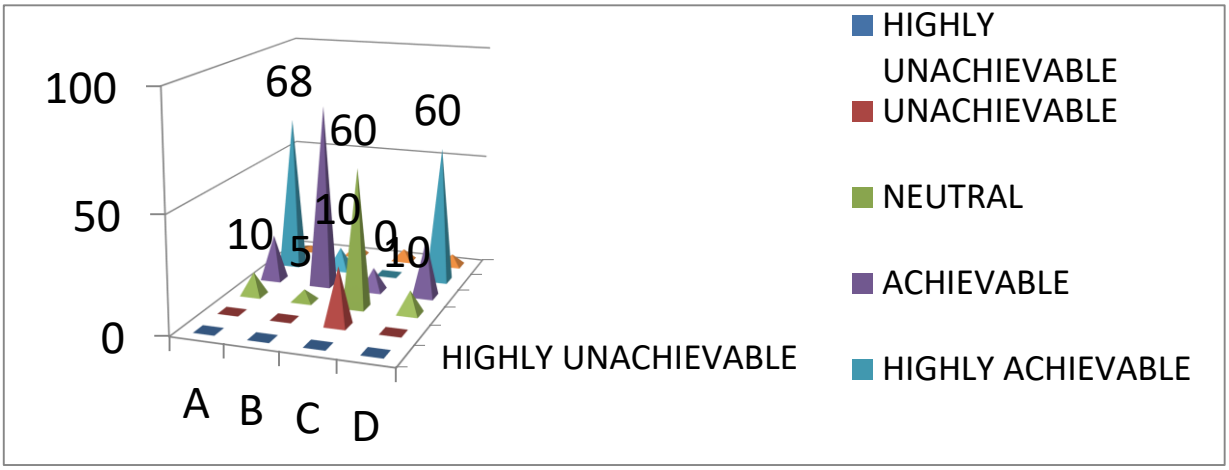

Fig.15. Achievability of Customer Values in Company Operations

• A PERFECT FIRST-TIME QUALITY: ACHIEVING ZERO DEFECTS, REVEALING AND SOLVING PROBLEMS AT THE SOURCE

• B KEEPING EVERYTHING SIMPLE, RIGHT FROM DESIGN THROUGH TO COMPLETION

• C INCREASING OUTPUT FLEXIBILITY: THUS, THE PRODUCTION OF DIFFERENT MIXES AND OR GREATER DIVERSITY OF PRODUCTS, WITHOUT COMPROMISING EFFICIENCY.

• D CONTINUOUS IMPROVEMENT: REDUCTION OF COSTS, INCREASE QUALITY AND PRODUCTIVITY

• F PROMOTE LEAN CONSTRUCTION

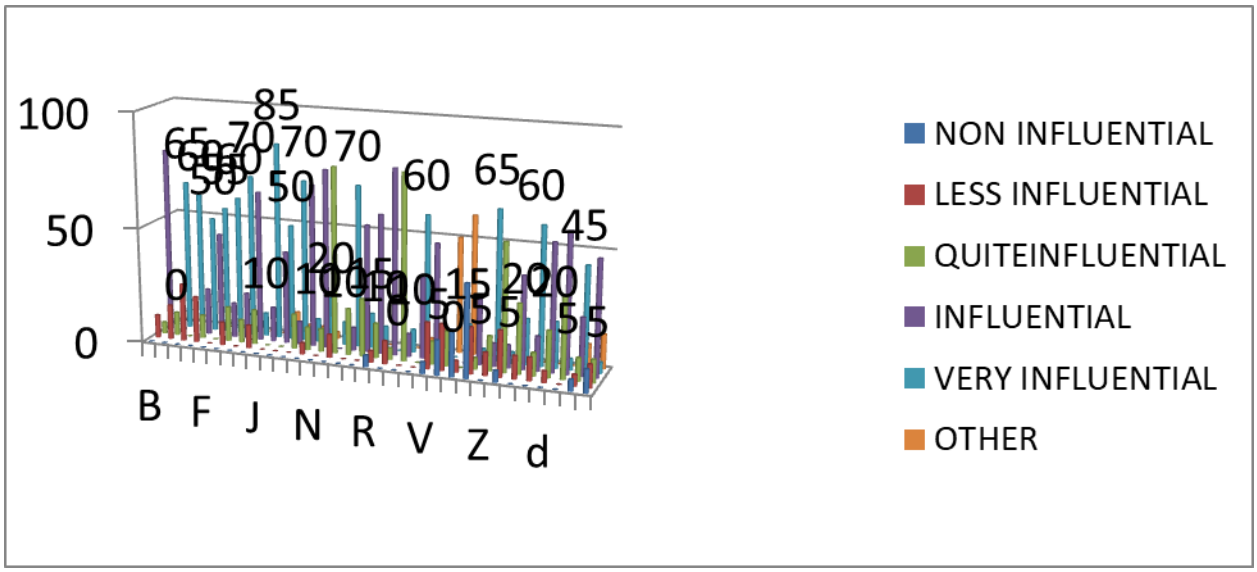

Fig. 16. Barriers to Implementation of Lean Concept

KEY

• A LACK OF INTEREST FROM CLIENTS
• B WASTE ACCEPTED AS INEVITABLE
• C POORLY DEFINED INDIVIDUAL RESPONSIBILITIES
• D LACK OF TRAINING
• E LESS INVOLVEMENT OF CONTRACTORS AND SPECIALISTS IN DESIGN PROCESS
• F DELAYS IN DECISION MAKING
• G LACK OF TOP MANAGEMENT SUPPORT AND COMMITMENT
• H POOR PROJECT DEFINITION
• I DELAY IN MATERIALS DELIVERY
• J LACK OF EQUIPMENT
• K MATERIALS SCARCITY
• L UNSUITABLE ORGANIZATIONAL STRUCTURE
• M LACK OF SUPPLY CHAIN INTEGRATION
• N POOR COMMUNICATION
• O LONG IMPLEMENTATION PERIOD
• P INADEQUATE PRE-PLANNING
• Q LACK OF CLIENT AND SUPPLIER INVOLVEMENT
• R CORRUPTION
• S POOR PROFESSIONAL WAGES
• T LACK OF STANDARDIZATION

- U LACK OF TECHNICAL SKILLS
- V HIGH LEVEL OF ILLITERACY
- W LACK OF AWARENESS PROGRAMS
- X DIFFICULTY IN UNDERSTANDING CONCEPTS
- Y INCOMPLETE DESIGNS
- Z LACK OF BUILDABLE DESIGNS
- a INCONSISTENCY IN GOVERNMENT POLICIES
- b LACK OF AGREED IMPLEMENTATION METHODOLOGY
- c HIGH DEPENDENCY OF DESIGN SPECIFICATIONS ON IN-SITU MATERIALS AND COMPONENTS RATHER THAN STANDARDIZED AND INDUSTRIALIZED PREFABRICATED COMPONENTS
- d EXTENSIVE USE OF SUBCONTRACTORS
- e LACK OF LONG- TERM COMMITMENT TO CHANGE AND INNOVATION
- f LACK OF LONG-TERM RELATIONSHIP WITH SUPPLIER

g THE FRAGMENTED NATURE OF THE CONSTRUCTION INDUSTRY

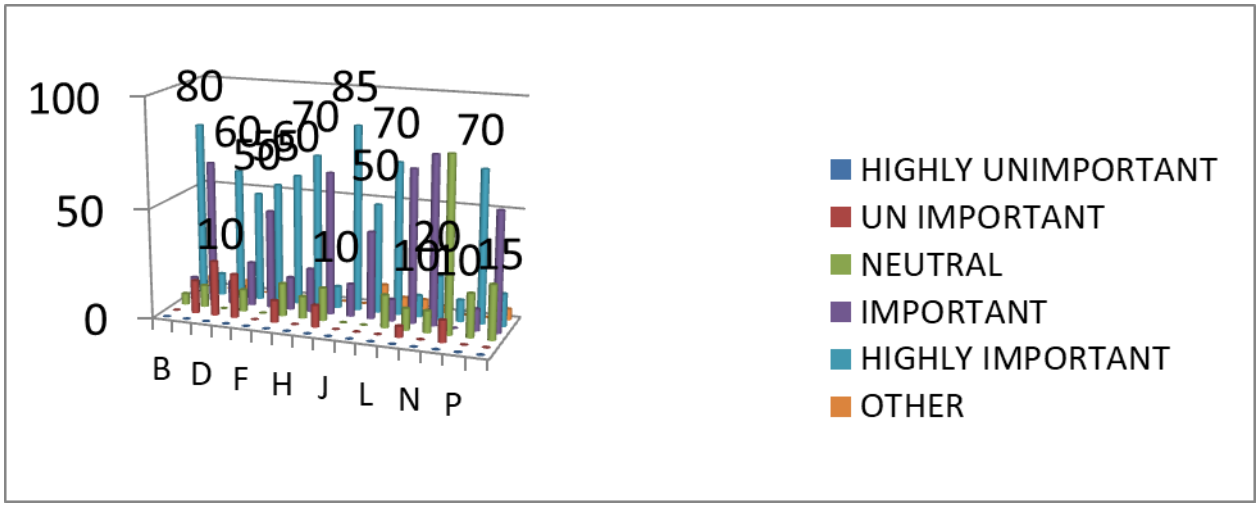

Fig. 17. Measures to overcome Barriers to Implementation of Lean Concepts

- A MANAGEMENT SHOULD TRAIN EMPLOYEES ON LEAN CONCEPTS
- B COMMUNICATION SHOULD BE IMPROVED AMONG PLAYERS IN CONSTRUCTION PROJECTS
- C CONSTRUCTION SHOULD ENSURE OR MAINTAIN CONTINUOUS IMPROVEMENT: THUS, REDUCTION OF COSTS, INCREASE QUALITY AND PRODUCTIVITY
- D CONSTRUCTION MANAGERS SHOULD BE COMMITTED TO CHANGES
- E WORKERS SHOULD BE ABLE TO WORK IN TEAMS
- F PROACTIVE MEASURES TO PREVENT DEFECTIVE PRODUCTION SHOULD BE ESTABLISHED BY FIRMS
- G TIMELY DELIVERY OF MATERIALS TO CONSTRUCTION SITES
- H FIRMS SHOULD UNDERSTAND CLIENT NEEDS AND EXPECTATIONS AND POSITION THEMSELVES ACCORDINGLY
- I COMPANIES SHOULD BE MORE CLIENT FOCUSED
- J STANDARDIZED CONSTRUCTION ELEMENTS SHOULD BE PROMOTED IN THE INDUSTRY
- K FIRMS SHOULD BE WILLING TO CHANGE ORGANIZATIONAL CULTURES THAT DO NOT PROMOTE LEAN CONSTRUCTION
- L THE OPINION OF EMPLOYEES SHOULD BE CONSIDERED IN DECISION MAKING
- M GOVERNMENT AGENCIES SHOULD EMBARK ON APPLICABLE POLICIES THAT COULD PROVIDE CRITICAL SUPPORT TO MAKE LEAN METHODS FEASIBLE

– N MANAGEMENT SHOULD MONITOR INFLATION RISKS AND PRICING LEVELS THAT COULD PROVIDE THE STABILITY THAT ORGANIZATIONS NEED IN ORDER TO MAKE LEAN METHODS FEASIBLE

• O MANAGEMENT SHOULD DEAL WITH UNCERTAINTIES AND FEARS THAT CAUSE ORGANIZATIONS TO CONCEAL INFORMATION INSTEAD OF SHARING IT

• P PARTNERING SHOULD BE PROMOTED TO MAXIMIZE TEAM BUILDING AND DEVELOPMENT OF TRUST

• Q TEAM MEMBERS SHOULD BE EMPOWERED IN DECISION-MAKING TO MAKE THESE PARTNERSHIPS MEANINGFUL

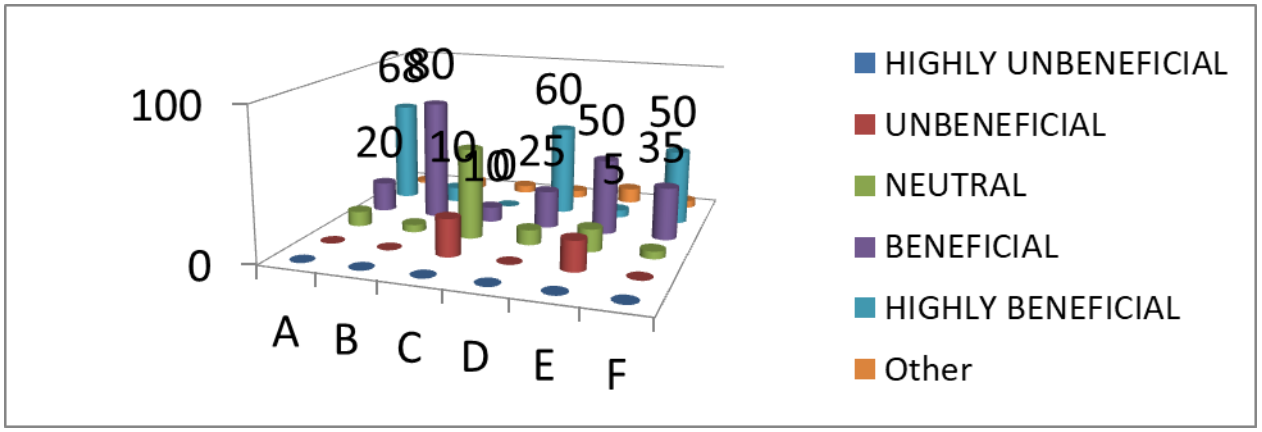

Fig. 18. Benefits of the Implementation of Lean Concept in the Construction Industry

• A DELIVER PRODUCTS OR SERVICES THAT ENABLE CUSTOMERS TO BETTER ACCOMPLISH THEIR GOALS

• B DELIVER PRODUCTS OR SERVICES ON TIME AND WITHIN BUDGET MINIMIZE DIRECT COSTS THROUGH EFFECTIVE PROJECT DELIVERY MANAGEMENT MAKE WELL -INFORMED BUSINESS DECISIONS AT ALL PROJECT LEVELS

• C DELIVERS A CUSTOM PRODUCT, INSTANTLY, WITHOUT WASTE

• D REDUCE SYSTEM NOISE IMPROVE PROJECT DELIVERY METHODS

• E PROMOTE CONTINUOUS IMPROVEMENT IN PROJECT DELIVERY METHODS THROUGH LESSONS LEARNED

• F MINIMIZE RISK AND MAXIMIZE OPPORTUNITY INJECT RELIABILITY, ACCOUNTABILITY, CERTAINTY, AND HONESTY INTO THE PROJECT ENVIRONMENT

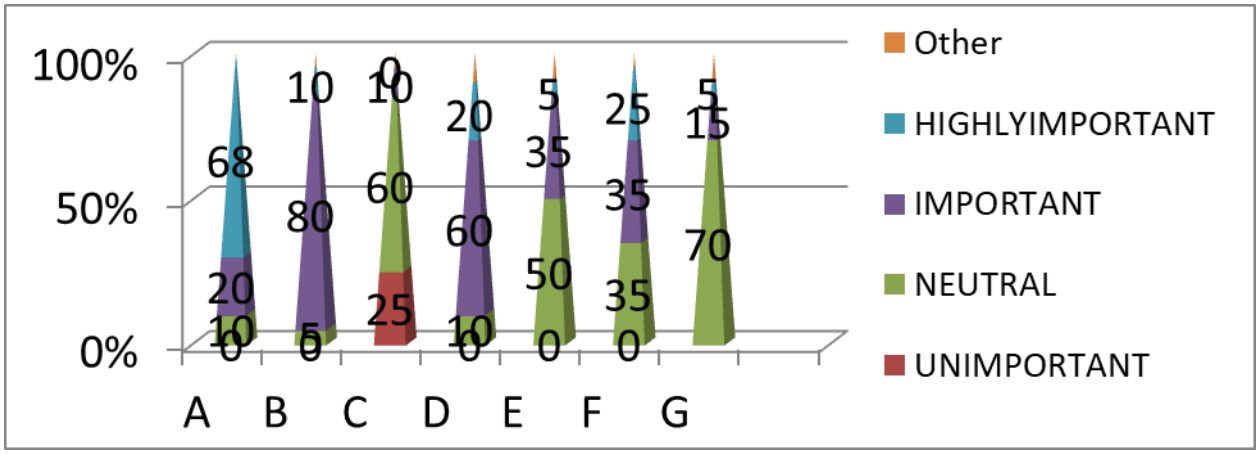

Fig. 20. Measures of Bridging Knowledge Gaps

KEY

• A TRAINING OF EMPLOYEES AT ALL LEVELS ON LEAN CONSTRUCTION

• B ENGAGEMENT OF COMPETENT AND SKILLED SITE OPERATIVES

• C PROMOTION OF THE CONCEPT TO FIRMS, PROFESSIONAL BODIES AND MAJOR STAKEHOLDERS

• D THE CONSTRUCTION INDUSTRY SHOULD FUND WORKSHOPS AND RESEARCH CONFERENCES TO PROMOTE TRANSFER OF KNOWLEDGE ON LEAN CONSTRUCTION

• E WORKING ON IMPROVING PERFORMANCE WHEN CARRYING OUT PROJECTS

• F CONSTRUCTION MANAGERS SHOULD BE COMMITTED TO CHANGES

• G FIRMS SHOULD CHANGE ORGANIZATIONAL CULTURE THAT DOES NOT PROMOTE LEAN CONSTRUCTION

5. Conclusion

The availability of data on material wastage in construction sites was relatively scarce as indicated from reviewed literature. Studies conducted in different countries are small and mostly focused on limited number of materials in a few construction sites. Distinct measurement procedures and different technologies were involved, therefore comparison of the results difficult.

Results from the current study confirmed that the level of waste in the Nigerian construction industry is fairly high and that much of this waste is predictable and avoidable. The fact that some relatively simple and inexpensive preventive measures have not been implemented indicates a lack of knowledge among construction managers about the performance at their sites.

In fact, several managers from the construction sites that took part in the research were surprised by their low performance Indeed; very few of the sites involved in the studies had organized records on the actual delivery, storage, and consumption of materials.

Project control in those companies is mostly based on financial performance measures, which tend to be backward focused and do not make it easy to trace operational costs (Hope, Frazier, 2013).

The analysis of sources of waste indicated that a large proportion of material waste occurs because flow activities, such as material delivery, inventories, and internal transportation and handling, are often neglected by site management. A similar conclusion was found by Bhasin (2015).

It must be pointed out that the waste of materials tends to increase the amount of non-value-adding activities and thereby the waste of other resources such as labor and equipment time. For instance, the excess of material that needs to be purchased tends to increase stocks, the demand of the transportation system, and the effort necessary to remove debris from site. These problems might also negatively affect health and safety conditions.

The current study has summarized the findings deduced from the analysis of available data and related it to the objectives of the study.

The study has identified the main sources and causes of materials waste in the Nigerian construction industry from the perception of construction practitioners. The level of contribution of the waste sources to the generation of waste saw differences between the perceptions of the respondents. A great number (67 %) agree that „design and documentation factors", „procurement factors" and „material handling factors" have significantly high contribution to the generation of waste on construction sites. Operational factors were however, not of significance to some (43 %) since they believed these problems could easily be dealt with if proper management actions are put in place. They considered „materials handling", „operational factors", „design and documentation factors" and „procurement factors" as having high significant contribution to the generation of waste on construction sites. The results showed that whereas the 47 % of respondents identified design and documentation as the major source of waste, 35 % identified materials handling as the major source of waste.

All the fifteen factors evaluated were considered as major causes of design and documentation waste on construction sites. The results further showed that „last minute client requirement (resulting in rework)", „poor communication leading to mistakes and errors",

„selection of low quality products", „designer's inexperience in method and sequence of construction" and „poor/ wrong specifications" are the first five major causes of waste resulting from design and documentation. Other causes of waste include „lack of knowledge about construction techniques during design activities", „lack of attention paid to dimensional coordination of products", „lack of information in the drawings", „poor site layout", „lack of attention paid to standard sizes available on the market", „complexity of detailing in the drawings", „variations in the design while construction is in progress", „designer's unfamiliarity with alternative products", „incomplete contract documents at commencement of project" and „overlapping of design and construction".

The results from the survey revealed that the respondents consider all the seventeen factors as causes of waste arising out of operational activities on construction sites. The results further revealed that „errors by tradesmen or task operatives", „use of incorrect material, thus requiring replacement", „required quantity unclear due to improper planning", „delays in passing of information to the contractor on types and sizes of products to be used" and „poor interaction between various specialists" were the first five major causes of waste that arise out of operational activities on construction sites. Other equally important causes of operational waste are „unfriendly attitudes of project team and task operatives", „choice of wrong construction method", „damage to work done caused by subsequent trades", „inappropriate placement of the material", „accidents due to negligence", „equipment malfunctioning", „inclement weather", „poor technology of equipment", „effects of political and social conditions", „shortage of tools and equipment required", „frequent breakdown of equipment" and „difficulties in obtaining work permits".

The findings revealed that „purchasing products that do not comply with specification", „unsuitability of materials supplied to site", „substitution of a material by a more expensive one", „ordering errors" and „changes in material prices" are the major causes of waste arising out of procurement activities.

It was established from the survey that „lack of onsite materials control", „damage to materials on site during transportation", „poor handling of materials", „waste resulting from cutting uneconomical shapes" and „using excessive quantities of materials than required" are the major causes of waste arising from materials storage and handling. The results further revealed that „overproduction/ production of a quantity greater or required than necessary", „theft", „poor method of storage on site", „manufacturing defects," „unnecessary inventories on site leading to waste", „use of whatever material close to working place", „insufficient instructions about handling", „use of wrong method of transport" and „overloading of transport equipment" are other important causes of materials waste arising from storage and handling.

Timber, cement/mortar, concrete, blocks, steel, quarry chippings/ coarse aggregates, paint, sand and tiles are the key materials wasted on construction sites. The results showed that all the materials with the exception of pipes have high levels of contribution toward the generation of waste on construction sites.

The respondents considered all the 26 measures as important for minimizing wastage of materials on site. The results further showed that „purchasing raw materials that are just sufficient, using materials before expiry dates, good coordination between store and construction personnel to avoid over ordering, „use of more efficient construction equipment and „adoption of proper site management techniques are the five most important measures which can minimize the wastage of materials on construction sites. The least but important measures identified by the respondents include „encouraging re-use of waste materials in projects , „use of low waste technology (WMM 12)" and „recycling of some waste materials on site .

The study has provided empirical evidence on the levels of contribution and the levels of practice of waste minimization measures in the Nigerian construction industry. It has shown that purchasing raw materials that are just sufficient, using materials before expiry dates and use of more efficient construction equipment are perceived as the three measures that most significantly contribute to waste minimization and also the most practiced waste minimization measures. Encouraging re-use of waste materials in projects, using low waste technology and recycling of some waste materials on sites are, however, perceived as the least significant factors that contribute to waste minimization and the least practiced measures simply because such measures are seen as adding to their production cost instead of reducing cost.

Analysis of the results obtained from the structured questionnaire survey showed the existence of some level of awareness among professionals in the Nigerian construction industry on the concept of lean construction. Principles adopted by construction organizations in their activities such as „delivering what the client wants", „establishing continuous improvement", „constantly seeking better ways to do things", „waste minimization" and „avoiding defects in works done" are observed to be generally consistent with lean construction practice. Majority of the construction professionals surveyed are receptive to lean principles implementation in the construction industry, and are also of the opinion that the transfer of lean construction principles into the construction industry would bring a lot of benefits including „improvement of project delivery methods" and „delivery of products or services that enable clients to better accomplish their goals".

Among the factors identified by construction organizations and consultancy firms as potential barriers to the implementation of LC, factor analysis enabled 26 of them to be placed under six categories: 1) lack of proper planning and control comprising delays in materials delivery, inefficient use of quality standards, long implementation period, waste accepted as inevitable, inconsistency in government policies, high dependency of design specifications on in-situ components and materials, extensive use of subcontractors, lack of long term commitment to change and innovation, lack of long term relationship with suppliers, delays in decision making and materials scarcity; 2) Lack of teamwork comprising the fragmented nature of the industry, lack of interest from clients, poorly defined individual responsibilities and less involvement of contractors and specialists in design process; 3) Poor project management comprising poor project definition, lack of equipment, lack of agreed implementation methodology and unsuitable organizational structures; 4) Lack of technical capabilities comprising lack of buildable designs, incomplete designs and lack of standardization; 5) Lack of professional motivation comprising poor professional wages and corruption; 6) Poor communication between parties comprising difficulty in understanding lean concepts and poor communication.

The results revealed that the five most significant measures to overcome potential barriers to implementation of LC in the Nigerian construction industry are „management should train employees on lean concepts", „communication should be improved among players in construction projects", „construction should ensure or maintain continuous improvement: thus, reducing costs, increasing quality and productivity", „construction managers should be committed to changes", and „the ability of workers to work in teams".

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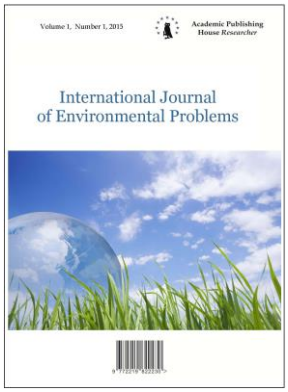
Published in the Slovak Republic
International Journal of Environmental Problems
Has been issued since 2015.
E-ISSN: 2413-7561
2018, 4(1): 76-82

DOI: 10.13187/ijep.2018.1.76
www.ejournal33.com



Identifying the Challenges Affecting Contractors Performance in the Execution of Building Projects

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Abstract

The aim of this research work is to assess to the challenges affecting contractors in public sector the execution of public sector building projects in Bauchi Local Government of Bauchi State. To identify the challenges facing the execution of projects in Bauchi Local Government through literature review and personal experiences of contractors. To evaluate the extent to which these challenges affect the execution of public building projects in Bauchi. Structured questionnaires were distributed to specialist practitioners and companies. It was discovered that due to the nature of public sector building projects, contractors have a remote relationship with the client. Hence, delay in payments was found to substantially pose a challenge to the contractor when executing public sector building projects. It was also found corruption of government officials to be a great challenge during execution as discovered here. Theft of materials, fluctuation of prices, and poor workmanship were also discovered to generally pose a challenge to the process of executing works.

Keywords: corruption, material waste, structures', construction, monitoring.

1. Introduction

The construction industry is that sector of the National economy of Building and Civil engineering structures for the development of both structures and infrastructures. It embraces a wide range of loosely integrated organizations that collectively construct alter and repair a wide range of different range of Building and Civil engineering structures (Seeley, 2011).

The construction industry globally is an array of professionals, operatives, technicians, laborers' as well as clients and contractors working together towards the realization of a specific goal. It represents nearly 70 % of the capital base of the National economy and it is an indication of the significance of the industry within the economy (Bmpiu, 2012).

Sani (2011) discovered that government is the Quantity surveyors major client having a percentage of 87.10% with building projects as the project type with 80.65 % and the highest contract size of 74.19 %.

While some construction projects are realized through direct labor, the bulk is contracted to independent construction firms.

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According to Sani (2011), cited by Oxford advanced learner's dictionary defines challenges as a statement or action that disputes something'. Challenges may also be regarded as problems that stimulate or objects efforts (Onwusonye, 2014).

The execution of a project involves the mobilization of plants and materials to site and recruitment of the human resources necessary for the construction of buildings.

A contractor is an individual or group of individuals that contract with these organizations or individual (the client) for the construction, alteration or repair of structures. They produce the primary product of the industry Buildings. Over time, the sector appears to have lost grip of the traditional core values and in a bid to eliminate corruption, reduce poverty, and rebuild our institution and systems, the federal government of Nigeria in 2001 created the Budget Monitoring and Price Intelligent Unit to implement Public Procurement Reforms.

Various challenges such as inflation, changes in scope of work, changes in Government, improper pre-contract planning etc. have been identified as those that are faced during building project execution in Nigeria (Abdulwahab, 2011)

Huge amounts of money being spent on the building of schools, Hospitals, houses and other public buildings and the standard of living of the people deteriorates rapidly (Akintoye, 2011). In his work, Sani (2013), identified that parties to a contract pose greater challenge than time, payment, and economy-related challenges to construction firms during execution. The contractor is responsible for the finished product of the industry.

Windapo and Yakubu (2011) present a gloomy picture of dismal performance in the sector. Windapo (2012) documented 62 cases of reported building collapse in Nigeria between 2011 and 2012.

Carnell (2010), in his book postulated that the scope for disputes is at its greatest at the point of day to day contact between the contractor and employer and/or contractor and subcontractor.

Projects which do not get executed or are haphazardly executed leave the people yearning for the same needs or they do not have maximum utility from the existing ones. In a nutshell, the significance and need of this study to the construction firms, contractors, subcontractor and the general public in order to affect a lasting impact on their lives cannot be overemphasized.

2. Relevance

Jonathan (2010) stated that the importance of assessing the current state of all the federal government projects to provide accurate information on their status has become not only necessary but critical to National development. We have received reports of non-performance of some contracts. Jonathan (2010) listed the terms of reference of the committee to include "To examine the reason given if applicable why the projects were not executed in accordance with the terms of agreement at the time of the award and to make appropriate recommendations to Government on how to fast track the completion of the projects.

3. Materials and Methods

A descriptive research approach was used for the study; the study was carried out through a field survey involving the propriety and administration of structured questionnaire, as the instant of the research and source of primary data.

A total of 38 questionnaires were administered out of which 32 (84.21 %) were returned and 6 questionnaires (15.78 %) were withheld. The questionnaire listed out the challenges affecting the execution process under 7 sub headings with a rating done on a 1-5 scale, not serious to very serious as they affected each respondent.

The sample was drawn from a list of construction companies in Abuja and Kaduna metropolis due to larger construction activities there. The population study was made up of 38 different construction companies.

The data obtained from questionnaires was analyzed using descriptive statistics, in form of mean score value, standard deviation, standard errors. They were arranged from the most important challenge to the least important challenge.

4. Discussion

Table 1. Administration of questionnaires

NUMBEROF QUESTIONS	NO. OF COMPANIES	PERCENTAGES
Total number of questionnaire distributed	38	100%
Number returned	32	84.21%
Number not-returned	6	15.79%

Table 1 above shows the administration of questionnaires. A total of 38 questionnaires were administered out of which 32 questionnaires (84.21 %) were returned and 6 questionnaires (15.79 %) were withheld.

Statistical analyses were undertaken using the statistical package for social sciences (SPSS) version 17.0. The ranking of the challenges affecting the contractor were done based on the arithmetic mean value scores. A high value indicates a high level of importance and vice versa.

Table 2. Challenges posed by the contractors

S/N	Contractors Factors Identified in Order of Importance	RESPONSE			
		Mean Score	Rank	Standard	Standard Deviation
1	Relationship with the client	3.72	1st	0.202	1.143
2	Poor communication	3.37	2nd	0.182	1.030
3	Delay caused by sub-contractor	3.31	3rd	0.171	0.965
4	Inexperience of contractor	3.01	4th	0.225	1.270
5	Mistake during construction	3.00	5th	0.191	1.078
6	Nature of work	2.97	6th	0.193	1.092

Table 2 above shows the list of the factors as they relate to the contractor such that; Relationship with the client with mean score value of 3.72 is the most ranked with a standard deviation of 1.143 (i.e. most critical factor), while poor communication, with mean score of 3.37 is the second most critical factor with standard deviation 1.030 and ranked second.

Other factors like delay caused by subcontractor, inexperience of contractor, mistakes during construction, where ranked 3rd, 4th and 5th respectively, in accordance with their mean score values, while "nature of work" was ranked 6th as being the least critical factor with mean value of 2.97 and standard deviation 1.092.for standard deviation, the smaller the value, the more closely the opinions of respondents than a factor with larger standard deviation.

Table 3. Challenges posed by the employers

S/N	Employers Factors Identified in Order of Importance	RESPONSE			
		Mean Score	Rank	Significant effect	Standard Deviation
1	Delay in payment	3.84	1st	0.156	0.884
2	Slow response to request	3.59	2nd	0.145	0.837
3	Variation of works	3.41	3rd	0.195	1.103
4	Change orders	3.34	4th	0.183	1.035

5	Under valuation	3.28	5th	0.230	1.301
6	Over valuation	3.25	6th	0.233	1.320

Table 3 shows the challenges posed by employers to the contractor, ranked in order of importance. Delay in payments is ranked first with mean score value of 3.84 and standard deviation of 0.884, followed by slow response to requests, with mean score value of 3.59 and standard deviation of 0.837, as being the second critical challenge. Variation of works is ranked 3rd with mean score value of 3.41, change order is fourth with 3.34 mean, while under-valuation is the fifth critical challenge with mean value of 3.28. The low level of difference between the mean score value shows the significant effect of all the listed challenges caused by the employer to the execution of building projects.

Table 4. Challenges posed by the social environment

S/N	Social challenges	RESPONSE			
		Mean Score	**Rank**	**Significant effect**	**Standard Deviation**
1	Theft of materials	3.56	1st	0.174	0.836
2	Vandalization	3.19	2nd	0.188	0.621
3	Area boys syndrome	3.03	3rd	0.198	0.150
4	Community fracas	2.88	4th	0.205	0.143

Table 4 shows the respondents view on challenges posed by the social environment that affect the execution of a building project. Theft of materials, is ranked first, having mean score value of 3.56, the second ranked challenge is vandalization, while area boys' syndrome, is ranked third and community fracas, is the least ranked challenge on the table with a mean score of 2.88 and a standard deviation of 4.

Table 5. Challenges posed by the political and regulatory environment

S/N	**Political and regulatory challenges**	**RESPONSE**			
		Mean Score	**Rank**	**Significant effect**	**Standard Deviation**
1	Corrupt government officials	4.19	1st	0.138	0.780
2	Unstable politics	3.75	2nd	0.206	1.164
3	Long procedure for approval of work and payment	3.63	3rd	0.154	0.871
4	Instability of policies	3.59	4th	0.210	1.188
5	Statutory amendments	3.16	5th	0.163	0.920
6	Problems with land acquisition	3.09	6th	0.208	1.176
7	Custom and import restriction	2.75	7th	0.162	0.169

Table 5 shows the challenges posed by the political/regulatory environment affecting the execution of building projects, ranked according to their level of impact on projects from the highest and the least in order of decreasing mean score values. Corrupt government officials is the first ranked challenge with mean value of 4.19 and standard deviation of 0.780, while unstable politics ranked second has a mean score value of 3.75 and standard deviation of 1.164. Last on the list is custom and import restrictions which is ranked 7th with mean score value of 2.75 and standard deviation of 0.196. long procedures for approval and payment, instability of policies,

statutory amendments and problems with land acquisition are ranked 3rd, 4th, 5th and 6th respectively in order of decreasing mean score values.

Table 6. Challenges posed by the economic and financial environment

S/N	Economic and Financial Challenges	Response			
		Mean score	**Rank**	**Significant effect**	**Standard deviation**
1	Fluctuation of prices	3.66	1st	0.172	0.971
2	Inflation	3.65	2nd	0.183	1.035
3	High interest rates	3.38	3rd	0.205	1.157
4	Lack of capital	3.38	4th	0.219	1.238
5	Exchange rate	3.22	5th	0.189	1.070
6	High local and national tax effects	2.94	6th	0.185	1.045

Table 6 shows the challenges posed by the economic/financial environment affecting the execution of building projects .Fluctuation of prices is ranked first with mean score value of 3.66 and standard deviation of 0.971, while inflation is ranked second on the table with mean score value of 3.65 and standard deviation of 1.035. High local and national tax effects are ranked least (6th) as having mean score value of 2.94 and standard deviation of 1.045.

Table 7. Challenges posed by the Infrastructure environment

S/N	Environment and Infrastructure Challenges	Response			
		Mean score	**Rank**	**Significant effect**	**Standard deviation**
1	Poor infrastructure e.g roads etc	3.53	1st	0.149	0.842
2	Site location and access	3.19	2nd	0.152	0.859
3	Unfavorable site conditions	3.06	3rd	0.179	1.014

Table 7 is a representation of challenges posed by the infrastructural factors affecting the execution of building projects. The table shows poor infrastructure as the highest ranked challenges by respondents with mean score value of 3.53 and standard deviation of with mean of 3.19 and standard deviation of 0.859. Unfavorable site conditions are ranked third and least with mean score value of 3.06 and standard deviation of 1.014.

Table 8. Challenges posed by the Management environment

S/N	Management Challenges	RESPONSE			
		Mean score	**Rank**	**Significant effect**	**Standard deviation**
1	Corruption and Fraud	3.94	1st	0.190	1.076
2	Poor planning and organization	3.84	2nd	0.136	0.767
3	Poor financial management	3.63	3rd	0.178	1.008
4	Poor communication between users developers	3.28	4th	0.163	0.924

5	Coordination problems	3.19	5th	0.138	0.780
6	Dispute between team members	3.16	6th	0.186	1.051

Table 8 above represents the challenges posed by the managerial environment affecting the execution of building projects; ranked in order of decreasing mean score value. Corruption and fraud is ranked highest with mean score value of 3.94 and standard deviation of 1.076, poor planning and organization is second ranked with mean score value of 3.84 and standard deviation of 0.767, while dispute between team members has the least mean score value of 3.16 and standard deviation of 1.051.

Table 9. Challenges posed by the technical and labor environment

`	TECHNICAL AND LABOUR CHALLENGES	RESPONSE			
S		**Mean score**	**Rank**	**Significant effect**	**Standard deviation**
1.	Poor workmanship	3.44	1st	0.233	1.318
2.	Low productivity of labor	3.41	2nd	0.200	1.132
3.	Lack of technological improvement	3.31	3rd	0.193	1.091
4.	High cost of labor	3.22	4th	0.178	1.008
5.	Design failure/errors	3.13	5th	0.232	1.314
6.	Construction failure	3.06	6th	0.195	1.105
7.	Shortage of labor	2.94	7th	0.224	1.268
8.	Volume of work	2.78	8th	0.184	1.039
9.	Labor strikes	2.59	9th	0.195	1.103
10.	Difficulty in acquisition of plant	2.44	10th	0.190	1.076
11.	Collapse of building	2.41	11th	0.173	0.979

Table 9 above shows the challenges posed by the technical/labor environment that affect the execution of building projects, with poor workmanship as the most critical challenge ranked the first with a mean score value of 3.44 and standard deviation of 1.318. Low productivity of labor is second with a mean of 3.41, lack of technological improvement, 3.31. Collapse of buildings is the least and ranked eleventh with a mean score value of 2.41 and standard deviation of 0.979.

5. Conclusion

Due to the nature of public sector building projects, contractors have a remote relationship with the client. Hence, delay in payments was found to substantially pose a challenge to the contractor when executing public sector building projects. This fact was reiterated by Maryam (2009). Sani (2008) disagreed as he highlighted bureaucracy to post the greatest challenge followed by delay in payments during the execution of public sector building projects. He also found corruption of government officials to be a great challenge during execution as discovered here. Theft of materials, fluctuation of prices, and poor workmanship were also discovered to generally pose a challenge to the process of executing works. Under economic factors, Maryam (2009) highlighted material fluctuations as a problem affecting contractors' cash flow.

From the foregoing analysis and findings of this study, it is obvious that a lot of challenges faced during the execution of building projects have severe impact on the execution stage of such projects. These challenges are caused by all parties involved in the project and their respective employers, while others were caused by neither parties nor their employers. The environment is affected mostly in terms of esthetics and beautification. Where low grade materials are used, it is most likely to cost havocs in terms of structures collapsing, and drainages overflowing and hazardous gases when bad roofing materials are used. The aforementioned anomalies can be corrected when a lot of bureaucracy and hitches by governments and policy makers are removed. When the

professionals maintain high ethics in their work, on site and off site during designs. Materials of high quality should also be procured.

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