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RESEARCH ARTICLE

Appraising the Impact of Rule of Law, Control of Corruption, And Govt. Effectiveness on Inflation: An Empirical Case of Bangladesh

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Abstract

This study is an effective initiative to find out the impact of noneconomic determinants as well as the importance of noneconomic determinants on inflation in Bangladesh. Time series data was used from 1996 to 2020. The unit root test, on the other hand, indicates that the stationary at the first difference of all variables indicates I(1). Cointegration results ensure long-run associations among variables. The econometric methods apply the Generalized Linear Model (GLM) technique for measuring the importance of noneconomic determinants for controlling inflation. Findings show the importance of noneconomic determinants to controlling inflation, where the controls of corruption, the rule of law, and government effectiveness have influenced the reduction of inflation in Bangladesh. It should be focused on improving the quality of noneconomic performances and emphasizing the significance of those factors through the implications of rules and regulations, digitalization, and ensuring open-door services and accessible information for all consumers of goods and services. Further study may consider the other noneconomic as well as macroeconomic determinants that have a large contribution to determining inflation in Bangladesh.

Keywords: Control of Corruption; Government Effectiveness; Inflation; Role of Law

Introduction

In recent years, the price level has been getting higher and higher due to the rising rate of inflation, which has become a major concern in Bangladesh. Despite being one of the fastest-growing economies in the global economy, analysts warn that rising inflation and growing prices could hamper economic recovery and possibly lead to food shortages in a country already hit by severe weather and pandemic-related disruption. Here, the term “inflation” refers to the constant upward movement in the general price level of goods and services that causes a reduction in the standard level of purchasing power over time. In Bangladesh, the current rate of inflation has gone up to 6.17 % from 5.86 % in February of 2022, which is the highest rate of inflation since October 2021 (Bangladesh Bureau of Statistics

(BBS) Report, 2022). Such high inflation could seem like a temporary blip but can spiral out of control if adequate measures are not taken. According to Ashraf et al. (2016) and Islam et al. (2022), inflation can negatively impact macroeconomic performance because it disrupts the exchange mechanism. Asako (1983) also found that inflation can cause slower capital accumulation during the transition under certain situations. Apart from that, inflation adversely affects a country’s underprivileged population due to pricey groceries, commodities, and other necessities (Rahman et al., 2022; Elahi & Rahman, 2021; Rahman & Habib, 2021; Majumder & Rahman, 2022). As the prices of essentials go up, so does the cost of living, causing suffering for most people. Therefore, inflation control is one of the primary objectives of monetary policy in Bangladesh.

The reasons behind inflation in Bangladesh are multidimensional and dynamic here, both economic determinants and non-economic determinants such as the rule of law, control of corruption, and government effectiveness influence the rate of inflation (Rahman & Majumder, 2021; Majumder et al., 2022; Rahman et al., 2023; Rahman & Majumder, 2022; Rahman & Majumder, 2020). Irregularities, unrest, and political instability can also cause inflation. For example, since economic determinants for inflation have always gotten more focus compared to the non-economic determinants, the rule of law, control of corruption, effective government, and other crucial factors were overshadowed despite having an impact on controlling inflation. As per Coase (2005), economists did not even take into account the importance that lies between the economy and the state of law until recently. Even though non-economic determinants like control of corruption and the rule of law positively affect economic growth (Majumdar, 2022). Hence, the impact of the rule of law, control of corruption, and government effectiveness on inflation is yet to be discussed broadly in the research field. Therefore, to combat the adverse effects of inflation, maintaining a steady inflation rate while considering economic and non-economic determinants is now necessary. As per economists, a low-inflation environment accelerates economic growth. At the same time, a country also needs good governance for its economic development (Grindle, 2012; Rocha & Jotty, 2022). And good governance covers non-monetary aspects like the rule of law, control of corruption, and government effectiveness (Kaufmann et al., 2009). Ensuring the rule of law, controlling corruption and government effectiveness will eventually affect a country's economy, including the inflation rate. Thus, in this study, these three key non-economic indicators have been critically reviewed through general analysis and discussion to measure the impact they pose on inflation in Bangladesh. No one is above the law in a society where the rule of law prevails. It ensures accountability of the government as well as obedience to regulation by the citizens, providing the rights guaranteed by the constitution of a country. The rule of law has a direct influence on sustainable economic growth, particularly for countries with years of monetary instability (Barro, 1996; Fischer, 1984). Therefore, there is a good possibility that the rule of law can also influence economic growth indirectly by reducing the inflation rate to an acceptable level. As economists such as Majumder and Rahman (2020); Dilanchiev et al. (2021) put importance on transactional rites and conviction as factors in the cost of production of goods and services, which depends on acquiescence with the rule of law. On the other hand, corruption is a threat to the state that hinders the efficient operation of the market. Corruption occurs when public power is exercised for private gain. Markets get out of control due to careless responses by corrupt businesses. Corrupt business people are a small group of traders who

want to create a monopoly, influence, and control over the market prices. They sell out or stock up on commodities with their syndicate. All these illegal practices in the market increase the price level. In this case, the government's policies, commitment, and efforts to eradicate corruption can widen the scope for major investments, especially from foreign countries where control of corruption can influence inflation (Braun & Tella, 2004; Uroos et al., 2022).

According to the World Bank (2021), government effectiveness means the government's commitment to policies like public service, civil service, etc., and the implementation of such policies. It mainly depends upon the ability of a government to make democracy through intelligibility, accountability, and public involvement (Kosac & Fung, 2014). It builds people's trust in the government. And that eventually leads to law enforcement and less scope for corruption, indirectly contributing to a reduction in inflation in the country. Besides, the government can use a variety of policies and efforts to limit inflation, such as preserving law and order, ensuring effective resource allocation, resolving budget concerns, addressing trade deficits, etc. In addition, the government must limit the rate of population growth as well as the actions of middlemen to keep inflation under control. This study aims to provide and analyze empirical evidence of the impact of the rule of law, control of corruption, and government effectiveness on inflation in Bangladesh, which will aid in the implementation of a low-inflation strategy. As a result, considering the legal aspects affecting inflation particularly alters the approaches to studying inflation factors in general, removing the difficulties of excessive reliance on abstract theory. However, given the importance of the study in the context of Bangladesh, the influence of legal factors to ensure a stable economy with low inflation must be brought under the spotlight. The study adopted an analytical approach based on secondary data from World Bank.

However, the central focus of this study is to determine how non-economic determinants such as the rule of law, control of corruption, and government effectiveness influence inflation in Bangladesh. The specific objectives of the study are as follows: to analyze the importance of the rule of law, control of corruption, and govt. effectiveness for economic stability and control of inflation. Another objective is to measure the impact of the rule of law, control of corruption, and govt. effectiveness on inflation in Bangladesh.

The results can also be used to look into non-economic factors that contribute to low inflation and the creation of a well-organized legal system. As a result, the study makes an effort to assess how corruption, the rule of law, and government effectiveness affect inflation in Bangladesh, which will give the body of literature a new perspective. The remainder of the section is divided into five sections: Section 2, the literature review; Section 3, the methodology

section; Section 4, the result analysis and discussion; and Section 5, the conclusion and recommendation.

Literature Review

Over the last decade, the factors of inflation have gotten a lot of attention. A lot of research has been done on the determinants of inflation. However, most of the studies were based on the economic determinants behind inflation. Hence, this section of literature is focused on the three vital non-economic determinants of inflation, namely: rule of law, control of corruption, and government effectiveness, to identify the relationship and effect of these determinants on inflation. Shevchuk et al. (2020) used annual data for the period of 2013 to 2019 of the Rule of Law Index from the World Justice Project (WJP) for 40 countries. The estimates of cross-regression and panel data found a favorable anti-inflationary impact of the rule of law for the overall group of 40 countries. Therefore, the rule of law can have a positive impact on reducing the high rate of inflation. Again, according to Acemoglu (2008), empirical evidence discovered that the impact of the rule of law on inflation is nonlinear, and the degree of public control over power may be an influencing factor in such cases, which must be taken into consideration. Moreover, various research findings indicate that the central bank can take institutional decisions with a stronger anti-inflationary impact more independently when democratic institutions and the rule of law are present, as in Bodea (2015), Nurbayev (2018) and Garriga (2020). As a result, it proves that there is a far-reaching consequence of the rule of law on inflation in a country.

A study by Inim et al. (2020) showed that in Nigeria, other than money supply, inflation is also determined by other factors like corruption, government expenditure on security, political instability, etc. The word corruption is defined as “the abuse of entrusted power for private gain” and more often indicates the abuse of public office for private gain (Gray & Kaufman, 1998; Rose-Ackerman, 1999; Lambsdorff, 2007; Rahman et al., 2022; Islam et al., 2022). On the other hand, Mauro (1995) demonstrated that corruption has negative consequences not just on economic development but also on investments and the structure of official institutions, based on a study of 68 countries. According to Braun et al. (2004), inflation variability can lead to higher corruption and less investment. In a sample of 75 economically significant countries, the study discovered a positive association between corruption and inflation fluctuation. As per the findings, a one standard deviation increase in inflation over the median increases corruption by 12% and decreases economic growth by 0.33 percentage points, which shows the influence occurs in both ways.

According to Piplica (2011), corruption increased inflation after the analysis of 10 transitional economies in Central and Eastern Europe. Yousefi (2015) used data from 164

nations between 1995 and 2010 to test her hypothesis that corruption leads to an increase in monetary expansion and, therefore, the inflation rate. For the overall sample, the study's findings revealed a substantial positive link between corruption and inflation. Similarly, the findings of Abed (2002), Smith (2007), and Samimi et al. (2012) are some who say that there is a positive relationship between inflation and corruption. As a result, necessary steps to reverse the increase in corruption must be taken to balance the inflation rate. In this association, Becker (1974), Mookherjee (1989), Png (1995), Besley (1993), and Andreoni et al. (1998), among others, have given a theory that “control” can reduce corruption. Thus, control of corruption can significantly reverse the effect of corruption on inflation.

Apart from the rule of law and the control of corruption, government effectiveness also helps maintain social equality as well as the economic growth of a country. As per Kaufmann et al. (2008), the deciding variables of government adequacy are view of the nature of public administrations, the nature of common administrations, and the level of their autonomy from political tensions; furthermore, the nature of strategy planning and execution; and the believability of the public authority's obligation to such policies. Hence, government effectiveness ensures proper distribution of resources through the implementation of policy, transparency, and accountability to gain the trust of the people. But, the absence of government effectiveness may lead to autocracy, resulting in inflation (Adam & Alhassan, 2021; Raihan et al., 2022). As per Bueno (2005), autocracies by nature depend on a small number of elites in whom political and economic resources are disproportionately concentrated. Apart from this, Khalid (2015) has used an econometric model to examine the short-run and long-run relationships between inflation and each of the important dimensions like government effectiveness, rule of law, and corruption control in Pakistan. It was found that there existed short-run as well as long-run relationships among the dependent and independent variables according to the Engle-Granger methodology. But, research on government effectiveness is still rare from Bangladesh's perspective, which can prove beneficial to altering the high rate of inflation to a stable one.

Lastly, in the case of Bangladesh, only a few studies have examined the role of determinants on inflation. For example, Chowdhury (1995) notes that the inflationary process in Bangladesh cannot be explained exclusively by the monetarist or the structuralism explanation of inflation, but it does have a strong but relatively short-run impact on inflation. Hossain (2013) found that there is a positive relationship between money supply and inflation in Bangladesh. Uddin (2014) indicated that the GDP, money supply, and interest rates have contributed to increasing inflation in Bangladesh. Also, a few other studies have tried to examine the process of inflation in Bangladesh on

the economic determinants that affect the inflation rate, such as Uddin et al. (2014), Islam et al. (2022). However, the above studies are mostly focused on economic determinants and lack knowledge of the influence the non-economic determinants have specifically on Bangladesh, without which it is difficult to explain how political instability, rule of law, control of corruption, government effectiveness, and other crucial determinants impact inflation. This particular study fills the gap in the literature by developing an empirical case of Bangladesh that captures some of the necessary features that can lead to a robust change in how economists perceive inflation in an aspect of Bangladesh’s economy.

Methodology

Model Specification: Generalized Linear Model

The GLM model permits us to fabricate a direct connection between the response and indicators, in spite of the fact that their veiled relationship isn't straight. This is made conceivable by utilizing a connection capability, which interfaces the reaction variable to a straight model. In contrast to linear regression models, the error dispersion of the reaction variable need not be regularly conveyed. The mistakes in the reaction variable are accepted to follow a thespian group of circulation (for example, normal, binomial, and other distributions). Since we are attempting to sum up a straight relapse model that can likewise be applied in these cases, the name “Generalized Linear Model” which was developed by Nelder and Wedderburn (1972) However, the functional form of this model is represented in equation 1.

Inflation = f(Rule of Law, Control of Corruption, Govt. Effectiveness)

$$INF_t = \alpha_0 + \alpha_1 ROL_t + \alpha_2 CC_t + \alpha_3 GE_t + \omega_t \tag{2}$$

For the simplicity of estimated model, log transformation is a necessary step. The log form of this model is presented in equation 3.

$$\ln(INF)_t = \alpha_0 + \alpha_1 \ln(ROL)_t + \alpha_2 \ln(CC)_t + \alpha_3 \ln(GE)_t + \omega_t \tag{3}$$

Where, α_0 represent the intercept, α_1 to α_3 represent the coefficient of the estimation, ω_t represent the error estimation tenure and t indicates time.

The GLM permits us to sum up a wide assortment of assessment results (Le et al., 2020; Liu & Lu, 2018). The serious issue for the analyst who utilizes the GLM is model detail. The specialist is liable for determining the specific condition that best sums up the information for a review.

On the off chance that the model is miss-specified as well as small sample, the assessments of the coefficients such as α values are probably going to be biased and the subsequent condition won't depict the information precisely. In complex circumstances, this model determination issue can be a serious and troublesome one. The GLM is quite possibly of the main device in the measurable examination of information. It addresses a significant accomplishment in the headway of social exploration in the last couple of decades.

ADF Unit Root Test

Since the purposes of time series analysis, recognizable Augmented Dickey Fuller (ADF) test is one of the most outstanding techniques for testing the unit root of a variable. In this cycle, the unit root has been analyzed by thinking about the slacked request of chosen factors and mistake or residuals assessments. Stationarity tests permit checking regardless of whether a series has unit root problems or not. There are two unique methodologies: stationarity tests, for example, the ADF test that considers as H0 that the series is nonstationary with the presence of unit root.

$$\Delta W_t = \beta_1 + \beta_2 t + \tau(W_{t-1}) + \gamma_t \sum_{i=1}^f \Delta W_{t-1} + \varepsilon_t \tag{4}$$

Where; ε_t are an error component and ADF term W_{t-1} is the lagged order criteria, Δ indicates the change and t presents the time.

Result Analysis

In Table 1, the study of descriptive statistics shows that all the variables associated with this model are measured in terms of mean, median, maximum, minimum, standard deviation, skewness, kurtosis, Jarque-Bera, and probability. In the case of the measure of central tendency, it is estimated that the average of government effectiveness, inflation, control of corruption, and rule of law are -0.70, 5.58, -0.97, and -0.84 respectively. The average inflation rate, which is a dependent variable in this model, is the highest among the other variables. Also, after sorting the observations, the median value of variables including GE, INF, CC, and ROL is presented. The range, which is the dispersion, is presented by the minimum and maximum of the variables. Moreover, st.dev, which shows how far each data value is from the mean, of GE and ROL, is 0.11, which is the lowest compared to the other two values. It means that these values are more consistent and less spread out from the sample average. In addition, in the case of skewness, which measures the degree of asymmetry, it is seen that the values are positive except for control of corruption. In this table, GE shows normal skewness but not a symmetric or bell-shaped curve as it shows higher

values towards the right side of the curve. Also, INF, along with ROL, shows normal skewness. Moreover, CC shows a left-tail test in terms of skewness. With regards to kurtosis, which measures the flatness and peakness of the distribution, all variables, including INF and ROL, represent lower kurtosis values, which are less than 3,

except GE and CC, whose values are higher than 3. In this perspective, both variables like INF and ROL have a platykurtic, which means more flat than the normal curve, whereas GE and CC have a leptokurtic, which means more peak than the normal curve.

Table 1: Descriptive Statistics

Criteria	GE	INF	CC	ROL
Mean	-0.70	5.58	-0.97	-0.84
Median	-0.73	5.69	-0.94	-0.83
Maximum	-0.43	8.16	-0.44	-0.64
Minimum	-0.86	3.26	-1.49	-1.02
Std. Dev.	0.11	1.47	0.26	0.11
Skewness	1.16	0.09	-0.10	0.25
Kurtosis	3.64	1.90	3.20	1.92
Jarque-Bera (JB)	6.07	1.30	0.08	1.49
Probability (JB)	0.15	0.52	0.96	0.47

Source: Author's inference

Table 2: ADF Unit Root Test Results

Variables	At Level	At 1 st Difference
Ln(INF)	-1.85	-4.53***
Ln(ROL)	-3.26	-5.90***
Ln(CC)	-2.92	-4.24***
Ln(GE)	-1.90	-5.19***

Assumption: Trend and Intercept; *** tends to 1% level of significance

Source: Author's inference

Table 3: Result of Generalized Linear Model (GLM)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Dependent Variable: Inflation (Ln(INF))				
LnGE	-4.48*	2.87	-1.56	0.10
LnCC	-0.88	1.25	-0.70	0.48
LnROL	-4.63**	2.38	1.95	0.05
C	5.50**	2.79	1.97	0.05

Model Strength

LR statistic	12.36	Prob(LR statistic)	0.01
Pearson Chi-Square	32.55		0.05

** tends to 5% and * tends to 10% level of significance

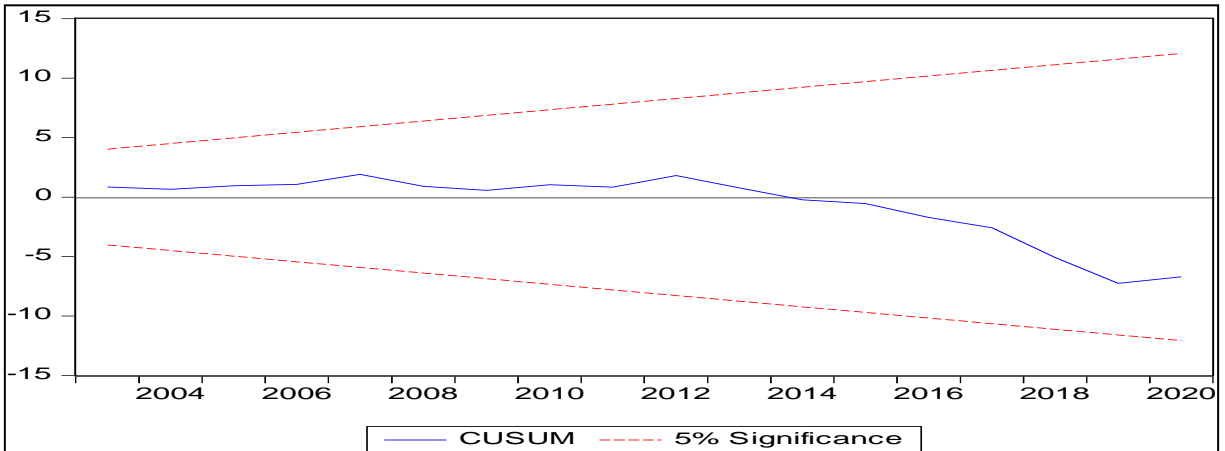
Source: Author's inference

Table 4: Cointegration Analysis by Wald Test

Test Statistic	Value	df	Probability
F-statistic	128.79	(4, 21)	0.00
Chi-square	515.16	4.00	0.00

Null Hypothesis: C(1)=C(2)=C(3)=C(4)=0

Source: Author's inference

Figure 1: Stability Diagnostics: CSUSM Test

Source: Author's inference

In Table 2, it is observed that variables are non-stationary at their level after converting into 1st difference, they turn into stationary. The hypothesis has been rejected at the first difference operation where the null hypothesis is rejected. The result from Table 3 is that inflation is a dependent variable where government effectiveness, control of corruption, and the rule of law are independent variables. If GE increases by 1 percent, INF decreases by 4.48 percent, keeping other factors constant. Similarly, if ROL and CC rise by 1%, INF falls by 4.63 % and 0.88 %, respectively, assuming all other variables remain constant. The results of the cointegration test are shown in Table 4, where the null hypothesis states that coefficients 1, 2, 3, and 4 are equal to zero and the alternative hypothesis states that these coefficients are not equal to zero. The estimated probability value is less than 5%, indicating that we are rejecting the null hypothesis and that these four coefficients are not equal to zero. They are significant variables in the model, and they add value to the model by incorporating the long run association among the selected factors. The stability diagnostic shows the CUSUM test in Figure 1, where the result estimation implies the stability rules in the GLM analysis. However, this study found the importance of the rule of law, corruption control, and government effectiveness. The results support the following statements, such as the rule of law helps to reduce inflation these findings are similar to those of Grindle (2012) and Shevchuk et al. (2021). On the other hand, this study also found the fact that government effectiveness has a large impact on the control of inflation. This finding is similar to that of Soh et al. (2021) and Yousefinejad et al. (2022). In addition, this study also finds out the actuality where control of corruption has a hefty impact on control of inflation in Bangladesh, which is supported by Haider et al. (2011) for Pakistan and Ali and Sassi (2016) for both developed and developing countries.

Conclusion and Recommendations

Nowadays, inflation is one of the major concerns and challenges for Bangladesh's economy. If the high inflation rate continues, it could pose an alarming situation for the economic development of a country. Therefore, a stable inflation rate must be maintained by identifying and controlling the significant determinants of inflation. The preceding discussion demonstrates that, despite being overlooked, the rule of law, corruption control, and government effectiveness have a huge potential to influence the rate of inflation as non-economic determinants. Thus, the impact of such crucial components must be studied in the case of Bangladesh. This is an effective initiative for determining the impact and significance of noneconomic determinants on inflation in Bangladesh. However, the unit root test indicates that I am stationary at the first difference of all variables (1). Cointegration results ensure long-run association of variables. The GLM technique is used in econometric methods to assess the importance of noneconomic determinants in controlling inflation. Controlling inflation should be one of the government's priorities. The empirical studies mentioned above show that there is a significant long-run positive relationship between inflation and the rule of law, corruption control, and government effectiveness in Bangladesh. Since the study shows the rule of law has an anti-inflationary impact, more emphasis should be given to ensuring fundamental rights of people and civil and criminal justice through proper enforcement of law and regulations. The rate of inflation must be easier to keep under control in a country when the government executes the rule of law. Moreover, corruption is the greatest threat to the government, and institutional reform is required to eliminate the breeding ground for corruption. Political and economic restructuring should be carried out

in tandem. And under a democracy, the government must be more careful to increase its effectiveness. Because it is the right of people in a democratic country to criticize and question government actions, and it is the duty of the government to ensure accountability to the people. This paper highlights a new perception of how the inflation rate can be more effectively balanced by controlling regulatory and legal mechanisms, bridging the legal perspective gap between economists and legal and regulatory authorities. The analysis was limited by the small sample size, and further research may consider other macroeconomic determinants such as regulatory quality, political stability, and accountability voice, where those factors have contributed to lowering inflation in a country.

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RESEARCH ARTICLE

Knowledge, perceptions and attitude towards open defecation and its health implications among residents in Ussa Local government Area, Taraba State, Nigeria

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Abstract

Background and Objective: Open defecation is the human practice of defecating in the environment rather than into a toilet. Open defecation is a public health menace and causes health problems such as diarrhoea, typhoid, cholera, etc., in areas where people defecate places other than toilets or latrines. This study was aimed at determining the knowledge, perception and practice of open defecation among residents in Ussa Local Government Area of Taraba State, Nigeria. **Material and Methods:** A cross-sectional study design was adopted and used for this study. Data were generated using a semi-structured questionnaire and an observational checklist. Data generated were collated, synthesized and analyzed using SPSS version 20. **Results:** The results obtained in this study showed that 260 (67.7%) had good knowledge of open defecation while 124 (32.3%) recorded poor knowledge. Most respondents 202 (53.6%) demonstrated positive perception about open defecation while 182 (46.4%) exhibited negative perception. Over two-third of the respondents 302 (78.6%) respondents indicated that they have defecated at least once in open space and only 110 (28.6%) have access to a toilet facility. Perceived health problems associated with open defecation practice as indicated by the respondents were mainly; malaria 341 (88.8%), typhoid 221 (57.6%) and cholera 210 (54.7%). It was also observed that 274 (71.4%) households do not have a toilet facility, 200 (69.0%) lack access to improved source of water supply, 356 (92.7%) household lack a drainage system, 308 (80.2%) had bushes around their surroundings, 256 (66.7%) had odour of excreta in the surrounding and 239 (62.2%) lack a proper waste storage facility and exhibit poor waste disposal. **Conclusion:** Findings in this study showed that respondents had good knowledge and exhibited positive perception about open defecation, but majority of the proportion confirmed to have defecated in open fields.

Keywords: knowledge; attitude; open defecation; health implications; residents; Ussa Local Government Area

Introduction

Open defecation is the human practice of defecating in the environment rather than into a toilet. Open defecation is a public health menace and causes health problems such as diarrhoea, typhoid, cholera, etc., in areas where people defecate places other than toilets or latrines (Clasen, Boisson, Routray, Torondel, Bell, Oliver, Ensink, Freeman, Jenkins, Odagiri, Ray, Sinha, Suar, & Wolf-Peter, 2014). The term is widely used in literatures on water, sanitation, and hygiene (WASH) problems in low-income countries. Eradicating open defecation is the main aim of improving sanitation worldwide and it is an indicator used to measure progress towards the Sustainable Development Goal (SDG6). Irrespective of availability of toilets, behavioral change efforts on human is needed to promote the use of toilets. Therefore, people need to be educated and convinced

to desist from open defecation and use the toilets. The option of open defecation may be due to lack of access to toilets or cultural practices and these practices are common within countries where sanitation infrastructures are not available (Clasen et al, 2014).

Ending open defecation would be an important public health intervention and success to healthy living (WHO/UNICEF, 2014a). It has been reported that extreme poverty and lack of sanitation facilities have been linked with open defecation. Therefore, eradicating open defecation is thought to be an important medium to also eradicate poverty. This was due to the publication by the Joint Monitoring Programme for Water Supply and Sanitation (JMP) in their international year of sanitation (WHO/UNICEF, 2014b). Open defecation is a common

example of poor sanitation. Over the years, the number of people practicing open defecation has fallen by 21%, from 1.3 billion in 1990 to 1 billion in 2012 (WHO/UNICEF, 2019). These 1 billion people with no sanitation facility continued to defecate in gutters, bushes, bodies of water and open field, etc. Most people (90%) who practice open defecation live in rural areas, but the number of people living in urban areas is also increasing (WHO/UNICEF, 2014a). According to World Bank report in 2015, 39.84% of Indian population practice open defecation and it is known as the country with the highest number of people practicing open defecation (WHO/UNICEF, 2014a). Other countries with a high percentage of people practicing open defecation are Indonesia (63 million people), Pakistan (40 million people), Ethiopia (38 million people), Nigeria (34 million people), Sudan (19 million people), Nepal (15 million people), China (14 million people), Niger (12 million people), Burkina-Faso (9.7 million people), (WHO/UNICEF, 2014a; (WHO/UNICEF, 2010).

Open defecation is influenced by a number of reasons which include lack of space to build toilets, lack of income, seasonal factors, and poverty. The major challenges faced by the residents in pursue to end open defecation is the lack of human resources base for sanitation. Although people living in slums constitute the highest percentage of those without the access to toilets, the whole communities suffer the effect of open defecation (Spears, 2014). Open defecation is a serious public health threat to human health especially for children under five years. Fecal-oral route is the major cause of diarrhoea disease as well as infections. Open defecation was identified by the World Health Organization, (WHO) in the year 2014 to be the leading cause of diarrhoea deaths and a threat to human health globally, due to unimproved sanitation practices (WHO, 2013). It can also lead to malnutrition and stunted growth in children (Spears, Gosh & Oliver, 2017).

Open defecation perpetuates the vicious cycle of disease and poverty and is widely regarded as an insult to personal dignity (WHO/UNICEF, 2014b). It causes serious harm when done in areas with high population or camping. With the insanitary situation in rural areas, open defecation has become a challenge and thereby an important public health issue and an issue of human dignity when it occurs in densely populated areas (O'Reilly, 2016). About 1.1 billion, people (15% of the global population) practice open defecation. On the 19th November, 2013, the United Nations General Assembly declared "World Toilet Day", to encourage changes in both human behaviors and policies on issues ranging from enhancing water management, creation of sanitation facilities, to ending open defecation (Afshan, 2013).

Research has also shown that the effect of open defecation is one of the most important factors of the groundwater sources pollution. The underground water is polluted when rain flushes feces that are dispersed in the environment into the water body (Tamberkar & Raigire, 2012).

Approximately, 46million Nigerians (25% of the country's population) practice open defecation, out of which, 33million live in the rural areas and 130million persons are using unimproved sanitation facilities and majority of those affected are rural dwellers (UN, 2014). The eradication of open defecation is the key strategy for morbidity and mortality control, particularly in children under the age of five years (5).

The general objective of this study was to assess the knowledge, perception and practice of open defecation among residents in Ussa Local Government Area of Taraba State, Nigeria. And the specific objectives were to: determine residents' knowledge of open defecation in Ussa Local Government Area of Taraba State; determine residents' perception of open defecation among respondents in the study area; determine the proportion of residents who practice open defecation in the study area; identify the factors influencing open defecation practice among residents in the study area; identify the perceived health problems associated with open defecation and assess the sanitation facilities and surroundings of residents in the study area.

Material and Method

Study Setting

The study area was Ussa Local Government Area of Taraba State. It has an area of 1495Km² and a population of 92,017 as at 2006 census. This study was carried between March and June, 2022. Ussa Local Government Area is located in the southern part of Taraba State. It shares boundary with Donga Local Government Area by the North, Kurmi Local Government Area by the East, Republic of Cameroon by the South and Takum Local Government Area by the West. It has eight (8) political wards. These are Lissam 1, Lissam 2, Kwesati, Lumbu, Fikyu, Kpambo, Kpambo puri, Rufu. Ussa is predominantly inhabited by Kuteb people who are mostly farmers, local politicians, traders and civil servants.

Study Design

A cross sectional descriptive study design was used for this study. This involved the administration of structured questionnaires and the used of observational checklist on sanitary facilities of respondents.

Study Population

The study population include adults of both gender between 18years old and above in the study area.

Sampling Procedure

A multi-stage sampling method was used to select wards, households and respondents under the following stages;

Instrument for data collection

The instrument for data collection was an interviewer administered structured questionnaire and an observational checklist.

Method for Data Analysis

Descriptive statistics was used to analyse the data obtained from questionnaire and the observational checklist. The responses were coded and analyzed. Data was analyzed using Statistical Package for Social Sciences, (SPSS) version 20. The results were expressed using descriptive statistics. Associations between variables were tested using Chi-square statistical test and significance level was set at 5%. It was interpreted and presented in tables, percentage, bar chart, and frequencies.

Ethical consideration

A letter of introduction was obtained from the Department of Public Health University of Calabar, Calabar. Ethical clearance was also obtained from the Department of Public Health Clearance Committee to seek for entry permission into the community through the village chiefs and clan heads in the study areas. Verbal informed consent was duly sought from every respondent. Participation was strictly voluntary; respondents were informed that they have the right to withdraw from the participation at any time without the fear of penalty. The respondents were assured of confidentiality and privacy. There was no required indication of names on the questionnaire to ensure anonymity.

Results

Socio-demographic characteristics of the respondents

All 384 copies of the questionnaire were returned for analysis giving a response rate of 100%. The results obtained showed that 202 (52.6%) respondents were females, 182 (47.4%) were males, 123 (32.0%) were aged between 26-30 years, 241 (62.8%) were married, 130 (33.9%) had secondary education, 150 (39.1%) were farmers and 319 (83.1%) were Christians (Table 1).

Knowledge of open defecation among respondents

Results on knowledge of open defecation showed that 339 (88.3%) respondents affirmed that they have knowledge of

the meaning of open defecation out of which 227 (59.1%) defined open defecation as the practice of people defecating outside and not in designated toilet. A reasonable proportion of the respondents 235 (61.2%) indicated that open defecation is harmful to human health and highlighted possible effects on human health which include; emission of offensive odour 200 (85.1%), environmental degradation 184 (78.3%) and pollution of water bodies 118 (50.2%). Most respondents 317 (82.6%) affirmed that the practice of open defecation can be avoided (Table 2). On the average, 260 (67.7%) had good knowledge of open defecation while 124 (32.3%) recorded poor knowledge.

Table 1: Socio-demographic characteristics of the respondents (n=384)

Variables	Number of respondents	Percentage
Sex		
Male	182	47.4
Female	202	52.6
Age (in years)		
18-25	61	15.9
26-30	123	32.0
31-35	112	29.2
36+	88	22.9
Marital Status		
Married	241	62.8
Single	135	35.2
Divorced	2	0.5
Separated	2	0.5
Widow/widower	4	1.0
Educational status		
No formal education	67	17.4
Primary	103	26.8
Secondary	130	33.9
Tertiary	84	21.9
Occupation		
Farming	150	39.1
Fishing	31	8.1
Trading	71	18.5
Civil servant	56	14.6
Artisans	45	11.7
Unemployed	31	8.1
Religion		
Christianity	319	83.1
Islam	53	13.8
Traditional religion	12	3.1

Table 2: Knowledge of open defecation among respondents

Variables	Number of respondents	Percentage
Have knowledge of the meaning of open defecation		
Have knowledge	339	88.3
Do not have knowledge	45	11.7
Total	384	100
Meaning of open defecation		
The practice if people defecating outside and not in designated toilet	227	59.1
The practice if people defecating outside and not in designated toilet	112	29.2
Do not know	45	11.7
Total	384	100
Open defecation is harmful to human health		
It is harmful	235	61.2
It is not harmful	104	27.1
Do not know	45	11.7
Total	384	100
Harmful effects of open defecation*		
Causes disease outbreak	51	21.7
Degrades the environment	184	78.3
Pollution of water bodies	118	50.2
Emission of offensive odour	200	85.1
Practice of open defecation can be avoided		
It can be avoided	317	82.6
It cannot be avoided	22	5.7
Don not know	45	11.7
Total	384	100

*Multiple responses

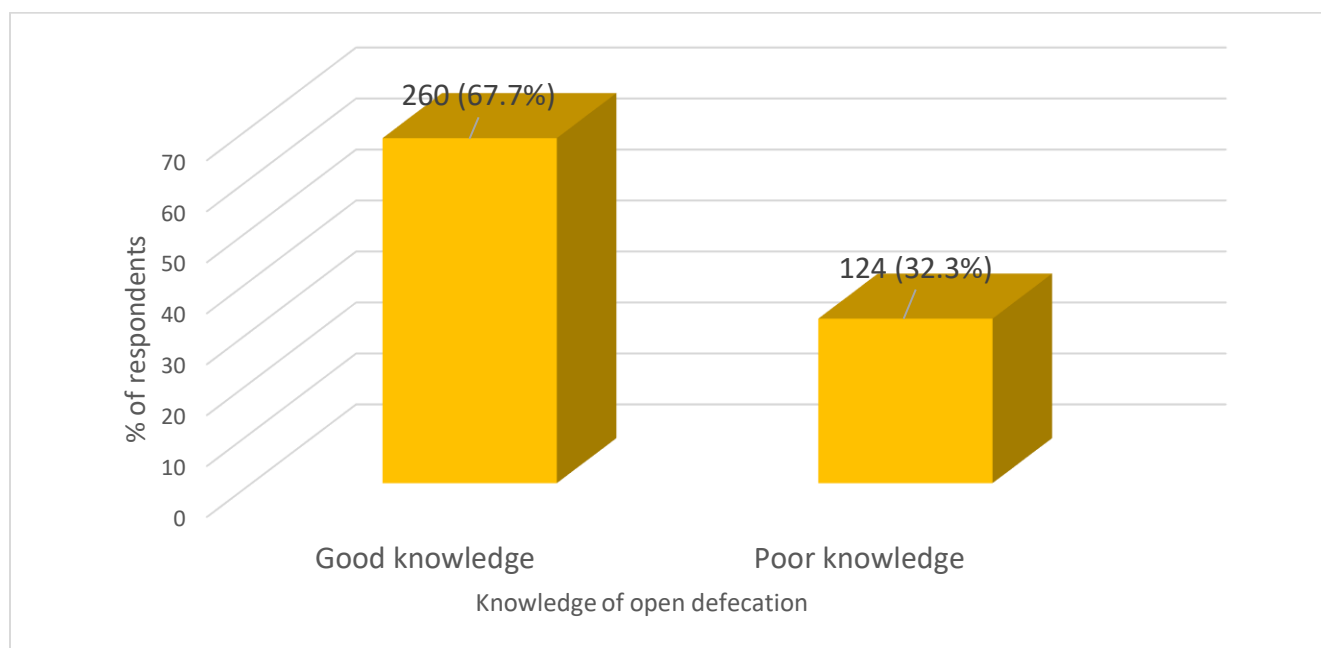


Fig 1: Knowledge of open defecation among respondents Perception of respondents about open defecation

Results on perception of respondents about open defecation shows that 45 (11.7%) strongly agreed to the statement that open defecation is dangerous to human and community health, 67 (17.4%) agree, 113 (29.4%) disagree and 93 (24.2%) strongly disagree; 58 (15.1%) strongly agree to the statement that open defecation is more hygienic than defecating in the toilet, 100 (26.0%) agree, 84 (21.9%) disagree and 112 (29.2%) strongly disagree; 54 (14.1%) strongly agree to the statement that infection can be easily contacted through the use of public toilet, 79 (20.6%) agree, 122 (31.8%) disagree and 106 (27.6%) strongly disagree; 82 (21.4%) strongly agree to the statement that defecating on farmlands increases soil fertility and is beneficial to man and environment, 105 (27.3%) agree, 87 (22.7%) disagree and 69 (18.0%) strongly disagree; 66 (17.2%) strongly agree to the statement that open defecation contributes to environmental degradation, 111 (28.9%) agree, 105 (27.3%) disagree and 31 (8.1%) strongly disagree (Table 3). On the average, 202 (53.6%) respondents demonstrated positive perception about open defecation while 182 (46.4%) exhibited negative perception.

Practice of open defecation among respondents

Results on practice of open defecation shows that 302 (78.6%) respondents indicated that they have defecated at least once in bushes, gutters, streams or uncompleted buildings, out of which 195 (64.6%) respondents always defecates in the open space, 68 (22.5%) defecates sometimes/occasionally and 39 (12.9%) practice open defecation only when traveling/during an emergency. More than half of the respondents' 179 (59.3%) practice open defecation during the dry season while 123 (40.7%) practice theirs during the wet season (Table 4).

Of the 384 respondents, 110 (28.6%) have access to a toilet facility and pit latrine 71 (64.5%) was identified as the type of toilet mostly used. Reasons for not having access to a latrine/toilet as indicated by the respondents include; High cost of building an improved latrine/toilet 201 (73.4%), lack of enough space 42 (15.3%) and 31 (11.3%) felt it's not a priority (Table 4).

Table 3: Perception of respondents about open defecation (n=384)

Variables	Strongly agree (%)	Agree (%)	I don't know (%)	Disagree (%)	Strongly disagree (%)
Open defecation is dangerous to human and community health	45 (11.7)	67 (17.4)	66 (17.2)	113 (29.4)	93 (24.2)
Open defecation is more hygienic than defecating in the toilet	58 (15.1)	100 (26.0)	30 (7.8)	84 (21.9)	112 (29.2)
Infection can be easily contacted through the use of public toilet	54 (14.1)	79 (20.6)	23 (6.0)	122 (31.8)	106 (27.6)
Defecating on farmlands increases soil fertility and is beneficial to man and environment	82 (21.4)	105 (27.3)	41 (10.7)	87 (22.7)	69 (18.0)
Open defecation contributes to environmental degradation	66 (17.2)	111 (28.9)	71 (18.5)	105 (27.3)	31 (8.1)

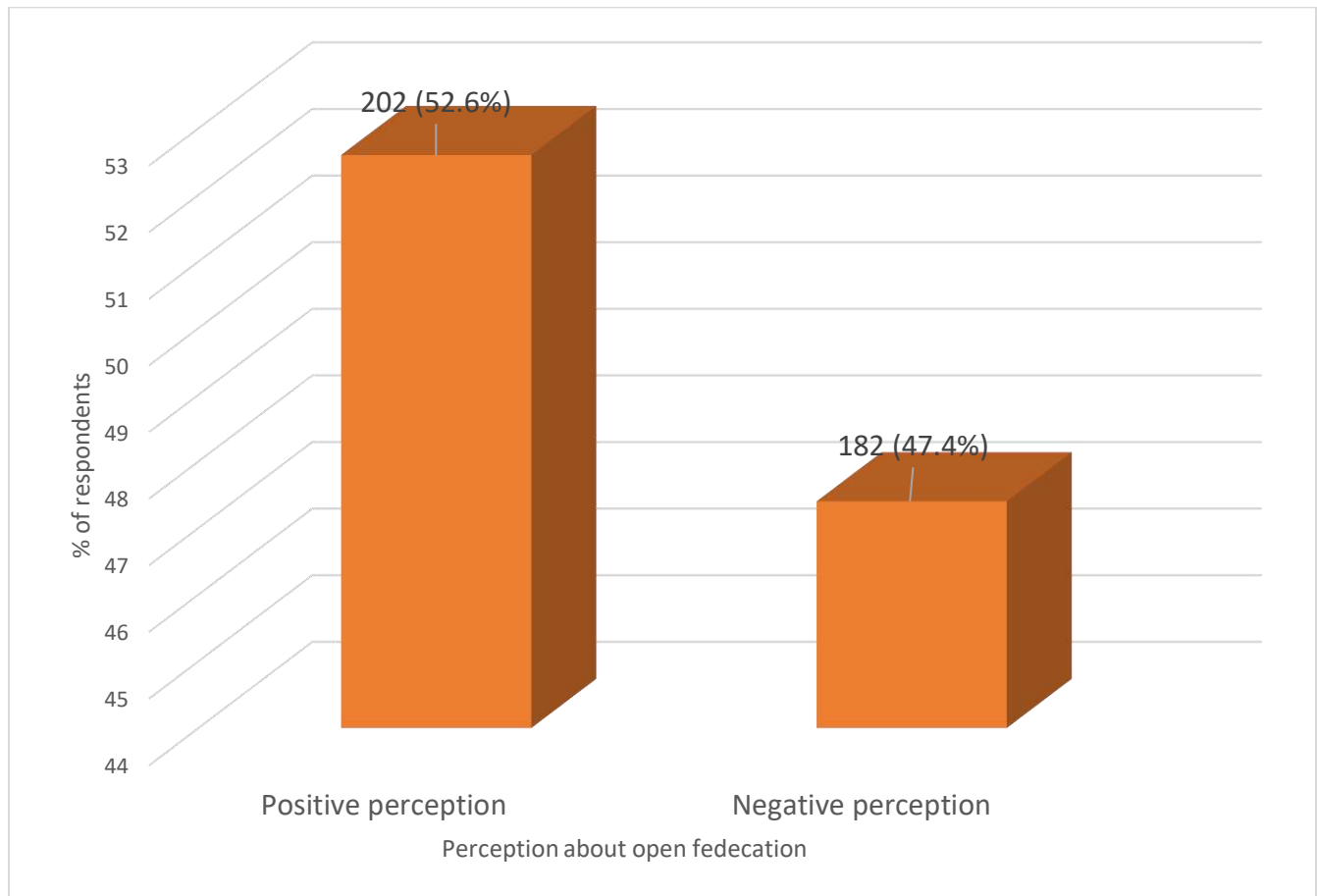


FIG 2: Perception of respondents about open defecation

Factors influencing open defecation practice among respondents

Factors influencing open defecation practice as indicated by the respondents were mainly; low cost 300 (99.3%), requires little or no maintenance 281 (93.0%), lack of access to toilet facility 274 (90.7%) and convenience 256 (84.8%) (Fig. 3).

Perceived health problems associated with open defecation practice

Perceived health problems associated with open defecation practice as indicated by the respondents were mainly;

malaria 341 (88.8%), typhoid 221 (57.6%), cholera 210 (54.7%) and dysentery 87 (22.7%) (Fig. 4).

Assessment of sanitary facilities and general surrounding of households

Of 384 household surveyed, 110 (28.6%) households had a toilet facility of which 38 (34.5%) were pit latrine without cover, 33 (30.0%) were pit latrine with cover and 31 (28.2%) were swat flush, 8 (7.2%) were water system closet. Of the 110 toilet facilities, 58 (52.7%) toilets, were sanitary while 52 (47.3%) were unsanitary. Regarding water supply, 290 (75.1%) households have access to water supply of which 200 (69.0%) lack access to improved source of water supply. In terms of general surrounding, 356 (92.7%) household do not have a drainage system, 308 (80.2%) had bushes around their surroundings, 118 (30.8%) had stagnant water, 256

(66.7%) has odour of excreta in the surrounding and 239 (62.2%) do not have a proper waste storage facility and exhibit poor waste disposal (Table 5).

Table 4: Practice of open defecation among respondents

Variables	Number of respondents	Percentage
Ever defecated in bushes, gutters, streams or uncompleted buildings		
Have defecated	302	78.6
Have not defecated	82	21.4
Total	384	100
Frequency of defecating in the open space		
Always	195	64.6
Sometimes/Occasionally	68	22.5
Only when traveling/during an emergency	39	12.9
Total	302	100
Period of the year individuals defecate in open space		
Wet season	123	40.7
Dry season	179	59.3
Total	302	100
Have access to a latrine/toilet		
Have access	110	28.6
Do not have access	274	71.4
Total	384	100
Type of latrine/toilet		
Water system closet	8	7.2
Pit latrine	71	64.5
Swat flush	31	28.2
Total	110	100
Reasons for not having access to a latrine/toilet		
Lack of enough space	42	15.3
High cost of building an improved latrine/toilet	201	73.4
Not a priority	31	11.3
Total	274	100

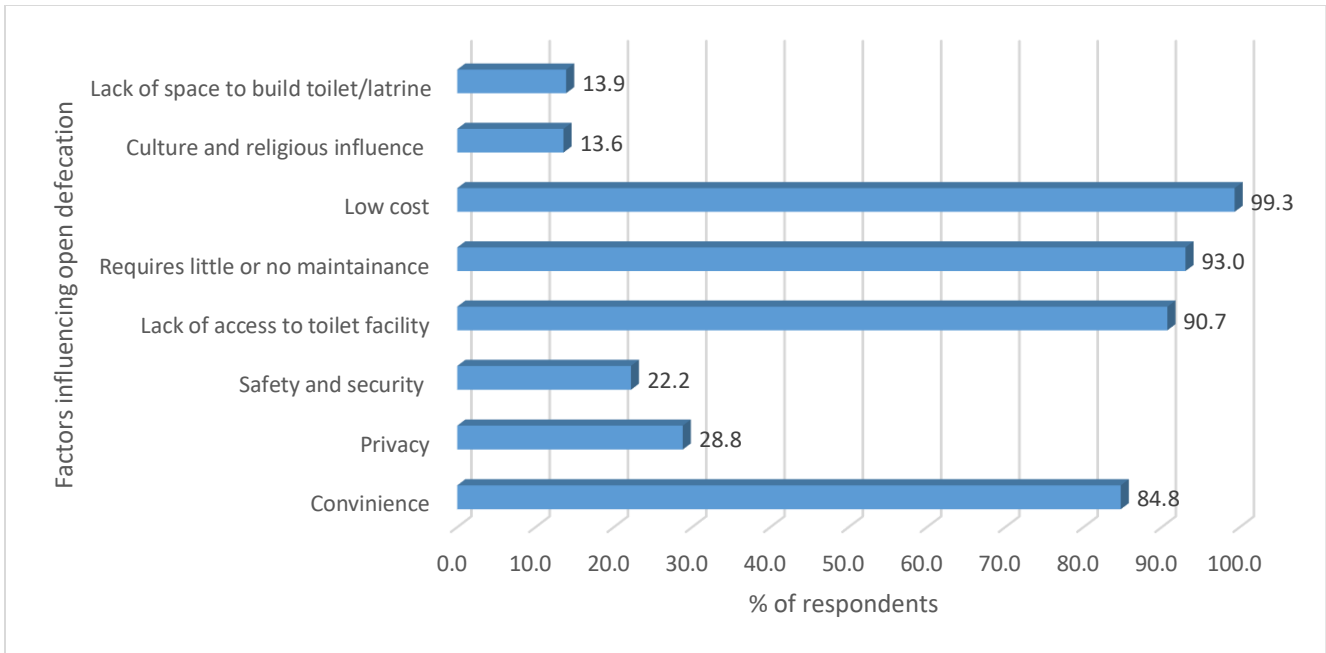


Fig 3: Factors influencing open defecation practice among respondents

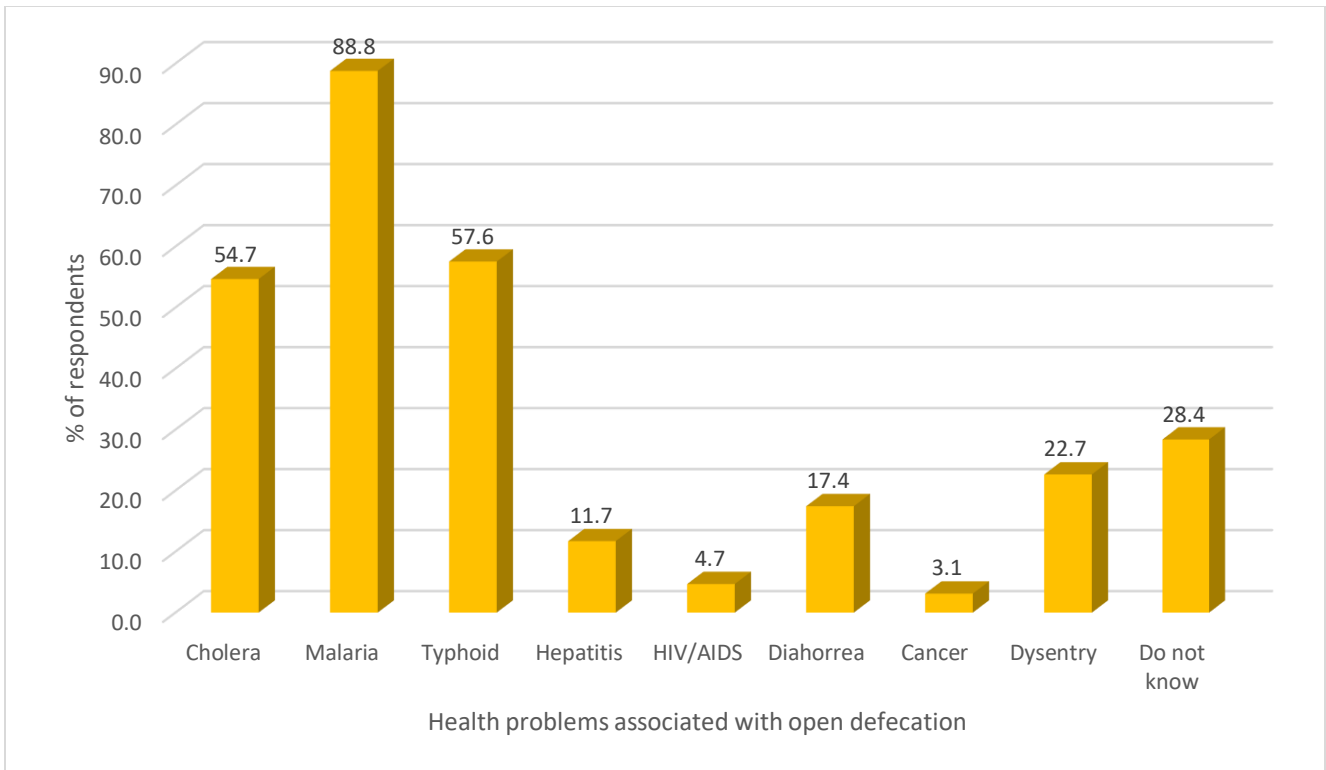


FIG 4: Perceived health problems associated with open defecation practice

Table 5: Assessment of sanitary facilities and general surrounding of households

Variables	Number of respondents	Percentage
(A) Toilet facility		
Availability of toilet facility		
Available	110	28.6
Not Available	274	71.4
Total	384	100
Type of toilet facility available		
Pit latrine with cover	33	30.0
Pit latrine without cover	38	34.5
Swat flush	31	28.2
Water system closet	8	7.2
Total	110	100
Sanitary condition of toilet facility		
Sanitary	58	52.7
Unsanitary	52	47.3
Total	110	100
Water supply facility		
Availability of water supply facility		
Available	290	75.5
Not Available	94	24.5
Total	384	100
Source of water supply		
Improved	90	31.0
Unimproved	200	69.0
Total	290	100
C) General surrounding		
Availability of drainage system		
Available	28	7.3
Not Available	356	92.7
Total	384	100
Sanitary condition of drainage system		
Sanitary	9	32.1
Unsanitary	19	67.9
Total	28	100
Bush in the surrounding		
Present	308	80.2
Absent	76	19.8
Total	384	100
Proper waste storage and disposal		
Available	145	37.8
Not available	239	62.2
Total	384	100
Odour of excreta in the surrounding		
Present	256	66.7
Absent	128	33.3
Total	384	100
Presence of stagnant water		
Present	118	30.8
Not present	266	69.2
Total	384	100

Discussion

The practice of open defecation is a global issue due to its implication on human health, dignity and the environment. It is mostly prevalent in third world countries including Nigeria and significantly fuels the spread of infectious diseases, cause the proliferation of neglected tropical diseases (trachoma, schistosomiasis, intestinal worms, etc.) and increase cases of malnutrition especially amongst the rural populace (Ngwu, 2017). Ensuring an open defecation-free environment requires a strong synergy between the community and health professionals. In the light of this, understanding their perception about open defecation and identifying the factors influencing open defecation practice would be a perfect road-map to avert the practice of open defecation in Nigeria.

As documented in the current study, it was observed that two-third of the respondents 260 (67.7%) had good knowledge of open defecation especially in the aspect of defining open defecation, acknowledging that open defecation is harmful to human health and highlighting the possible effects of open defecation practice which include; emission of offensive odour, environmental degradation and pollution of water bodies (Table 2). The exhibition of high knowledge level of open defecation among respondents could be attributed to their routine observation of events and practices within their environment, personal/family members/friends experiences and access to health promotion information. This finding was congruent with a recent Ghanaian study where the study participants demonstrated high knowledge of open defecation (Asare, Gyan & Denteh, 2019).

More than half of the respondents 202 (52.6%) demonstrated positive perception about open defecation while the remaining 182 (47.4%) exhibited negative perception. Respondents' perception about open defecation may be influenced by their belief system, cultural practices, superstition, myths and religious affiliations. Each of these perspectives may exert significant level of influence (whether positive or negative) on their level of practice. This suggests that interventions on achieving an open defecation-free environment should be tailored towards changing behavioural patterns of individuals who frequently practice open defecation. This finding was similarly reported by Asare, et al. 2019, where respondents perceived open defecation as bad practice. However, it is worrisome where respondents in the current study believe that defecating on farmlands increases soil fertility and felt is beneficial to man and environment. This shows pure negligence of the effect of open defecation on human health. The low risk perception of the adverse effects of open defecation on human health may largely account for their negative perception towards open defecation practice.

More than two-third of the respondents 302 (78.6%) indicated that they have defecated at least once in bushes, gutters, streams or uncompleted buildings, out of which 195

(64.6%) respondents frequently defecates in the open space (Table 4). This finding was similarly reported in other studies but the percentage of open defecation was lower than that reported in the current study (Verma, 2017; Anuradha, Dutta, Raja, Lawrence, Timsi & Sivaprakasam, 2017; Panda, Chandrakar, & Soni, 2017). The high prevalence reported in the current study suggests that open defecation is a common practice in the study area with a mix of lifestyle, culture and ancestral practices. Open defecation tends to be more practiced in the dry season than during the wet season (Table 4). The reason may be linked to the fact that wet season (especially during heavy rainfall) restrict or limit movement and operation of activities. As a result, respondents who do not have access to a toilet facility either defecate in a polythene bag or bucket and dispose it by throwing into the bush or in flowing water. In essence, dry season tends to be more favourable to practice open defecation than during wet season. It was also documented that only one-fourth of the respondents have access to a toilet facility and pit latrine was identified as the most type of toilet used. Main reasons for not having access to a latrine/toilet as indicated by the respondents include; high cost of building an improved latrine/toilet, lack of enough space and some felt it's not a priority (Table 4). These reasons may be linked to respondents' socio-economic status where the poorer population suffer most from lack of access to sanitation facilities. This finding corroborates with that of Anuradha et al., 2017, where similar reasons for not having access to a latrine/toilet were documented. The significant lack of access to toilet facilities confirms the high prevalence of open defecation practices among respondents in the current study. Factors influencing open defecation practice as indicated by the respondents were mainly; low cost, requires little or no maintenance, lack of access to toilet facility and convenience. This finding is congruent with other studies where similar factors influencing open defecation were documented (Asare, et al. 2019; Verma, 2017). Contrariwise, a Keyanian mixed-method study identified culture and poverty as major factors contributing to open defecation practice (Busienei, Ogendi & Mokua, 2019). Unlike the modern toilet facilities, defecating in open fields do not require any cost implication or any form of maintenance. This is often considered in households when building a latrine or toilet facility is less prioritized. Lack of access to toilet facility has been identified as a contributory factor to open defecation practice. This was evident during the sanitary inspection of households conducted in the current study where only one-fourth of households had a toilet facility (Table 5). In the light of this, communities and settlements without access to toilet facilities would continuously practice open defecation until a lasting solution is provided to address end this practice. Even with the availability of toilet facilities, once the users outweigh the number of toilet facilities available, open defecation would still be practice. Hence, adequate provision of toilet facilities can significantly curb open defecation practice.

Convenience as a factor contributing to open defecation could be linked to the fact that available toilet facilities is always dark, filthy, smelling, poorly ventilated and lack privacy. This was confirmed during the sanitary inspection of households where out of 110 households who had a toilet facility, toilet facilities in 52 households were unsanitary (Table 5). The unhygienic conditions of some toilet facilities constantly encourage the practice of defecating in open fields. Hence, while it is imperative to ensure the provision of toilet facilities for household use, effort should be tailored towards constructing user-friendly toilet facilities as well as devise an approach to ensure the toilet facilities is constantly in hygienic condition.

Perceived health problems associated with open defecation practice as indicated by the respondents were mainly; malaria, typhoid, cholera and dysentery (Fig 2). This finding supports that of Anuradha et al. 2017, where respondents knew at least one disease associated with open defecation practice. A number of health problems are largely associated with infected human excreta which contain several harmful organisms (Saleem, Buedett & Heaslip, 2019). The identified health problems often affects a significantly proportion of the poorer population who do not have access to improved sanitation facilities (Peprah, Baker, & Moe, 2015; Njuguna & Muruka, 2017). The diseases are usually transmitted via faecal-oral route which arise from consumption of contaminated agricultural food products and underground water sources. Open defecation also propel flies and rodent infestation as well as emission of offensive odour which account for why malaria was the most identified health problem associated with defecation in open fields.

Regarding sanitary facilities and general surrounding of households, more than two-third of the respondents lack access to toilet facilities, improved source of water supply, drainage system, proper waste storage facility and exhibit poor waste disposal and had bushes and odour of excreta

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around their surroundings, (Table 5). This results showed that a significantly proportion of the rural populace still lack access to basic sanitation facilities. Lack of these facilities increases their vulnerability to contract infectious diseases within their vicinity and continually encourage the practice of open defecation. A healthy and open defecation-free environment can only be achieved if these sanitation facilities are adequately provided in rural communities.

Conclusion

Open defecation is still a common practice in rural Nigeria especially where there is significant lack or limited access to improved sanitation facilities. The drive to protect human health and improve environmental sanitation would essentially require ending open defecation practice. Findings in this study showed that respondents had good knowledge of open defecation, exhibited positive perception about open defecation, but majority of the proportion confirmed to have defecated in open fields. It was also observed that basic sanitation facilities in the study area such as toilets, access to improved water source, drainage system were not available in two-third of the household surveyed. Hence, achieving an open defecation-free environment would require the collaborative effort of relevant stakeholders.

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RESEARCH ARTICLE

Productive Safety Net Program Determinants and their Impact on Rural Household Food Security in Somali Regional State: The Case of Kebri Dehar District) Ethiopia

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Abstract: The study looked specifically at household food security, factors influencing people's decisions to participate in productive safety net programs, and the impact of production safety net programs on rural household food security, as measured by calorie intake. Primary data were collected from 334 households in four kebeles samples in Kebri Dehar, the district, using a multistage sampling technique. A binary logit model and a propensity score matching model were used to investigate the factors influencing the decision to participate and their impact on food security, respectively. The age of the household head and the size of the family have a positive effect on the decision to join the household. However, extended contact and distance from the property market had a negative impact on the decision to join. In this study, the nearest neighbor match method (5) was used to estimate the mean treatment effect for those treated. The propensity score matching results also show that the production safety net program has a positive and significant impact on household food security. Households participating in the production safety net program have 214.5 kcal/adult/day more than households not participating. The study concluded that there was a significant difference in household calorie intake between participants and nonparticipants.

Key words: Food security; Impact; Productive safety net program; Propensity score matching

Introduction

Background of Study

Food security emerged as a concept in the mid-1970s after a number of implications sparked debates about the global food supply and its responsiveness at both the global and local levels (Ingela and Nagothu, 2017). However, problems such as family or man-woman supply, dietary quality, and environmental sustainability have not been noted (Ingela and Nagothu, 2017).

In terms of food security, Ethiopia is one of the poorest international locations in Sub-Saharan Africa. A large proportion of the country's population suffers from chronic and power meal insecurity (Anderson et al., 2015). Many elements contribute to rural poverty and persistent food insecurity. The important causes of food insecurity in Ethiopia are drought and animal diseases, restrained rural infrastructure, a very susceptible agricultural technical base, constrained access to fundamental services, and fluctuating file costs (FISN, 2017).

The population's meal insecurity is anticipated to increase from 5.6 million in 2016 to 8.5 million in 2017 (WFP,

2017). Food insecurity is often understood in Ethiopia in the context of repeated meal crises and famines, and the response to meal insecurity is regularly dominated by the meal emergency response. Between 1994 and 2005, nearly 5 million Ethiopians were declared "inclined" and "wanting" assistance. However, large proportions of households receive emergency food assistance, participate in community service projects, and no longer go hungry every year; they are, however, frequently food insecure. Because of constrained agricultural manufacturing and poverty, they face predictable annual meal shortages.

As a result, despite a long history of providing large amounts of food, the safety of their meals has deteriorated over time. Instead, reliance on meals as a useful resource has progressively extended over time, as has the wide variety of Ethiopians experiencing continual meal insecurity (Devereux et al. 2006). The purpose of the Safety Net Program is to reallocate assets to chronically food-insecure households and enhance long-term options for food-insecure households (USAID, 2012).

Statement of Problem

The Food Security Program used to be created to tackle the difficulty of meal manufacturing while additionally enhancing people's lives and alleviating poverty. Recognizing its significance, the authorities have taken a number of steps. Beginning in 2005, the Ethiopian authorities and donor companies carried out a new kind of protection, the Productive Safety Net Program (PSNP), with ambitions to minimize persistent meal insecurity, asset depletion, and productive funding to overcome long-term meal insecurity (Gilligan et al., 2008).

The application is aimed at her 8.5 million inhabitants, who make up 10% of Ethiopia's population. These human beings are chronically food insecure; 60% of them stay in pastoral areas, and their buying power has decreased due to farm animals' losses. The final 40% are affected by erratic rainfall, which reduces crop manufacturing (WFP, 2017)

In the Somali region, the Ethiopian authorities have prepared to assist negative rural households registered in chronically food-insecure districts. Learn about the effect of productive protection internet packages (PSNP) on family livelihoods with the help of (Mohamed, 2017): Babile Case discovered that effective internet security programs had a significant impact on the food safety of families. Various studies have been performed on the outcomes of PSNP in special fields and at exclusive times. The findings of these investigations varied. Food safety research, on the other hand, necessitates a multidimensional shift supported by well-informed lookup disciplines. By assessing the influence of PSNPs on meal safety in rural households, this study contributes to the current body of knowledge. As a result, the goal of this study is to fill knowledge gaps about the factors that influence productive safety net programs determinants and their impact on rural household food security.

Objective of the study

The primary aim of this study was to assess the Productive Safety Net Program Determinants and Their Impact on Rural Household Food Security in Somali Regional State: The Case of Kebri Dehar District) Ethiopia

Specific objectives are as follows:

1. To investigate the current food security situation of rural households in the study area.
2. Determining the Impact of Productive Safety Net Programs on Food Security in Rural Households
3. Assessing the Impact of Productive Safety Net Programs on Food Security in Rural Households

Significance of the Study

It was thought that the study's findings will benefit the ongoing RPSNP efforts in rural Kebri Dahar households to enhance the current state of food security. By adding fresh information to the research of food security in relation to PSNP in Rural households of the Korahey zone, the study thereby fills a gap in the existing understanding regarding PSNP. Additionally, it might assist other academics who want to look into the PSNP issue more deeply. Additionally, the study's methodological importance helped other researchers by imparting knowledge and learning lessons to better understand the difficulties, achievements, and improved living standards of RPSNP. The study served as a starting point for future investigations into the PSNP problem.

Empirical Literature

Results of a find out about carried out via of Abdusalem (2017) we learned that household size, schooling level, increased seed use, and distance to the nearest market have been drastically positively associated with a rural household's likelihood of participating in a productive safety net program. It shows that you made an impact. There were significant negative effects on participation in productive safety net programs

According to Abdukarim (2015), family size, active workforce, access to credit, off/off farm income, farm income, and household education level significantly influence participation in productive food security programs. In the same study by Tadelee (2011) Family safety nets in productive programs have been linked to the gender of the family head, the educational level of family members, meal protection issues, and the frequency of contact with improved employees. Additionally, a high-quality affiliation was confirmed between big household measurement and participation in the PSNP, suggesting that small family measurement was once related to larger meal demand compared with smaller households excessive and may additionally be related to a greater possibility of meal insecurity.

According to Ayalneh and Wubshet (2012) livestock ownership correlates positively with well-being but negatively with program participation, whereas having the ability to use credit services correlates positively with program participation. The study undertaken by Yibrah (2010) discovered that as a household's age increased, so did the likelihood of participating in a productive safety net program, which had a negative effect on participation. The find out by Aman (2014) holdings, cultivated land, and distance from markets significantly affect participation in productive safety net programs. Participation in the PSNP was positively and significantly affected by variable distances from the market, whereas participation was negatively and significantly affected by access to credit

services, extension contacts, the number of oxen, livestock holdings, and cultivated land. Similarly, the study by Anwar (2015) indicated that family head educational level, household size, livestock holding, extension remoteness, and market distance were significantly associated with participation in productive safety net programs. Also, the study undertaken by Mesfin (2018) indicated that the educational level of households

Conceptual Framework

It is clear that several factors may help to explain the determinants of household food security and the Rural Productive Safety Net Program (RPSNP). Based on the objective of the study, the independent variables selected to achieve the ultimate objective of the study are broadly categorized into socioeconomic, institutional, and demographic factors the relationship between two variables in this study.

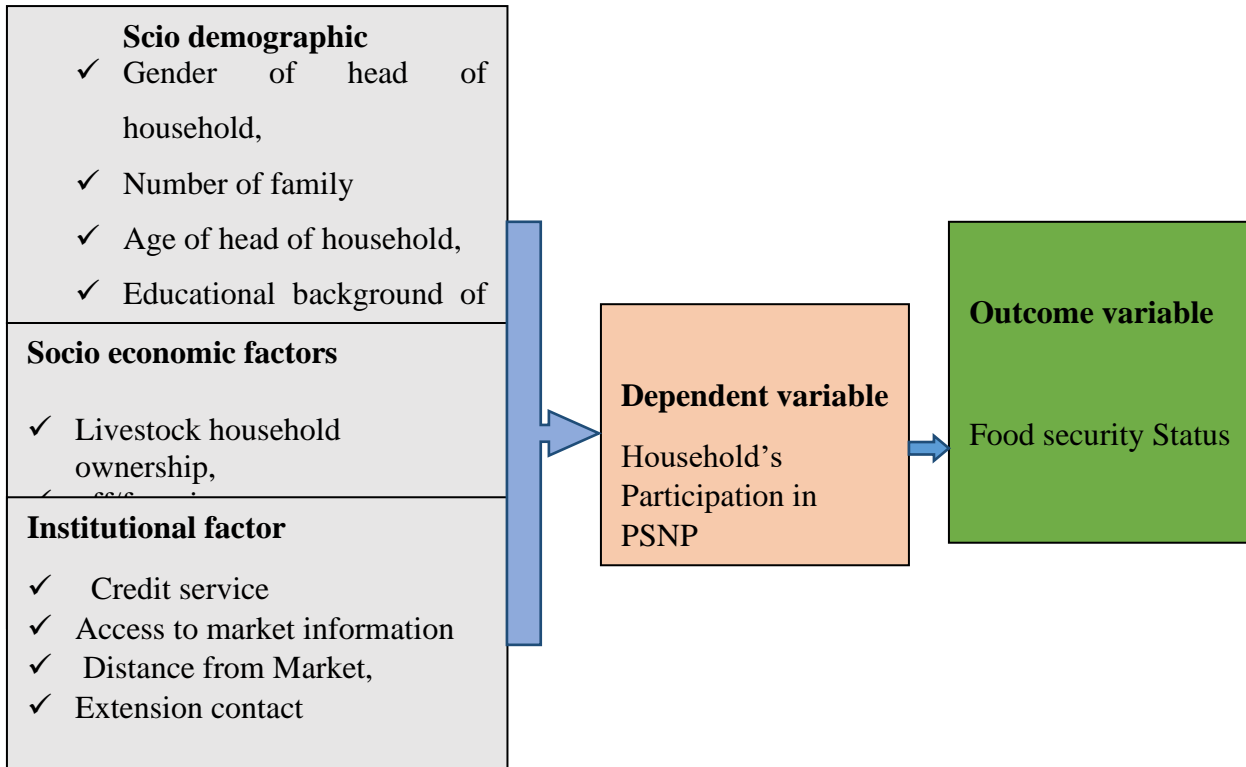


Figure 1: Conceptual Frame work of food security and UPSNP

Source: Own design based on literature review

Method of Research.

In this chapter, the research methodology for the study is described, along with a description of the research field, data sources and types, target population, sampling techniques, sample size, data collection methods, data analysis techniques, and justifications for their use.

Study Area

The Korahey Zone contains the study area. The distances between the city and Addis Ababa, the capital of Ethiopia, and Jiggiga, the regional capital of Somalia, respectively, are approximately 405 km and 1015 km. The Korahey

Zone had a total population of 312,713 people as of the 2007 Central Statistics Agency (CSA) census, 177,919 of whom were men and 134,794 of whom were women. The majority of these people belonged to pastoral societies. I'm right here. This region's latitude and longitude are 6° 44' N, 44° 16' E / 6.733° N, 44.267° E, and its elevation is 493 meters above sea level. Kabri Dahar Governorate has a total population of 136,142, of which 77,685 are men and 58,457 are women, according to the Central Bureau of Statistics for 2007. The remaining 50,361 people (6 .99 percent) are pastoralists, while 29,241 people (21. 48 percent) live in cities.

Research Design

For this study, the researchers used descriptive and explanatory research designs. The research design refers to the processes and methods used to gather and analyze the necessary data. The goals a researcher wants to accomplish or the research questions they want to address will determine the study strategy they use (Crosswell, 2007). According to (Kothar, 2004), claims that surveys and diverse types of fact-finding enquiries are included in descriptive research.

Sampling Procedure and Determine the sample size.

Several steps of a sampling process were used to create a sample of respondents in the first phase. The Kebri-Dehar region was deliberately chosen because of its widespread application of productive social protection programs. With 11 in the second-stage rural kebeles, five kebeles were randomly chosen as participants and non-participants in a productive social protection program. In the third step, sample 1 obtained from Kebele's office is divided into two groups, and proportions are used.

$$n = \frac{Z^2 pqN}{e^2(N-1)+Z^2 pq}$$

$$n = \frac{(1.96)^2 0.5 * 0.5 * 4577}{(0.05)^2 (4577 - 1) + (1.96)^2 * 0.5 * 0.5} = 354$$

The survey was carried out with the help of development agents (DAs) in each of the target. Where: n = sample size; N = total population (1,925); Z = 95% confidence interval under the normal curve (1.96); e = acceptable error term (0.05); and P and q are estimates of the proportion of the population to be sampled (P = 0.5 and p + q = 1).

Sources and Types of Data

To obtain the necessary information for this study, both quantitative and qualitative data were collected from primary and secondary data sources. Demographic, socio-economic, market and institutional-related variables relevant to the study were collected based on the nature of the information needed on various aspects of this study, employing a mixed method of data collection methods to generate adequate and reliable data from the respondents. In addition, data on the type of food items consumed by households in the last seven days were also collected.

Data analysis techniques

The methods of data analysis used in this study were both quantitative and qualitative. To analyze the data, descriptive and econometric methods were employed.

Using frequencies, percentages, means, and standard deviations, descriptive statistical analysis techniques were used to discuss the results. To confirm the existence of statistically significant differences and systematic associations between the program and program participants on the hypothesized variables, chi-square tests and t-tests were used. Frequency, percent, and chi-square tests were used to analyze different types of quantitative categorical data. The Social Science Statistics Package (SPSS) version 25, STATA 13, and Excel were used to analyze the data for this study.

Food Security Measurement Models

The household caloric acquisition approach: this model was used to measure household food security, which is measured by daily calorie intake, which is a continuous variable measured by Kcal/AE/day at the household level. To measure the food security of households in the study area, information concerning the types and amounts of food items prepared for consumption by each household in the last seven days preceding the survey was collected.

Econometrics model specification

Binary logistic regression

The binary logit model is defined as follows, according to Gujarati, (1995):

$$P_{i \in \epsilon} \dots\dots\dots (Y=1/X_i)$$

$$= \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_i)}} \dots\dots\dots$$

..... (2)

Equation (1) can be expressed by:

$$P_i = \frac{1}{1 + e^{-Z_i}} \dots\dots (3)$$

Where; $Z_i = \beta_0 + \beta_1 X_i$

If P_i is, the probability of being participated and the probability of not participated in productive safet net program $1 - P_i$, which is expressed, follows in equation 3.

$$\frac{1 - P_i}{1 + e^{Z_i}} \dots\dots\dots$$

..... (4)

Equation 4 is obtained by dividing the participator to non-participator

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \dots\dots\dots$$

..... (5)

Therefore;

Is the odds-ratio (the ratio of the probability that an individual would choose an alternative).

P_i is the probability of household participating ranging from 0 to 1.

Taking natural logarithms of $\frac{P_i}{(1 + P_i)} = e^{Z_i}$

$$L_i = \ln \frac{P_i}{(1 + P_i)} = \beta_0 + \beta_1 X_1 + \dots\dots\dots + \beta_k X_k + \mu_i \dots\dots\dots$$

..... (6)

Where; $Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$
 Z_i is a function of k-independent variables β_0 = is the intercept or constant term
 X_i = ith independent variable K = represents number of independent variables
 K = Total number of independent variables.

Propensity Score Matching (PSM)

The propensity score matching method was used in this study to analyze the impact of a productive safety net program on rural household food security. According to Caliendo and Kopeinig (2008), some steps apply in PSM. These steps are predicting propensity scores, choosing matching algorithms, restricting common support areas, testing the matching quality or balancing tests, and performing sensitivity analysis. These are described as follows:

Step 1: Propensity scores: A logistic model is used to estimate propensity scores for each observation. The advantage of this model is that the probabilities are bounded between zero and one. The dependent variable is dichotomous, taking two values: 1 if an individual participated in a productive safety net, and 0 otherwise. The covariates used to predict treatment assignment using logistic regression are specified as follows:

$$L_i = \ln \left(\frac{p_i}{1 - p_i} \right) = \ln \left(e^{\beta_0} + \sum_{j=1}^n \beta_j X_{ji} \right) = Z_i$$

$$= \beta_0 + \sum_{j=1}^n \beta_j X_{ji}$$

Where L_i is a log of the odds ratio in favor of participating in productive safety net program?

- Z_i = participant
- β_0 = intercept
- β_j = regression coefficient to be estimated

Discussion and conclusions

Descriptive statistics study findings

Age of Household Heads: The mean age of the entire sample of all interviewed household heads was 48.03 years, with a standard deviation of 12.08. As a result, she had an average age difference of 1.48 years between households that were enrolled in the program, which had

an average age of 48.80 years, and households that were not enrolled, which had an average age of 47.32 years. The average age of the sample household is 86, while the median age is 21, and vice versa.

Education: The highest grade was ninth grade, with the lowest grade being the 0th. The average educational background of all household heads in the survey area was 1.74. Thus, with a mean difference of 0.32 years, the average number of school years for households in the program versus those who did not participate was 1.58 for the former and 1.885 for the latter. Between households with and without program participants, they discovered that there was no statistically significant difference in the level of education.

Family Size: There were 5.1706 people living in each household on average in our sample of respondents. When respondents were split into households with and without program participants, the average family size was 5.575 and 4.798, respectively. According to the statistical analysis, there was a statistically significant difference at the level of 5% ($\chi^2 = -0.426$ and $p = 0.0061$). Livestock: The average number of livestock owned by participating and non-participating households in the sample surveyed was 2.979 at TLU. According to the survey's findings, livestock had a mean difference in TLU of 0.062 and 3.01 TLU for program participants' households and 2.948 for non-participating households, respectively. The results of a t-test ($t = -0.426$ and $p = 0.000$) also indicated that this difference was not statistically significant.

Extension Contacts: Across all households in the study area, there were, on average, 2,455 extension contacts. There were, on average, 2.13 and 2.74 contacts between households participating in the program and households not participating, with a mean difference of 0.04. The difference was also statistically significant with a probability of 5%, according to a t-test ($t=4.7603$ and $p=0.0000$). According to statistical findings of the typical distance across the sample of respondents from the market center, the market distance (km) between participating and non-participating households for a sample of respondents is 15.82 km. The findings revealed that program participants were spaced apart on non-participants was 10.51 km and 20.71 km, with a mean difference of 10.02 km

Table 1: Descriptive statistics for continuous variables

Variables	Total Households (334)	sample Participant (160)	Non-participant (174)	T-test	P-value
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	Mean	Std.	Mean	Std.	Mean	Std.		
Age (years)	48.03	12.08	48.80	11.60	47.32	12.51	-1.121	0.2629
Education level (years)	1.74	2.61	1.58	2.498	1.885	2.709	1.040	0.149
Family size	5.1706	2.59	5.575	3.119	4.798	1.920	-2.762	0.0061
Livestock holding (TLU)	2.979	1.37	3.01	1.37	2.948	1.373	-0.426	0.6703
Extension contacts	2.455	1.206	2.13	1.162	2.74	1.175	4.7603	0.0000
Market distance(km)	15.82	15.47	10.51	12.18	20.71	16.55	6.365	0.0000

Determinant of Rural participant households programs Food Security

According to Table 2 of the PSNP participant households program, the binary logit model was estimated to determine the primary factors influencing household decision-making. The dependent variable in the PSNP is a dummy that represents the household program and has a value of 1 for participant household programs and 0 for non-participant household programs.

The specified binary logit model's explanatory power is adequate because the model's overall validity has been established and it is statistically significant at a P-value of 0.00. The pseudo-R-square was found to be around 0.1898, indicating that all explanatory significant variables included in the model explained 18.98 percent of the probability of household program participant households. The logit model's overall significance can also be inferred from the LR chi2 (10) = 87.76 and p-value (Prob > chi2) = 0.000.

Table 2. Marginal effect from logit estimation for determinants of participation in PSNP

PSNP	Coef.	Std. Err.	Z	P>z
SEXHH	-.7766406	.2727943	-2.85	0.004
AHH	.0273654	.011947	2.29	0.022
EDL	-.0416035	.0540904	-0.77	0.442
FMS	.1186982	.0526031	2.26	0.024
OFFACTV	.0395364	.2829799	0.14	0.889
LOWSHIP	-.1033271	.0959166	-1.08	0.281
MKINFRMN	.3018203	.261217	1.16	0.248
EXTCONT	-.4575165	.1117969	-4.09	0.000
CRDTSERV	.5167317	.2851846	1.81	0.070
MRKTDST	-.0564234	.011167	-5.05	0.000
_cons	.4784761	.7796265	0.61	0.539

334 obs are present.
 LR chi2(10) 87.76
 Prob > chi2 0.0000.
 -187.33573 log likelihood.

Pseudo-R2 0.1898

The binary logit model's results demonstrate that, of the 10 explanatory variables used for analysis, five are significantly related to households participating in the program, while the remaining five have a minimal impact and are more useful in describing the variation of households participating in the dependency program in the study area. At a 5 percent significance level, these are the respondent's age, family size, household age, gender, and distance to the market. Other factors like household education, market information access, credit service availability, and off-farm/non-farm activities did not differ significantly between program participants and non-participants (above table).

Age of the household head: The results of the binary logit model indicate that, at a 5% level of significance, the household head's age positively and significantly affects the likelihood of households participating in the PSNP program. When compared to younger people, household heads are more likely to participate in the program as they get older. The outcomes agree with Mohammed (2017).

Family size: The results of the binary logit model indicate that, at the 5% level of significance in the study area, the age of the household head has a positive and significant impact on the household probability. Statistical analysis reveals that, in terms of household size, there is a statistically significant difference between participants and non-participants. Similar to this, focus group discussions reveal that households participating in the PSNP have more family members than non-participating households According to Mohammed (2017) and Mesfin (2018).

Extension contact: The results of the binary logit model indicate that, at the 5% level of regional significance, the age of the household head significantly and positively influences the likelihood of households participating in the PSNP program. When compared to younger people, household heads are more likely to participate in the program as they get older According to ((Mohamed, 2017).

Propensity scores matching model on PSNP's effect on rural household food security

Calculating the propensity score

Using the propensity score matching technique, the impact of a production safety net program on rural households' diets was evaluated. PSM deployment consists of five steps. These include calculating p-scores, selecting a matching method, ascertaining overall support, calculating fit quality and effect, and carrying out a sensitivity analysis. Using the logit model, propensity scores (ps scores) for participating and non-participating households were calculated. This stage gathers all the information on the independent variables that were generated using propensity score matching, which was used to perform the match on a single variable.

A very low R2 value of 0.189, as seen in the table below, signifies that there aren't many differences between the typical characteristics of the sample's households. As a result, it might not be difficult to find a good match between effective safety net participants and non-participants. The results of the point estimates show that the household head's gender, household age, family size, extension contacts, service credit, and marketing strategy have a significant impact on the production safety net program. Negative and insignificant (-187.33573) is the predicted logit intercept According to (Caliendo and Kopeinig, 2005).

Imposing Common Support Region between Participant and Non-Participant

Based on the likelihood of participation, estimates of PSNP participation and propensity scores for all participating and nonparticipating households are created. The general support condition is the next stage in the propensity score matching technique after generating propensity score values for participants and nonparticipants using logit models. As the primary criterion for determining the area of common support between the two groups, eliminate any observations with a propensity score that is higher than the non-maximum participant's and lower than the participant's minimum

propensity score (Calindo and Kopeinig, 2008). In order to determine the general area of support where the distribution of propensity scores for the treatment and comparison groups overlap, this is necessary (Shahidur et al., 2010).

Potential scores are estimated for participating or treated households and the corresponding non-participating (control) household. The estimated propensity scores range from 0.0087 to 0.9118, with a mean of 0.6040 for participants and 0.3691 for those who have not been treated.

Table 3. Shows the estimated propensity score distribution

Group	Observatio n	Mea n	STD	Min	Max
All rural household s	334	.481 6	.236 6	.0087	.9669
Participan t	160	.604 0	.205 5	.0586	.9669 8
Non- participan t	174	.369 1	.205 8	.0087 6	.9118

In order to ensure the greatest possible comparability between the treatment groups (PSNP) and the comparison households (no PSNP), local households were used as the samples for matching, as previously mentioned in the table above. Both PSNP and non-PSNP households' propensity score values fall within common support categories. This method's fundamental criterion is the elimination of all observations with trend values in the opposite group that are below the minimum and above the maximum.(Kopeinig, 2005)

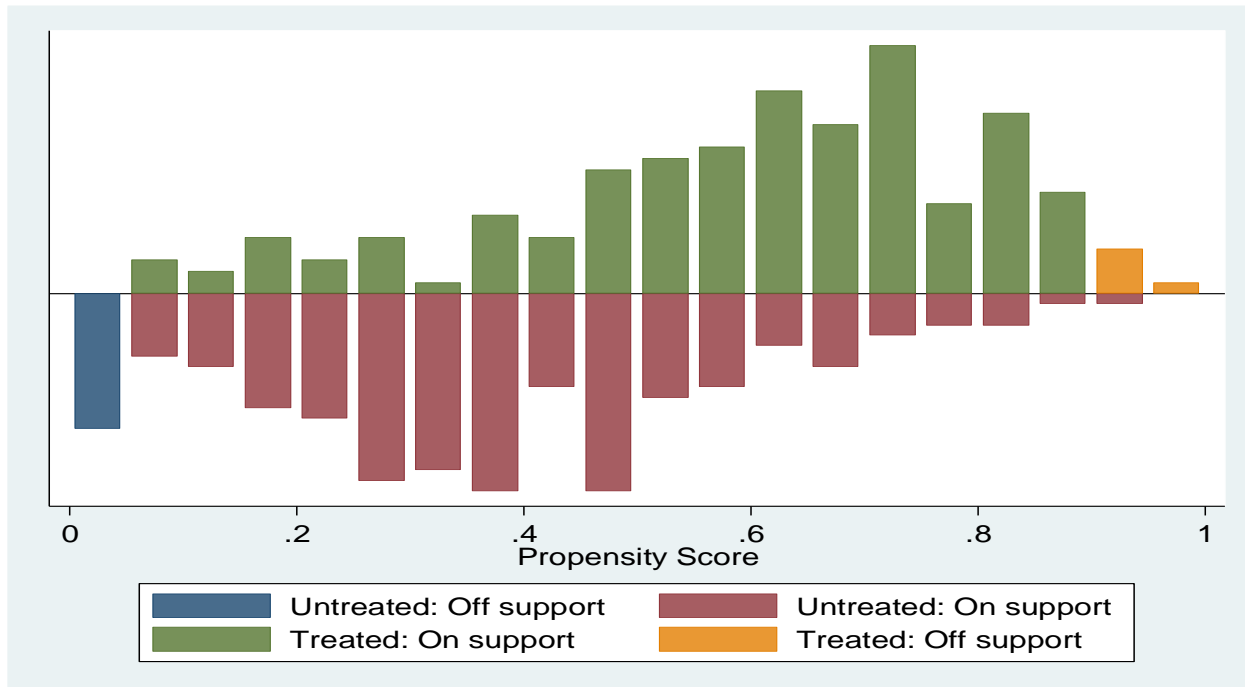


Figure 2. Density distributions of propensity scores using NNM n (4)

Looking for Common Support

It was discovered that 316 observations (147 from untreated participants and 158 from treated participants) were within common support, while 18 observations (13 from untreated participants and 5 from treated participants) were outside the purview of common support and regional analysis. But 316 observations—161 from untreated (non-participants) and 155 from treated (participants)—were within common support and were included in the analysis. These few observations served as the foundation for an analysis of the PSNP program's effects on household food security in the district.

Table 4. Support for Psmatch2

Psmatch ² Treatment assignment	Common support		
	Off support	On support	Total
Untreated (non-participant)	13	161	174
Treated(participant)	5	155	160
Total	18	316	334

Choosing of Matching Algorithm.

The general livelihood realm, additional comparable estimators were used to match participating and non-participating family units. The best outcomes for a good estimator depend on a number of factors, including testing for equality of means (also known as pseudo-R2) and examining the size of paired samples. The ideal estimator is one that is fitted, controls for all explanatory variables, has a small mean difference between groups, a low pseudo R2 value, and a large fitted sample size. The conformance quality test estimates are based on the following performance standards: The results show that 5-neighbor agreement with 0.1 bandwidth is the best estimator of the available data.

PSM and covariance balance before and after matching are statistically tested

The average standardized bias before and after matching, or the overall bias reduction made possible by the matching procedure, are shown in the table below. For prematched covariates, standardized differences had an absolute value ranging from -0.8% to 115.8%. Following matching, the residual standardized differences of covariates for all covariates fell below the 20 percent critical value suggested by Rosenbaum and Rubin (1985) and ranged from 1 point 2 to 16 point 7 percent.

Table 5. Balancing tests of the covariates (Pseudo R2, Rubin’s B and Rubin’s R)

Sample	Ps R2	LR chi2	p>chi2	Mean Bias	Med Bias	B	R	% Var
Unmatched	0.202	93.39	0.000	35.3	30.0	117.7*	1.15	29
Matched	0.031	13.37	0.270	10.6	11.3	42.1*	1.20	29

As a result, the matching procedure generates a highly covariate balance between the treated and control samples that is prepared for use in the estimation procedure. Similar to this, the t-test showed that all covariates were non-significant after adjustment, whereas 8 of them were significant before adjustment. This demonstrates that the standardized mean difference of all covariates used to calculate propensity scores, which was 35 point 3 percent before adjustment, is now only about 10 point 6 percent. Furthermore, the likelihood ratio tests' p-values show that the joint significance of the covariates was always rejected after adjustment but not before. Low pseudo R2, low standardized bias, significantly reduced overall bias, and no significant p-values in the adjusted likelihood ratio test suggest that trends between the treatment and control groups have been successfully identified.

The average treatment effects (ATT) are estimated.

The impact of production safety net programs on rural households' access to food is demonstrated in this section. As a result, the mean therapeutic effect (ATT) of PSM was calculated with a neighbor of 0.5. The corresponding results only provide proof that production safety net programs have a statistically significant effect on rural households' access to food. Thus, the program participant's 214.5 kcal/EA/household-day increases her PSM model results in Table 6 below, showing that households taking part in the production safety net program have a true average wage guarantee means that having a household's food security affected in any way by participation in production safety net programs. This suggests that under the same covariates, the production safety net program has an impact on food security of 214.5 kcal/AU. The fact that households choose to take part in the program seems to make them relatively safer and less prone to food insecurity than households who do not is encouraging for ATT.

Table 6. Impact of program participant households PSNP on household resilience to food security

Variable	Sample	Treated	Controls	Difference	S.E	T-stat
Kcal	Unmatched	2726.523	2451.010	275.512838	37.5	2.26
	ATT	2730.041	2515.652	214.388826	16.55	1.30

Sensitivity Analysis

It is becoming more and more important for researchers to test how robust their findings are to changes in certain presumptions. Sensitivity analysis can be used to address this problem because non-experimental data cannot be used to estimate the level of selection bias. To test the putative ATT's sensitivity to departures from the CIA, Rosenbaum (2002) suggests employing the Rosenbaum boundary approach.

Table 7. Rosenbaum Sensitivity Analysis for Hidden Bias

Gamma (Γ)	sig+	Sig-	t-hat+	t-hat-	CI+	CI-
1	0	0	2484.9	2484.9	2350.44	2628.7
1.25	0	0	2364.47	2614.34	2233	2767.48
1.5	0	0	2267.76	2724.09	2144.79	2878.3
1.75	0	0	2193.02	2816.38	2074.93	2966.75
2	0	0	2132.69	2894.05	2018.08	3041.87

Recommendations and Conclusion

Conclusion

In order to find out how the production safety net program affects rural households' access to food, four rural areas in the Kabri Dahar district of the Somali Regional State of Korahey were randomly selected out of a total of 11 rural areas. After thorough research, design was used. A multi-stage sampling method was used to collect data from the 334 household heads that were sampled.

Results from descriptive statistics reveal a statistically significant difference in household characteristics, such as age, gender, family size, distance from the closest market, and extended contact, between program participants and non-participants. However, there were no appreciable differences between participants and non-participants in terms of other factors like household education, market information access, financial services access, and off-farm activity. Aside from age, family size, and distance to the closest market, the logit model's findings also revealed contact information for Extension. was significantly and negatively affected by PSNP participation, whereas household education status, access to market information, access to credit services, and off-farm activity were not significantly different between program participants and non-participants.

The findings show that a total of 194 (58.80%) of the sampled households were found to be food secure, providing the minimum daily calorie recommendation, while 140 (41.92%) were food insecure, not meeting the minimum daily calorie requirement. This was established by using a cut point of a minimum of 2200 kcal/AE/day.

The outcome of the impact estimation indicates that the study area's household food security was improved by the productive safety net program. Compared to non-participating households, rural households that took part in the program consumed 214.5 kcal/AE/day more food on average. In comparison to non-participants, program participants were older, had larger households, and lived farther away from local shops and extended networks. Participating families were more likely to match their age, gender, family size, and distance from the closest marketplace and extension contact person. In order to address the issue of food scarcity, the study site's PSNP program is essential. The production safety net program has had a significant positive impact on participants' food security in the study area. These studies support the idea that PSNPs significantly improve household food security.

Recommendations

The following recommendations are provided in consideration of the study's findings mentioned above:

➤ Household length becoming substantially longer has an effect on family participation in PSNP. A family with a large age range, a large circle of relatives, a long distance from the nearest marketplace, and extended touch may be eligible to participate in an application. As a result, it is far from optional to take into account personal family planning in any improvement interventions carried out by authorities and non-governmental organizations that may manipulate rapid population growth to provide solutions to the family meals security problem.

➤ Finally, given the sure diploma of versions of application effect studies, if similarly conducted studies with extra scope and in a one-of-a-kind region examined the effect of PSNP and different meal protection applications on meal protection, it would be better.

Future researches

The study included a limited number of households and did not include all important factors and other aspects of food security. It focuses on how the producer safety net program affects household food consumption and examines the variables that affect PSNP program participation. Accurate data on food consumption in the research area can be difficult to collect because rural households frequently struggle to recall all of their consumption details. It's possible that some participants and non-participants will be unwilling to provide an honest response to inquiries about their animals. This limitation may arise due to a lack of information and awareness in the rural household study areas. Regardless of these limitations, it is anticipated that the study will create valuable information that may not be advantageous to various stakeholders interested in the field.

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Contributions of the author: This research paper was written by all authors

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Ethical Consideration: One of the most significant aspects of research is ethical considerations. The

researchers was approach the research participants first by seeking their willingness to engage in the study, and then identify themselves, and all research participants involved in this study was properly informed about the study's goal and their willingness to participate in it.

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RESEARCH ARTICLE

Effect of Road Rehabilitation on Housing Renovation in Calabar South Local Government Area, Cross River State, Nigeria

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Abstract

Infrastructure provision has been identified as a potent tool for the improvement of neighborhoods globally. One such infrastructure is a good road network. Road rehabilitation, therefore, has the capability of promoting land use development and housing development/renovation. Despite the obvious effect that road rehabilitation has on predicting property development and renovation, there appears to be a paucity of studies as it relates to Calabar South Local Government Area where road several roads have been rehabilitated. It is against this backdrop that this study was conceived. The study, therefore, analysed the relationship that exists between road rehabilitation and housing renovation in Calabar South Local Government Area between 2002 and 2021. Six residential neighbourhoods were randomly sampled. Furthermore, a total of 399 copies of the questionnaire were distributed and 389 copies were retrieved and used for analysis. Descriptive statistics such as frequencies and simple percentages were used in carrying out the analysis. It was noted that road rehabilitation drastically triggered the renovation of properties in the study area. For instance, there was an increase in the extent to which housing units were fenced, painted among other renovation exercises in housing units before and after the rehabilitation of the roads.

Keywords: Housing; Housing renovation; housing quality; housing environment; road rehabilitation

Introduction

Rehabilitation involves enhancing the quality of deteriorating neighbourhood through improving and maintaining existing infrastructure. The essence of rehabilitation is to prevent infrastructure/properties from deterioration, dilapidation and collapse. Rehabilitation of roads basically requires repairs and improvements through reconstruction and recoating of road surfaces (Sule, 2005), upgrading and construction of road surfaces that were previously in a state of disrepair (Hartoyo, 2013; Bassey, Eteng and Ewah, 2022). Holistically, roads play diverse roles in the society that makes it very importance. For instance, in rural areas, roads basically promote agricultural development and productivity (Bassey *et al.*, 2022; Bassey and Eteng, 2022) while in urban setting, roads influence the siting of land uses/developments, housing, markets etc. While roads are largely important in predicting developments, scholars (Ajom, Etim and Bassey, 2022; Ajom, Eteng and Etim, 2022; Eteng, 2016) have showed positive relationships between road rehabilitation and property development. Eteng (2016) showed that developers are always clamouring for land in accessible area

for housing development. Ajom *et al.*, (2002a) argued that road is the prime factor on which housing development depend. Their study highlighted that without accessibility, it is impossible to survive in the environment, embark on social activities among other. Against this backdrop, roads have been recognized as an integral part of the developmental process of regions (Aderamo and Magaji, 2010). Specifically, housing represent a basic need of man. It is more than mere shelter for man. In fact, housing serves as one of the indicators of a person's standard of living and his place in the society. This justifies why low density areas are characterized by accessible areas.

In Calabar South LGA, the urban renewal drive which started in 1999, brought about the development and rehabilitation of several roads. The road rehabilitation process further triggered development of various land uses include residential housing (Eteng, 2016). The level to which the roads have promoted housing renovation has not been studied in available literature. This suggest that there is a gap in knowledge that needs to be filled. Against this backdrop, the paper analysed the level to which road rehabilitation has impacted on housing renovation in Calabar South LGA, Cross River State, Nigeria.

Literature Review

Rehabilitation involves enhancing the quality of deteriorating neighbourhoods by improving and maintaining existing infrastructure. The essence of rehabilitation is to prevent infrastructure/properties from deterioration, dilapidation and collapse. Rehabilitation of roads requires repairs and improvements through reconstruction and recoating of road surfaces (Sule, 2005), upgrading and construction of road surfaces that were previously in a state of disrepair (Hartoyo, 2013; Bassey, Eteng & Ewah, 2022). Holistically, roads play diverse roles in society which makes them very important. For instance, in rural areas, roads promote agricultural development and productivity (Bassey *et al.*, 2022) while in an urban setting, roads influence the siting of land uses/developments, housing, markets etc.

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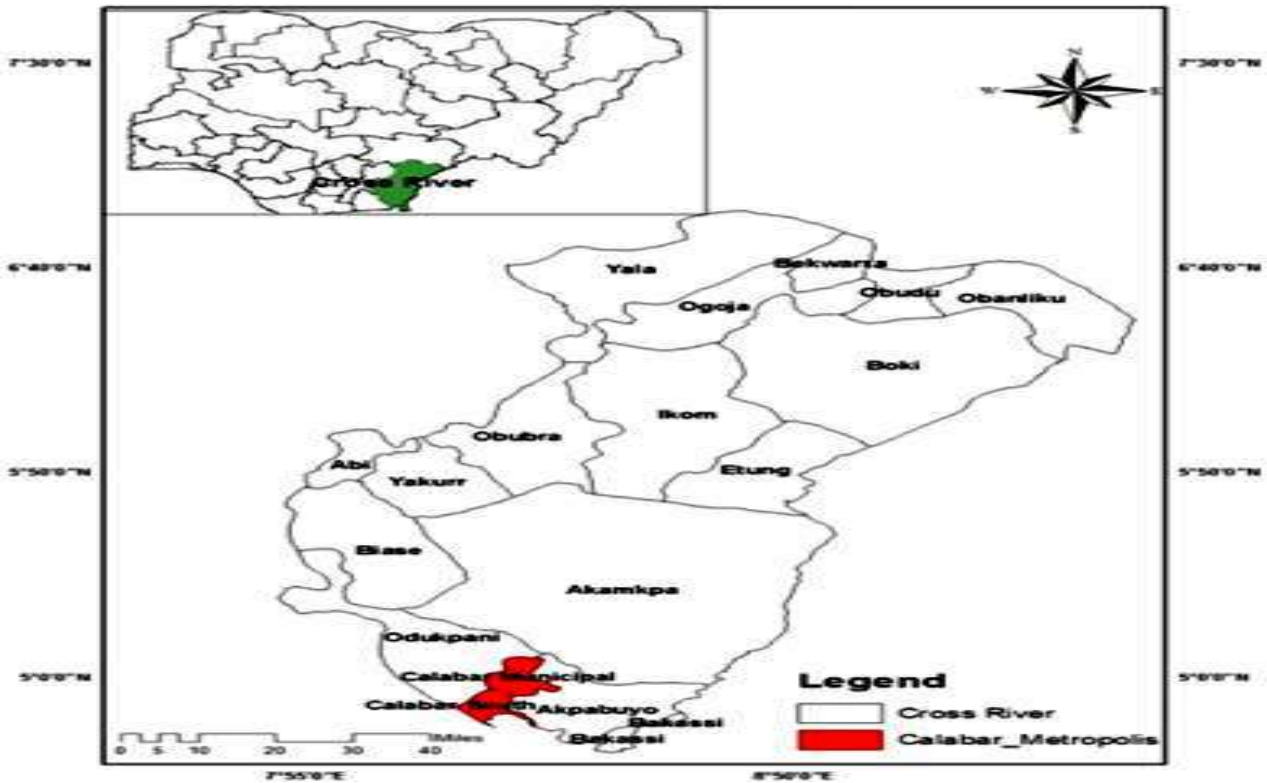


Fig. 1: Map of Cross River State showing Calabar South. Insert: Nigeria showing Cross River State

Source: Geographic Information Agency, 2020

Materials and Methods

Study Area

The study area is Calabar South Local Government Area in Cross River State. It has a total landmass of 262 km² and it is located between Longitude 8°15' East and 8°25' East of the Greenwich Meridian and Latitude 4°54' North and 4°58' North of the Equator. Owing to its latitudinal location, the area receives abundant and constant insulation. It is located in the Southern Senatorial District of Cross River State. The population of Calabar South was 185,787 persons according to the 1991 population census (NPC, 1991). Current projections show that over 400,000 persons are residing in the area. the topography of the area is a low-lying mass rising gradually upwards towards the Calabar Municipality. The vegetation of Calabar South is characterized by mangrove and rainforest ecosystems which form part of the rich fauna and flora of the state (Afandigeh *et al.*, 2011). Figure 1 shows the geographic location of the study area.

Methods

The survey design was used in this study. Data that were collected past and present housing conditions. The random sampling technique was used in the selection of the sampled areas. This is because, all neighbourhoods in the study area have the possibilities of being selected as roads have been rehabilitated in all the residential districts within the last 20 years (2002-2021). Therefore, in order to avoid bias, the random sampling technique was applied. Therefore, six residential neighbourhoods were selected. The selected neighbourhoods that were Henshaw Town, Anantigha, Efut Uwanse, Cobham Town and Duke Town and Mbukpa. In order to determine the appropriate sample size, the Taro Yamane equation was applied. The equation is mathematically expressed as follows;

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

Where; n = Sample Size, N = Finite Population, e = Level of Significance (Limit of tolerable error =0.05). In all, a sample of 399 households was taken.

The questionnaire were distributed at the household level.

Analysis and Discussions

Table 1: Condition of Wall before and After Road Rehabilitation

S/N	Condition of wall	Before road rehabilitation		After road rehabilitation	
		Frequency	Percentage	Frequency	Percentage
1	Sound/Intact	83	21.3	277	71.2
2	Cracking	121	31.1	73	18.8
3	Dilapidating	185	47.6	39	10
	Total	389	100	389	100

Source: Field Survey, 2022

Table 1 shows the comparison of the walls of houses by respondents before and after the rehabilitation of the road infrastructure. It showed that only 21.3 percent were staying in houses whose walls were sound and intact before the rehabilitation of the road while the road rehabilitation necessitated the upgrading of the walls of the houses of 71.2 percent. Furthermore, the numbers of cracking walls were

reduced due to the road rehabilitation exercise as seen in the table. As well, dilapidating walls in houses before the rehabilitation of the road were higher compared to the situation after the rehabilitation exercise. From the observations, it may be deduced that the condition of walls in housing units have witnessed improvements.

Table 2: Condition of Roof before and after road rehabilitation

S/N	Condition of Roof	Before road rehabilitation		After road rehabilitation	
		Frequency	Percentage	Frequency	Percentage
1	Sound/Intact	84	21.6	241	61.9
2	Leaking	187	48.1	96	24.7
3	Sagging	79	20.3	38	9.8
4	Part missing	39	10	14	3.6
	Total	389	100	389	100

Source: Field Survey, 2022

Table 2 indicates that before the rehabilitation of the road infrastructure, the condition of the roof tops on buildings were not in good conditions. For instance, 21.6 percent respondents were staying in houses with sound and intact roof tops before the rehabilitation of the road while the figure skyrocketed as 61.9 percent respondents affirmed that their roof tops were upgraded upon after the rehabilitation of the road. Equally, 48.1 percent reported that their roof tops were leaking before the rehabilitation of

the road. After the road rehabilitation, this figure was reduced as deduced from the opinion of 24.7 percent. Furthermore, 20.3 percent roofs were sagging before the rehabilitation of the road but were reduced to 9.8 percent. In addition, 10 percent parts were missing on their roof tops before the rehabilitation of the road while 3.6 percent respondents were residing in housing units with missing parts. From the table, it is obvious that the houses with leaking, sagging and missing parts have also reduced

Table 3: Fencing before and after the rehabilitation of road

S/N	Fencing	Before road rehabilitation		After road rehabilitation	
		Frequency	Percentage	Frequency	Percentage
1	Fenced	98	25.2	194	49.9
2	Not fenced	291	74.8	195	50.1
	Total	389	100	389	100

Source: Field Survey, 2022

Table 3 shows a significant difference in the extent to which residence set up fences in their compounds before and after the rehabilitation of road. The table indicated that the

percentage of residents that stay in fenced compounds rose from 25.5 per cent before the rehabilitation of the road to 49.9 per cent after rehabilitation. The observations suggest that road rehabilitation drastically increased the level to which fences were set up in properties by house owners.

Table 4: Painting Before and after road rehabilitation

S/N	Painting	Before road rehabilitation		After road rehabilitation	
		Frequency	Percentage	Frequency	Percentage
1	Painted	112	28.8	204	52.4
2	Not painted	277	71.2	185	47.6
	Total	389	100	389	100

Source: Field Survey, 2022

It was revealed in table 4 that the percentage of painted compounds along rehabilitated roads increased from 28.8 percent before road rehabilitation to 52.4 percent after the rehabilitation of the roads. This is because, the rehabilitation of roads drastically encouraged property owners to fix and upgrade their structures since demand for the housing properties became increased.

Recommendations

Based on the findings of this study, the following recommendations are made;

- i. Since road rehabilitation manifest positive effects on housing renovation, there is need to ensure regular rehabilitation of roads in the study area

- ii. Rehabilitated roads should also be maintained to avoid collapse faster than anticipated
- iii. There is need to incorporate public private partners in the rehabilitation process
- iv. Development control should be taken seriously in the study area to ensure that renovation in housing units do not contradict with approved urban development pattern.

Conclusion

This paper analyzed road rehabilitation and housing renovation in Calabar South Local Government Area, Cross River State, Nigeria. It was observed that the rehabilitation of roads leads to the improvement in the conditions of housing units. For instance, the study presented a variation in the quality of building components that were assessed in the appraisal. the variation suggests that housing renovation increased drastically after road rehabilitation. From the findings, it is clear that road rehabilitation is a positive contributor to housing development. Thus, amid growing population and the attendant need to ensure good quality housing units to shelter people within the study area, good road provision and rehabilitation can be adopted as a strategy that should be used.

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RESEARCH ARTICLE

The Path to Climate Sustainability: A Review of IPCC 2022

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Abstract

Working Group II of the IPCC Sixth Assessment Report focuses on climate change impacts, adaptation, and vulnerability in the context of sustainable development. This IPCC evaluates climate model simulations from CMIP5 and CMIP6 of the World Climate Research Programme. Depending on global warming levels after 2040, climate change will threaten natural and human systems. Mid- and long-term consequences are several times higher for 127 identified major hazards. Climate change is having increasingly dire, interconnected, and often irreversible effects on ecosystems, biodiversity, and human systems, and risk provides a framework for comprehending these effects and for devising strategies to prevent unfavourable outcomes for present and future generations. As climate change implications and actions are enacted, more is known about how they affect justice and socioeconomic advancement. AR6 emphasises change and quick climate action to achieve such goals.

Keywords: Climate change; IPCC; risk; disaster; adaptation

Introduction

In the last two decades of the twenty-first century, life expectancy, per capita income, and education have experienced unparalleled growth. However, the scale and intensity of human activity have also increased, leading to more negative environmental impacts. In this framework, the purposeful and unintentional human effects on the background cause the most urgent environmental issues, which are genuinely global: decreasing forests, expanding deserts, eroding soils, deteriorating rangelands, rising carbon dioxide levels, dropping water tables, rising temperature, more destructive storms, melting glaciers, rising sea level, increasing floods and forest fires. Timely examples include global climate change, which reduces human-managed natural resources (such as biodiversity, landscapes, and wildness), natural resource productivity (such as agriculture), damage to the built environment (such as flash floods from cloud burst has risen), and dangers to humans due to extreme weather changes.

Intergovernmental Panel on Climate change (IPCC 2022) is, therefore, the only event of its kind that focuses specifically on in-pit crushing and conveying on a global scale. The sixth episode of a conference series has been a significant success. When it comes to quantifying the global impact of climate change, no other organisation compares to the Intergovernmental Panel on Climate Change (IPCC) (Rama et al., 2022). They are crucial

sources of scientific data and technical advice for the UNFCCC, Kyoto Protocol, and Paris Agreement. After a successful event in Chile in 2018 (Birkmann, J et al., 2022), this meeting will continue the tradition of offering a forum for high-level networking and conversations on IPCC in all its forms. Impacts, adaptability, and susceptibility to climate change were the focal points of IPCC's 2022 report. By maximising synergies and minimising duplication, integrating adaptation and mitigation with the SDGs can boost the effectiveness of both. Literature, research, practice, and decision-making related to climate change have all elevated the importance of the notions of risk and risk management (Caretta et al., 2022). The AR6 report addresses adaptation options and their efficacy and adequacy in achieving societal goals related to climate change, such as decreasing vulnerability and boosting resilience. Three aspects of climate justice are highlighted in AR6: distributive justice, procedural justice, and acknowledgement (Shaw, R et al., 2022).

This study examines how IPCC Working Group II Assessment Report 6 (AR6), with three subsequent special reports, might help mitigate climate change and flood disasters. Because of their role in regulating temperature and natural hazards.

A Changing Climate in a Changing World

Since the IPCC Fifth Assessment Report (AR5) publication in 2014, many significant climate-related developments have occurred worldwide. That report indicated many simultaneous changes in the physical climate system, including higher average world temperatures, lower ice volumes, higher sea levels, and different global precipitation patterns. Globally, both natural and human ecosystems have been affected by changes in the physical climate system, particularly more intense extreme events. Water and food security were affected; infrastructure was damaged to a larger extent; more deaths and illnesses were documented; people were uprooted or relocated; their livelihoods were ruined; mental health issues were increased; and inequalities widened.

Additionally, since AR5, a growing number of individuals around the world have learned about climate change, found it to be a severe issue, and believe it to be an emergency that needs rapid attention (New, M et al., 2022). Compared to 2013, when just half of respondents in 23 countries saw climate change as a pressing issue, in 2017 nearly two-thirds of respondents from 50 countries—representing over half of the world's population—held this view (Fagan, M et al., 2019).

Since AR5, there has been a substantial rise in planning and initiatives to mitigate the current and future risks associated with climate change. Concerns about climate change have prompted actions from governments, businesses, and individuals (O'Neill, B et al., 2022). However, as the report details, current climate policies and efforts are insufficient on their own to meet these goals. The world is in the midst of some of the most profound cultural and environmental upheavals in decades when people take action on climate change (Parmesan, C et al., 2022). Rising inequities along gender, wealth, age, race, and ethnicity, as well as a rapidly urbanising world population, are all examples of Gendered Issues. While economic disparities between countries have narrowed globally, they are increasing domestically (Bongaarts, J, 2020).

Observed Changes to Hazards and Extreme Events

“Climatic impact drivers” (CIDs) are what Working Group I of AR6 refers to when discussing the causes of negative, positive, or neutral changes in the physical climate systems. Hazards, on the other hand, are frequently the subject of discussion in natural systems literature. Physical occurrences with the potential to have a detrimental impact on ecosystems and environmental resources can be classified as hazards, and these hazards can be either natural or manmade in origin (Allan, R et al., 2021). Extreme weather events and other natural disasters can happen rapidly, but the cumulative effects of various climate risks might take decades or longer to manifest in

the form of soil degradation and erosion. Risks to protected areas are evaluated based on observations of exposure.

The frequency and severity of disasters like floods, droughts, cyclones, heat waves, and fires have increased as a result of climate change and other disturbance regime alterations. To better represent both small-scale processes and exceptional occurrences, climate models with increased resolution would be very useful. These disruptions have a significant negative effect on ecosystem functioning, biodiversity, and ecosystem services, but are rarely taken into consideration in impact models. Many ecosystems rely on the regular occurrence of extreme events, and many species have adapted to the long- and short-term climate swings within the disturbance regime they have experienced (Cissé, G et al., 2022).

Extreme episodic occurrences can alter or disrupt ecosystems' functionality, which is essential for such adaptive strategies. While we have a good handle on the primary climatic hazards on a global scale, we know far less about the impact of many disasters on ecosystems at once, making it difficult to quantify the results in future forecasts. Even if individual occurrences are not particularly severe, the combination of several can have a devastating effect (Sharrief, A et al., 2019). Examples include sea level rise, exceptional coastal high tides, storm surges, and river flows can all have a multiplicative influence on flood risk and freshwater system consequences. The extensive dieback of some forests (for example, in Australian eucalypt forests) may be caused by a combination of causes, including changes in rainfall and heat, altered plant growth and nutrient allocation under elevated CO₂, and the rates of herbivores and insect outbreaks. Risk assessments usually consider a single climatic hazard with constant variability (Zscheischler, J et al., 2018).

Ecosystems And Disaster Risk Reduction

Reduced disaster risk is a stated goal of several environmental policies and strategies under the Hyogo Framework for Action (HFA), which includes land use, natural resource management, and adaptation to climate change. A key component of the HFA's approach to increasing the robustness of societies and states is the management of ecosystems. The 2011 Global Assessment Report on Disaster Risk Reduction stresses the importance of integrating ecosystem-based approaches into disaster management (Schipper, E et al., 2022). Disaster risk and the effects of climate change can be mitigated, thanks in large part to the regulatory and provisioning functions supplied by ecosystems. The ability of ecosystems to reduce risks has numerous positive effects on human security. Numerous studies have demonstrated the crucial role ecosystems play in mitigating dangers. Various names are used to describe ecosystems in the disaster literature. Some examples include: natural buffers, natural barriers,

natural infrastructures, green and blue infrastructures, bio shields, and protective greenbelts. Therefore, they protect individuals from the worst of what nature can throw at them. Example: studies done after the 2004 Indian Ocean Tsunami demonstrate the value of coastal forests and plants (such as mangroves) in protecting lives, property, and resources from the devastation of tsunamis(O'Neill et al., 2022).

Water Security in Climate Change and Climate Resilient Development

For a population to be considered water secure, they must be able to guarantee that they will always have access to sufficient supplies of high-quality water in an environment free from violence and political unrest. This water must be used to maintain livelihoods, human health and social progress, as well as to safeguard against water pollution and natural disasters. Water insecurity risks are a global issue. Water crises have been one of the top five threats in the World Economic Forum's Global Risks Report since 2015. Water is a crucial component in the necessary system transitions for climate-resilient development, and it is given significant attention in the SDGs. A majority of the SDGs will not be achieved unless everyone has access to clean water. Without effective adaptation, future water-related climate change impacts on many economic sectors are estimated to reduce global GDP by mid-century, with higher projected losses in low- and middle-income nations (Pörtner, H et al., 2022).

Second, freshwater availability across places and time is directly impacted by climate change, which also impacts water demands for various applications like irrigation and may exacerbate pre-existing social difficulties. Vulnerability to water-related consequences of climate change and extreme weather is now felt in all key sectors and is predicted to grow in the future, including agriculture, energy, industry, and water for health and sanitation. Agriculture and irrigation comprise 60–70% of all water withdrawals. Lack of clean water and sanitation causes several water-borne diseases. In 2017, 2.2 billion people needed adequate drinking water, and 4.2 billion people needed adequate sanitation. The present COVID-19 outbreak is exacerbating water inequities. Droughts and other extreme occurrences have damaged hydropower and thermal power production globally. Between 1971 and 2000, 16% to 39% of cities faced surface-water shortages. More than 440.5 million city dwellers would experience water scarcity by the year 2050 (Dodman, D et al., 2022). In South America, not many people have access to clean drinking water. If global warming is limited to 1.5 degrees Celsius, risks to water-intensive businesses can be reduced and flexibility can be maintained. The future of water security is in jeopardy due to the proliferation of mitigating strategies. Afforestation and reforestation can have major effects on water supplies, but only if they are carried out correctly. The risks associated with climate change on water security

can be mitigated by considering the direct and indirect effects of mitigation efforts on water resources(Shaw, R et al., 2022).

Climate change impacts are stressing agriculture, forestry, fisheries, and aquaculture

Short-term food shortages and price increases caused by weather extremes related to climate change exacerbate already severe food insecurity in some parts of the world. As a result of changes in agricultural output, food prices, and household incomes, the number of people who go hungry will rise as a result of climate change. Extreme climate occurrences will increase, forcing particular food-producing locations beyond safe climatic space. One study predicted that in Sub-Saharan Africa and Southeast Asia, heat stress from projected three °C warming over baseline (1986-2005) will lower labour capacity by 30-50%, contributing to a 5% increase in crop prices due to greater labour costs and production losses, so affecting food supply, access, and livelihoods (Morecroft, M et al., 2022). They are anticipated that by 2100, climate change might harm agricultural and marine fisheries in 90% of the world's countries. Globally, shellfish aquaculture habitat suitability will drop after 2060, but sooner in several Asian countries (Cooley, S et al., 2022). Climate change will raise food costs and management issues. Pathogens, HAB, and toxic inorganic bioaccumulation pose safety issues. Micronutrient insufficiency is widespread and will be a concern throughout the first half of the century, with serious health consequences. Damage to pollinator populations, soil biodiversity, and water infrastructure, thereby reducing agricultural employment and threatening human health are additional dangers to food safety and nutritional balance posed by climate mitigation plans, that ignore the possibility for increased rivalry between food production and other uses for scarce land and water(New, M. et al., 2022).

Policy

The IPCC WGII AR6 builds on the AR5, three special reports, and the simultaneous WGI and WGIII AR6 assessments. The findings and assessment methodologies employed across these reports influence the WGII AR6 starting point. They include the strong acknowledgement of the need for climate action, the increased attention to risk, and the effort to combine near-term climate solutions with longer-term changes.

The conference's consensus was that human activity had a noticeable impact on the global climate.

Climate change has affected human and ecological systems.

Unchecked greenhouse gas emissions increase the risk of severe, pervasive, and irreversible impacts on people and

ecosystems due to increased warmth and longer-lasting changes in all elements of the climate system.

A substantial cut in emissions over the next few decades can lessen 21st century climate risks, increase opportunities for effective adaptation, lessen mitigation costs and impediments, and help pave the way for climate-resilient pathways to sustainable development. Policies, partnerships, and integrated measures that connect adaptation and mitigation with other societal goals are essential for successful implementation.

At the time of the IPCC AR5, there was little scientific research on 1.5°C global warmings. In 2018, the IPCC released a Special Report on the implications of global warming of 1.5°C and corresponding global GHG emission scenarios. The analysis compared global warming at 1.5°C and two °C over pre-industrial levels (Schoeman et al., 2022). It discussed solutions to achieve the Paris Agreement's aims. Quoted report findings:

If warming continues at the current rate, 1.5°C might be reached by 2052.

- Global warming of 1.5°C increases climate-related dangers for natural and human systems compared to 2°C.

1.5°C warming will require less adaption than 2°C.

Models show that if global warming stays below 1.5°C, global net anthropogenic CO₂ emissions will fall to zero by 2050 from their 2010 levels (interquartile range: -40% to 60%). Interquartile range (IQR): 2045–2055.

- Even with extremely ambitious improvements in emissions reductions beyond 2030, national mitigation efforts as represented by the Paris Agreement would not be sufficient to keep global warming below 1.5°C.

Nature-based solutions not only help with adaptation and mitigation of climate change, but also with the achievement of other Sustainable Development Goals. Nature-based climate change mitigation relies on the creation of climate-resilient systems that serve various sustainable development goals, which in turn requires participatory decision-making and adaptive management. A move to more deliberate decision-making is required to keep management on track as the effects of climate change reverberate across infrastructure. Poorly managed, nature-based mitigation strategies could have negative effects on human health, reduce the amount of usable land and water, and compromise long-term sustainability.

Restoring natural ecosystems and natural processes that have been damaged or destroyed is an important adaptation and mitigation strategy. Landscape, marine, and biological community species composition are all at risk from the effects of climate change, and restoration efforts must account for this. When an ecosystem is nearing its tipping point, as is the case with tropical coral reefs, climate change may overwhelm efforts to restore or maintain the environment. Carbon is stored and many species are supported by thriving forest ecosystems that are lost in degraded areas. In low, boreal, and temperate biome

regions, natural forest ecosystems survive but are managed, degraded, or removed in many parts. Deforestation and land degradation continue to emit GHGs. Protecting natural forests and managing semi-natural forests sustainably are successful.

Urban climate adaptability can be aided by solutions rooted in nature. All of these elements have positive effects on human health and well-being: urban forests and green spaces (parks and green roofs) can provide cooling effects; coastal wetlands and mangroves can minimise storm surges and floods; sustainable drainage systems can prevent surface flooding due to extreme rainfall.

Water shortage is a mismatch between freshwater demand and physical availability.

Socioeconomic and governance inequalities generate water scarcity and insecurity. Climate change-caused water shortages require greater water management. Climate change, agricultural practises, water demand, and governance will influence future water security. Not simply climate change threatens water security. Climate change may affect water supply, water quality, and flooding in many locations, jeopardising water security. Alternative result probabilities rely on regional climate shifts and socioeconomic futures. Future water scarcity predictions complicate water security and adaptation methods due to climate change. Global warming can reduce water security challenges. At these temperatures, regional climate shifts are clearer.

Half of the world population is vulnerable to severe water scarcity for at least part of the year due to climatic and non-climatic variables, which is anticipated to worsen with increased warming. High population densities and insufficient water supply, accessibility, quality, and governance cause water insecurity worldwide, especially in South Asia, North China, Africa, and the Middle East. High-water-availability areas can be water-insecure due to flooding, low water quality, and inadequate governance. Future water security depends on socioeconomic, management, and climate change. Climate change can diminish water supply and increase flooding, contributing to water insecurity. Future socioeconomic conditions are a crucial driver of water insecurity, requiring adaptation to climate change. In many locations, policy problems are considerable due to climate uncertainty. Adaptation solutions in crop production range from the field and farm-level technical alternatives like crop management and cultivar/crop options to income diversification and index-based insurance.

Land use planning helps locate settlements and infrastructure. The built environment and its impact on natural systems are both impacted by climate change, which in turn drives growth in high-risk locations. Despite this, cities in varied situations have restricted climate adaptation zoning and land use regulations. Traditional zoning regulations (those that permit only one use in a given area) and land use planning can be used to mitigate

threats by encouraging people to move away from dangerous areas or hide from them. Zones for protective urban infrastructure (such seawalls, levees, dykes, and slope revetments) and avoidance measures that restrict or slow urban expansion are all part of a comprehensive plan for protection (e.g., growth containment and no-build zones). Research from both the Global North and South shows that conventional zoning is not as effective as land use policies for climate adaptation that prevent negative human-nature interactions and that curb spatial inequity, both of which can cause climate gentrification and increase the vulnerability of economically disadvantaged groups to climate-related risk.

Considerable variation exists between nations and regions, making it unlikely that current global efforts in health adaptation would be sufficient to safeguard the health of populations and communities from most climate-sensitive problems. Although health is a priority sector in 54% of NDCs, less than 1% of international climate financing goes toward adaptation to climate change in health.

When planning for and responding to climate change's potential health impacts, it's essential to consider the wide range of interconnected factors that can impact the health of populations and the efficiency of health care delivery systems. Given the complexity of the interconnected environmental, social, and health systems that are impacted by climate change, a systems-based approach can facilitate the identification, implementation, and evaluation of solutions that support population health and health systems in the short and long term. This approach provides insight into how to enhance health and wellbeing in a variety of contexts. In order to mitigate the risks to human health caused by climate change, it is essential to implement effective governance structures, arrangements, resources, and mandates for adaptation.

Health adaptation might be less successful or destructive if it becomes compartmentalised without integration and collaboration across sectors. Integration and collaboration include working across national ministries and agencies, as well as between federal and municipal governments and the commercial sector, academia, NGOs, and civil society. In addition to top-down approaches to policy development and implementation, bottom-up efforts, in which community actors are involved in programme design and draw on their local practises, perspectives, ideas, and experiences, are also useful. There is a chance to improve public health by incorporating it into discussions and decisions about climate change and by bolstering public health partnerships and collaborations. Cross-sector cooperation can be facilitated by building networks, integrating organisations, and developing policies.

Results and Conclusion

Working Group authors follow IPCC recommendations on expert judgement. The IPCC Sixth Assessment Report

(AR6) has advanced interdisciplinary climate change assessment from AR5. As a result, assessment findings spanning the entire gamut of climate science, consequences, risks, and policies are more directly comparable. The risks, consequences, vulnerability, societal adaptation, mitigation, and sustainable development associated with climate change have all been better understood because to the utilisation of a plethora of newly available sources of knowledge. Climate change adaptation is successful if reasonable efforts reduce risk and vulnerability and achieve their aims. Goals of this nature are established and monitored globally following pre existing international frameworks and norms. Achievable objectives for impact management at the local and national levels are conditional on the effects under consideration, the nature of the measures being taken, and the scale at which they are being implemented.

For a comprehensive evaluation of the impact of an act, it is essential to consider how well the adaptation serves its intended purpose, how well it works, and how well it fits with the principles of justice. Six reports have been released by the IPCC documenting climate and ecological changes brought about by humans. There is no hiding from these shifts; they are happening now and will only accelerate in the years and decades to come. As part of its AR6 report, the IPCC also highlights the efforts people are doing to adapt to climate change. Even positive adaptation might have negative effects on existing structures. When other acts are performed, the underlying structure of the system is altered. Example: constructing a seawall to defend a coastal neighbourhood from flooding. Changing land use restrictions and implementing a managed retreat programme may be a transformational adaptation.

A seemingly insignificant factor, climate risk in mortgages and insurance is actually quite game-changing. Because the amount of greenhouse gas (GHG) mitigation influences the amount of transformational adaptation required to prevent intolerable dangers, some transformations may be inevitable. Rapid adjustments in energy, land, urban, and industrial systems are needed to get on a low-emissions path that is in line with Paris Agreement goals. Dangers must be mitigated even on low-concentration paths, and transformational adaptation is essential for this. In order to mitigate (but not eliminate) intolerable dangers along higher concentration trajectories, superior transformative adaptation is required. If a transformation isn't well thought out, it may be necessary to make alterations along the way.

Water scarcity and insecurity are caused by socioeconomic and governance disparities. Better water management is needed to adapt to climate-caused water shortages. Future water security will depend on climate change, agricultural practises, water demand, and governance. Water security is endangered by more than climate change. Climate change may threaten water security in many countries by affecting water supply, quality, and flooding. Regional climatic

alterations and socioeconomic futures are needed to evaluate potential outcomes. Predictions of future water scarcity complicate climate change risks to water security and adaptation methods. Water security challenges can be alleviated if global warming is limited. Because at these temperatures, regional climate shifts are less obvious.

Climate change has monetary effects, some of which are precipitated by slow-onset and extreme weather events. The economies of those areas that use less energy and have a competitive edge in sectors like agriculture and tourism are doing well. Short-term economic growth has been slowed by some extreme weather occurrences like tropical cyclones. More assets have been exposed to extreme climate hazards due to non-climatic characteristics such as settlement patterns and infrastructure siting, leading to greater losses. Individual lives have been disturbed due to changes in agricultural productivity, repercussions on health and food security, damage to homes and infrastructure, and loss of property and income, which in turn has affected gender and social equity.

AR6 emphasises social justice and knowledge. As climate change consequences and actions are implemented, more is known about how they affect justice and socioeconomic progress. The AR6 emphasises transformation and swift climate action to satisfy societal goals.

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RESEARCH ARTICLE

Porous Morphology Eco-Efficiency Design Process of a Selected Masterpiece Building and its prospects on the Environment

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Abstract

The characteristic of urbanization, modernization and its effect on the environment has become a disastrous event especially towards the beginning of 20th Century (C). Researches have shown an excessive exploitation of minerals both on and beneath the earth crust were consumed every year for the purpose of construction alone. Thus, not only decrease in volume of earth materials but also the impact on environment thus need attentions. This study observes that the conversion of material; exploitation; energy used during construction; energy associated with heating; cooling; lighting and ventilating commercial buildings have potential consequence on the environment. A selected study of masterpiece building with philosophy of porous structure, which certified Leadership in Energy and Environmental Design (LEED) in Nigeria, was reviewed. Finding indicates that conceptual design from the school of thought help in setting reasonable objectives at the designing process stage. Also, energy efficient building will reduce wastage of earth materials with alternate source of natural energy, application of natural element other than artificial during building construction and occupancy stage are mitigation strategies to negate aforementioned effect on the environment. Conceptual frameworks with composite notions from various domains were explored to include concept of *porosity* from medicine among others was utilized, acceptable for maximum lighting, cross ventilation and circulations. Hence, energy efficiency was achieved which is friendly to the environment.

Keywords: Sustainable building; Porosity for fenestration; Iconic and modernization; Pollution; Environmental Impact Assessment (EIA)

Introduction

Vernacular building types evolved in response to local availability of resources such as wood, grass, clay, stone (Arthur, 1991) and the basic need of shelter for man (Adedeji and Olotuah, 2011). The discovery of copper, lead, iron and glass which are more efficient in response to structural stability and modern architecture encourages industrial revolution; manufacturing technologies created new opportunities from existing materials and introduced entirely new materials for construction with the help of mass exploitation of fossil fuels from abundant sources of coal, crude oil and natural gas in Nigeria but with energy inefficient buildings (RAEng, 2007; Arthur, 1991). The industrial revolution thus resulted to increasingly construction of mass building and simultaneously urbanization through commercial and industrial organizations (WHO, 1992; Olotuah, 2005, RAEng, 2010; Amoa, 2012; Aribigbola, 2001). Building types that evolved includes intensive, massive both in height and width and iconic.

Environmental Protection Agency (EPA) highlighted 'significant changes on the surface of the land' due to construction activity which involves clearing vegetation, excavation, disrupting habitats, changes to drainage patterns and the water table, noise pollution, dust, vibration among others (FRN, 2006). According to the United Kingdom Green Building Council (UKGBC, 2019) opined that the construction sector uses more than 400 million tons of material each year, much of which has a negative environmental impact due to intensive extraction of raw materials, transporting to manufacturing plant and site, consecutively with generation of waste, energy consumption both in manufacturing and in use.

The Town and Country Planning of England and Wales Regulations (2011) sets out a requirement to carry out an environmental impact assessment (EIA) as part of the planning application process for certain projects been large, high magnitude or complex projects basically to ensure that the environmental effects of a proposed project development are properly assessed before consideration (UKGBC, 2019). An EIA provides the local planning

authority with better information about certain types of project, enabling them to make an informed decision about whether permission should be granted or to allow imposition of more appropriate conditions and responsibility purposely to mitigate possible negative impacts (Development Control Department, 2007; FRN, 2006; Lagos State of Nigeria, 2005; Vagale, 2000; Oyo State of Nigeria, 2012; Oyo State Government of Nigeria, 2014; UKGBC, 2019). However, natural forces, element and advantages over time have been encouraged to be utilized and it is the major process to mitigate urban housing design and construction impact on the environment. In the 20C, many buildings became totally dependent on fossil fuel energy to make them habitable. Before 21C, buildings must be designed to function with much lower levels of energy dependency (RAEng., 2010). Natural ventilation is one of the most familiar aspects of energy efficient building design. This work tend to review existing completed construction project that satisfied LEED criteria and requirements, to correlate its existing ecosystem friendly expectation thus, to propagate its contribution to knowledge, to encourage springing up of friendly prototype and typology towards safe of the built environment.

Problem Definition

Impact on the environment of masterpiece development in the urban center takes a cognizance examination of processes, materials and technologies to improve air movement, thermal performance, and control of moisture, ambient energy, light and acoustics during construction, occupancy stage and variably, need to mitigate change in climatic implication on the environment. Research has demonstrated that buildings which combine good architecture to include perceptions, beliefs, principles, aims and or school of thought underlying individual's practices and conduct with environmental design can result in significant increase in occupant satisfactions and productivity as regard low energy building (Fadamiro, 1998).

The aim is to study the impact of masterpiece development on the environment while the objectives of the study are to:

- i. Identify and to select a masterpiece building in Nigeria,
- ii. Determine the architectural philosophy of the Design process,
- iii. Examine the impacts of such development on the environment,
- iv. Examine significant increase in occupant satisfactions with good architecture of environmentally energy efficient design.

Background Knowledge to Philosophy of Porosity in Design Process

Schön (1990) examines the design process as a situated activity during which designers seek to solve a problem.

The conceptual task of a designer is to analyze the problems that require solution and the approach through a framework. Steven Holl is one of the most influential contemporary American architects, Holl as stated in the work of Sotirious (2007) implemented porosity as a concept transferred from medicine, biology and organic chemistry in designing the 350-unit student residence named Simmons Hall at MIT as shown in Plate 1. Holl's philosophy is identified as porous (Sotirios, 2007).

Review of Porosity's School of thought in Simmons Hall Building

Sotirious (2007) described the features and location of the Simmons Hall dormitory that it belongs to a strip of potential new MIT buildings along Vassar Street, in Cambridge, Massachusetts. The strip forms the Vassar Street edge along the Briggs Athletic Field, and it is located next to the railroad tracks. The Simmons Hall is 350 bed residences of 10 stories high, 382 feet long, providing amenities to students such as a 125-seat theater, a night café, a restaurant with an exit to the Vassar Street. Instead of the typical in Massachusetts urban brick wall model, the strip was envisioned by architect Holl and his architectural team with a "porous" membrane characteristic (Sotirious, 2007). During the process of designing Simmons Hall as shown in Plate 1, the features of *pores* and porous materials were approached. Sotirious (2007) explained further that the design concept of *porosity* was imported from biology, medicine and organic chemistry to transform a "porous" morphology for Simmons Hall, via a series of design operations. Accordingly, building mass of Simmons Hall was designed to have five large scale recesses, while a system of vertical cavities creates vertical porosity allowing light and air to circulate within the building envelop. Moreover, the building facades have a large number of operable sieve-like windows (Sotirios, 2007).



Plate 1: Simmons Hall student residence at MIT showing pores on its facades

Source: Sotirios, 2007

Environmental Emission Performance

In the early 20C, the modern architectural movement emerged, bringing new forms of building (Amao, 2012) that neglected former primitive form and many of these early examples of modernist movement showed little concern about rate of energy consumption, pollution, scope, magnitude, building’s performance and impact consideration to its immediate environment. Effect consideration arose after World War II in response to building’s environmental performance (RAEng, 2010). The field saw a strong interest at the time of the energy crisis during 1970s and again now as energy efficiency is becoming more concern in the evolution of buildings.



Figure 1: Building Metamorphosis from shelter, house, mansion and masterpiece
 Source: RAEng, 2010

Vernacular building types evolved in response to local availability of resources (Arthur, 1991). The mass exploitation of fossil fuels instigated man to build resource and energy inefficient buildings (RAEng, 2010). Figure 1, shows the metamorphosis of primitive shelter which is one

of the three major necessity of life has opined by Adedeji and Olotuah (2011), vernacular architecture is the traditional ways of life which simultaneously reflect on human shelter whereas; modern architecture involves revolutionary ideas and styles in art especially, architecture as a reaction to traditional forms; and international style is an early 20C architectural style in the United States and Europe that favored the use of simple geometric lines, spacious interiors, materials such as steel, reinforcement concrete, glass, columns, long façade/open window, open space are achievable with aid of technological advancement (Adedeji and Olotuah, 2011; Anthony, 2014; Fadamiro, 1998).

Building impact studies became one of the principal drivers in construction of new buildings for the 21C to meet emerging challenges. Hence, the urgent need to reduce mass exploitation of the earth materials, dependence on fossil fuels for energy and resources conservation which are the major steps to reduce effect on the ecosystem. The need for sustainable buildings is important and achievable through application of energy efficiency and natural element (RAEng, 2010). However, Low energy buildings require a detailed understanding of the natural forces (sun, natural ventilation and other climatic factor) at play.

Figure 2, shows the Building Regulations Carbon Emission and Emission Relative Revision Trajectory by RAEng. (2010) shows that for domestic sector projects over the periods of 2004 to 2015, there is successful progressive changes in regulation to carbon neutral which is not significant in the building industries thus, need to set a targets for energy efficiency which is carbon reduction to mitigate impact on the environment.

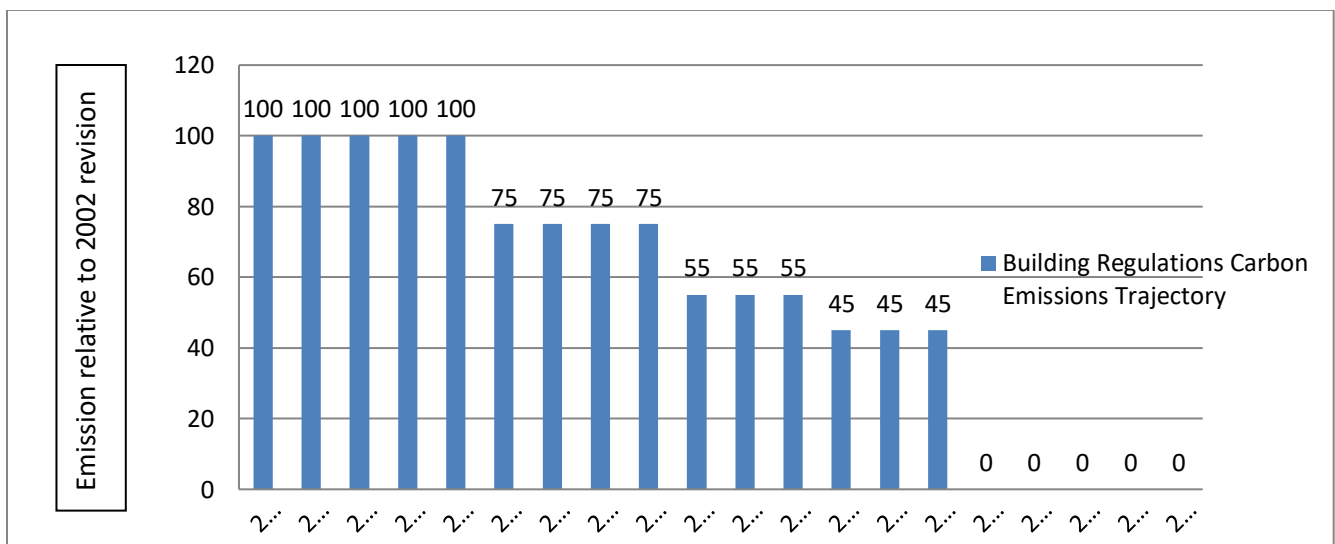


Figure 2: Building Regulations Carbon Emissions
 Source: RAEng., 2010.

Methodology

This research pivoted at analyzing elements on development and optimal use of master piece buildings in Nigeria, taking a review of not only an iconic building but relatively tall. That is, this study involves physical investigation of a selected high-rise building by visual inspection, personal interviews with employees occupying this tall building, physical appraisal and deficiencies in the building. Questionnaires were distributed to thirty (30) professionals and thirty (30) non-professionals on problems they perceived, associated with masterpiece structure in Nigeria and how they can be avoided. The administrations of structured questionnaires included colored photographs of the selected building and questions relating to eco-friendly evaluation and demographic information of respondents. Regarding the selection of respondents, the sampling did not pretend to be statistically representation of the population of Lagos but preference was given to understanding the energy efficiency expression of the building. Information on efficiency element, renewable natural element (sunlight for day lighting, wind for ventilation through control fenestration), exploitation of construction materials, fossil fuel and alternate source of energy, landscaping element and their

immediate effect on the environment was investigated while secondary data were collected from library banks to include journals, newspapers, magazines, Internet and also from other personnel with information as regard masterpiece buildings. Lagos state in Nigeria was selected as the study area being the economic stronghold of West Africa sub-region and former capital of Nigeria. Tall, masterpiece and iconic building development in Nigeria are noted to be significant in the city. Hence, data for this research was collected by visiting a selected high-rise structure in Lagos to determine its current status compare to a selected case study of international standard. Amongst problems investigated include maintenance, functionality, emergency preparedness, energy efficiency and comfort.

Tall Buildings in the Continents, Africa and Nigeria Hierarchically, Anthony (2014) noted that most tall buildings of significance were built in the United State of America, some countries across Europe and later Asian countries. Anthony (2014) quoted data published in the 1980s that about 49% of the world's tall buildings were built in North America and that it has now changed drastically as Asia now has the largest share of 32% against North America's 24% as shown in Table 1.

Table 1: Tall Buildings per Continents

Region	Nos. Countries	Percent (%)	Nos. Building
Asia	20	32.2	35,016
North America	18	23.9	26,053
Europe	20	23.7	25,809
South America	10	16.6	18,129
Oceania	7	2.6	2,839
Africa	20	1.0	1,078
Total	95	100	108,92

Source: Emporis, 2006

In 2009, Anthony (2014) pointed that the UN population fund recorded that the population of Africa had reached 1,022,234,000 hence, proclaimed Africa the second most populated continent behind Asia and also noted that the continent's population is expected to reach 1.9 billion by

the year 2050 and this will definitely spur developmental challenges especially in the urban cities. Massive, tall and masterpiece development begun to spring up to meet the demand of the increased population in Africa and notable buildings are listed in Table 2.

Table 2: List of High-rise Masterpiece Buildings in Africa

S/N	Building's Name	Floor	Height	Year	Country
1	Carlton centre	50	223m	1973	South Africa
2	Ponte city Apartments	54	173m	1975	South Africa
3	Bahia centre	31	161m	2008	Algeria
4	NITEL building	32	160m	1979	Nigeria
5	Marble towers	32	152m	1973	South Africa
6	Pearl Dawn	31	152m	2010	South Africa
7	SA Reserve Bank Building	38	150m	1988	South Africa
8	Villagio Vista	35	150m	2011	Ghana
9	Metlife Centre	28	150m	1993	South Africa
10	88 on field	26	147m	1985	South Africa

Source: Anthony, 2014

Nigeria with high increasing population is blessed to be one of the most economically developed nations on the African continent occupies a land area of about 923,768 sq. km and Lagos state happened to be former capital with major economic activities in the country also houses majority of the tall, iconic and masterpiece building which are largely attributed to the fact that most of the major financial and governmental activities are conducted in the city (Anthony, 2014). Ogundeji and Fadairo (2018); and Ogundeji, Fadairo, Ogundeji and Ekundayo (2022)

explained further the urbanization as the movement of people from rural areas to urban areas to experience or acquire different benefits that are rare in the rural milieu. Thus, experiences massive influx of citizens from the rural areas in search of greener pasture which also contribute to Lagos growth hence, reason Lagos is selected as the study area. Table 3 shows list of some tall and masterpiece buildings in Nigeria with majority located in Lagos, Nigeria.

Table 3: List of Tall and masterpiece Buildings in Nigeria

S/N	Name Of Building	Floors	Height	Year	Location
1.	NITEL/NECOM house	32	160m	1979	Lagos
2.	Union Bank Headquarters	28	124m	N/A	Lagos
3.	Cocoa house	26	105m	1965	Ibadan
4.	Independence house	23	103m	1960	Lagos
5.	CBN Building	19	100m	U/C	Lagos
6.	Great Nigeria house	22	95m	N/A	Lagos
7.	Heritage Place	14	N/A	2016	Lagos

NOTE: N/A means Not Available; U/C means Under Construction;

Source: authors' archive, 2019

A Selected Masterpiece Building in Lagos, Nigeria

Susty Buildings (2016) opined that Heritage Place is one of the iconic buildings in Nigeria. The selected masterpiece development which is Heritage Place is Located at Alfred Rewane Road, Ikoyi, it provides quality office space in the commercial capital of Nigeria. Plate 2 and Plate 3 are pictures describing the building. Heritage Place is a massive rectilinear Modernist building with its office tower spreading on fourteen (14) floors providing over 15,736 square meters (sqm) of offices space ranging from 450sqm to 2,000sqm, 350 parking bays, double volume reception, suspended ceilings, and a cafe/coffee shop. It was completed in the first quarter of 2016 (Susty Buildings, 2016). Laurus Development Partners was nominated to oversees consortium of consultants including Capita Symonds UK, ECAD Architects, CA Consultants, Morgan Omonitan Abe and Tillyard Limited. The main contractor was ITB Limited which is also one of the leading construction companies in Nigeria while the nominated developer, Actis and Primerose Development Company which is a private equity firm were also the team behind the completed Ikeja City Mall, Abuja's Jabi Lake Mall Development and 9-floors office property with sustainable features located within the bustling Airport City of Accra which is in close proximity with Kingsway Tower, Alliance Place, B.A.T Rising Sun, Chelsea Group Hotel and Temple Tower (Susty Buildings, 2016). According to Susty Buildings (2016), Actis ensure that the project meets international green and sustainable building standards by attaining a Leadership in Energy & Environmental Design (LEED) certificate, a sustainable building rating system set

out by the United States Green Building Council (USGBC). These features were expected to lead to 30-40 percent reduction in energy consumption, a valuable asset considering high power and energy costs in Nigeria. (Susty Buildings, 2016)



Plate 2: Aerial View of the Heritage Place Building at Night Time

Source: Susty Buildings, 2016

Porosity as Conceptual Framework

Pore from Greek means “a minute opening”. Porosity or “the state of being porous” in the context of organic chemistry and the study of plants and animals indicates the existence of small openings. In biology and in medicine porosity is defined as:

“the attribute of an organic body to have a large number of small openings and passages that allow matter to pass through” (Sotirios, 2007).

Holl’s contextual definition of *porosity* by Sotirios, (2007) was defined as part of “permeability hypothesis” that a porous morphology would produce considerable effects and positive impact on urban and building scale. That is, better air and light circulation, better accessibility and visibility, better communication between interior and exterior spaces. The assembly of the building container was practice by the production of pores, openings, internal channels and cavities. Sotirios, (2007) explained further that porosity can be accomplished in four ways:

- i. First, by creating large-scale recesses of building envelop;

- ii. Second by creating protrusions of building mass/envelop as shown in Plate 3;
- iii. Third, by distributing a large and wide windows of various shape and size on the elevations as shown in Plate 3;
- iv. Fourth, by distributing a number of free-form cavities penetrating the building from top to bottom, or and a case of typical court yard.



Plate 3: Aerial View of the Heritage Place Building at Daytime
 Source: *Susty Buildings*, 2016

Steven Holl team of Architects, NY as noted by Sotirios (2016) explained typical word and synonyms of porosity as the case may be to be porous, permeable, honeycomb, screen, net, riddle, sponge, pore, opening, hole, aperture, passageway, cribriform, sieve-like, sieve, pervious, and unrestricted.

Findings and Discussions

Table 4 shows that 60% of the professional respondents are males while 40% are females. 80% of the non- professional

respondents are males while 20% are females. Also, 43.33% of the respondents are within the age group of 21-30 for the professionals while 50% of the non-professionals respondents are within the age group 41-50. In addition, 50% of the non-professionals are Bachelor’s degree holders while 60% of the professionals hold same level of education. Table 4 indicates that majority of the respondents are learned with probability of understanding the research area, questions with a reliable response.

Table 4: Respondents’ Characteristics

Gender	Professionals		Non-Professionals	
	Frequency	Percentage	Frequency	Percentage
Male	18	60	24	80
Female	12	40	6	20
Total	30	100	30	100
Age				
21-30	13	43.33	8	26.67
31-40	10	33.33	7	23.3
41-50	5	16.67	15	50.0
51-60	2	6.67	-	0

Total	30	100	30	100
Education				
HND	3	10	12	40
BSC/B.TECH	18	60	15	50
MASTERS	9	30	3	10
Others	--	-	-	-
Total	30	100	30	100

Source: Authors' archive, 2019

Table 5: Shows findings towards environmental friendly need on Heritage Place building

Factors and findings	Representation in graph	%
Design zoning	A	100
Natural air and light circulation	B	98
Functionality and communication	C	95
Open and wide windows	D	93
Double glazing to reduce emission of heat	E	92.3
LEED Certificate in design and construction	F	90
Façade and cladding	G	88
Water efficiency and storm water control	H	85
Technology advancement; cctv, sensors, alarm etc	I	80
Vertical parking	J	78
Mechanical facilities zoning	K	75
Landscaping degree	L	50
Fossil fuel consumption	M	30
Noise pollution	N	15
Smoke pollution	O	10
Floods	P	2

Source: Authors' archive, 2019

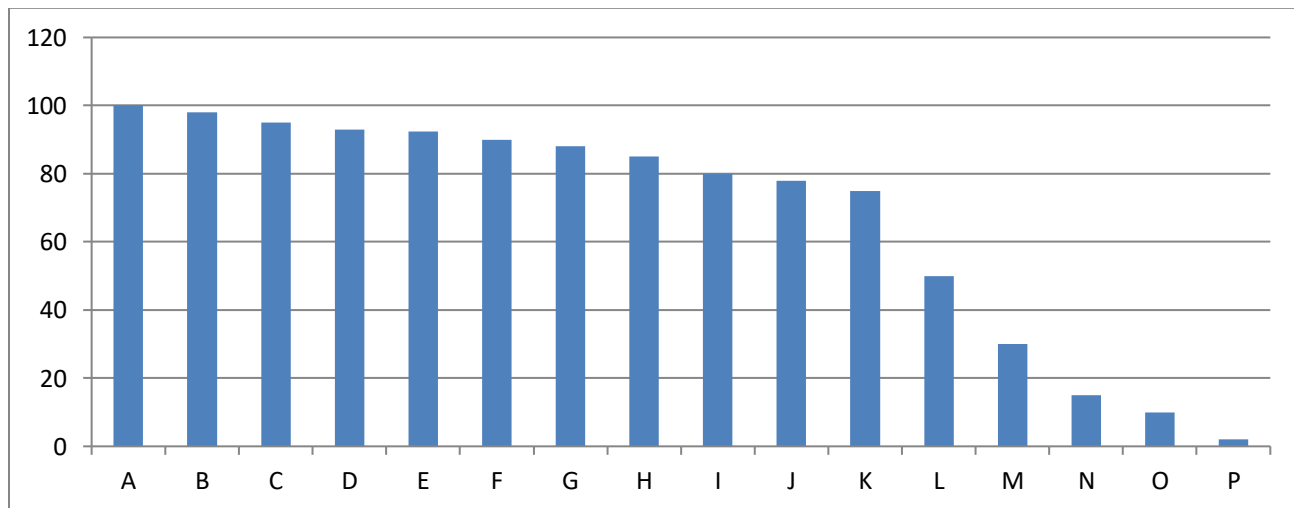


Fig. 3: Findings towards environmental friendly advantages on Heritage Place building

Source: Authors' archive, 2019

The philosophy of Heritage building takes after the porosity structure's school of thought earlier implemented by Holl's Architect purposely to achieve environmental friendly building with air, light circulation, better accessibility, visibility, and better communication between interior and exterior spaces which made it a functional building scale (Sotirios, 2007).

Heritage place is the first commercial building to achieve LEED certification in both design and construction; it applies cutting edge technology to fulfill environmental expectations at all time. The façade of the edifice comprises of alternating composite cladding and high quality Low-E double glazing on the upper floors reduce need for artificial lighting during the day and hollow fins substituting the floor to ceiling windows on the first five floors which forms the parking space compare to common horizontal we are used to which consume much space (Susty Buildings, 2016). UKGBC (2019) maintained that LEED basically includes a method of rating system for building types around the world with the aim of helping owners, occupants and operators be environmentally responsible and use resources efficiently. Thus, table 4 and Fig. 3 indicate attributes among other features that were utilized and that categorized the case in study to be energy efficient with LEED Certification.

Plate 4 shows drop-off point for visitors from which the 5 level multi storey parking could be accessed. Plate 5 also shows the reception area, the use of wood has been creatively employed to the ceilings as one advances from reception to the elevator lobby to give a sustainably pleasing experience.



Plate 4: Drop-off Zone
Source: *Susty Buildings, 2016*



Plate 5: Reception Area with wooden finishes on the ceiling

Source: *Susty Buildings, 2016*



Plate 6: Meeting Room with Folding Door Partition

Source: *Susty Buildings, 2016*

Open space meeting room with partitions by folding door to allow for expansion of meeting space for variety usage whenever desired is shown in Plate 6 indicate functionality of the building, the rentable meeting rooms are also located on the ground floor beside the reception. The cafeteria is serviced by a dry kitchen and can be found on the opposite side of meeting area. Plate 6 also observes floor to ceiling glazing which provides vista of the outdoor with provisions of an outdoor eating area to improve that experience. Mechanical services such as the Generator House is also on the ground floor but zoned away from the public areas. Plate 7 shows other mechanical facilities such as heating, ventilating, and air conditioning (HVAC) plants, exit deck and hydraulic-powered devices are located on the roof level.



Plate 7: Showing floors, long window façade, deck housing mechanical facilities and green areas
Source: *Susty Buildings*, 2016

Plate 7 also describe the general planning of the facility, service core is placed at the center and comprises 6 lifts for passengers and one lift for goods movement, an escape stair, storage and office spaces for the Facility Mangers. The centrally placed core actually provides an advantage of arranging all office space with the inevitable wide-view of the outdoor.

The Characteristic of Heritage Place after careful review has less environmental impact. Hence, the primary features are itemized;

The building's orientation maximizes natural lighting, ventilation and minimizes solar exposure which variably reduces energy requirements for cooling, heating and air quality systems

High efficiency glazing and external thermal envelope also reduce demand on cooling requirements (*Susty Buildings*, 2016).

It is the first LEED Certified Commercial Building in Nigeria both at design and construction.

Heritage building also achieved between 30–40% reductions in energy consumption compared to common practice building in Lagos (*Susty Buildings*, 2016). The use of natural light and natural ventilation to minimize energy demand is also observed.

The automatic presence detectors, sensors and high efficiency lighting from technological advancement are milestone achievement as energy efficiency is concern.

Occupants' thermal, visual and working comfort is increased by level of indoor air quality through adequate ventilation and quality of materials (*Susty Buildings*, 2016).

Water demand is minimized through rain water harvesting and condensate recovery from cooling units. Also, there is provision of water tank to collect or retain discharge of foul and storm water to the local sewers in Lugard Road (*Susty Buildings*, 2016).

Recommendations

Measures put in to consideration by the building professionals in the course of Heritage Building construction and it effect on the environment which consequently made the building an environmental friendly are specifically not limited to the followings;

Architect philosophy of porosity encourages environmental friendly building with air and light circulation, better accessibility, visibility and better communication between interior and exterior spaces of building.

The urgent need to reduce dependence on fossil fuels and massive exploitation of building materials will go a long way to reduces carbon emission impact on our environment. Thus, integrating renewable energy such as energy obtainable from the Sun, wind, waves, etc. other than energy generated from fossil fuels, thermal for heating water are economical, reliable, with viable technologies and simple application.

Conventionally, designed buildings priority must be to minimize energy demands in the first place. Hence, building should be designed to be naturally ventilated and lighting in architecture. Natural ventilation is one of most familiar aspects of energy efficient building design.

Use façade innovation system that will moderate solar gains and maximize potential for daylight.

The use of local knowledge to suit climate through insulation to standards

Uses of double and or triple glazed windows to prevent drafts which is current of air flow to minimizes heat loss through windows

Building materials of high thermal mass were used to prevent fluctuation of indoor temperature, to minimize heat loss and the impact on the environment is the energy required to produce materials of high thermal mass.

All pipes that were used were insulated purposely to minimize heat loss and gain for hot and cold pipes and the effect on the environment is understanding aspect that the colored insulation could be perceived or interpreted by the individual.

Position and orientation of windows and light shafts encourage maximum utilization of natural day lighting which is enough to reduce need for artificial lighting thus, with the effect of creating in-door and out-door connection. Open-able windows, chimney for stack effect, underground culvert and availability of air inlet are existing features on Heritage building which also amount to energy conservation to the milieu.

Thermostat were used to ensure that heat is efficient, stays at a set temperature as 'heat control' and can be regulated as conditions change throughout the year.

The use of motion sensors for water taps reduces water consumption as taps turn off automatically and simultaneously reduces impact of sewage in to the milieu. Also, use of spray taps reduces water and energy used consumption by 80% compared to normal taps. This also yielded water conservation.

Waterless urinals do not require water supplies, cheap to install with no possibility of damage by frost. In addition, a dual flush or low flush toilet too reduces water consumption from 6l to 4.5l or less per flushing. Recently, dual flushing has raised awareness on water consumption

Rainwater harvesting achievement through provisions of storage tanks and treatment is to collect rainwater to be used for flushing toilets and that has reduces demand for local water supply. Collection of water from washbasins and other grey water with necessary minimal treatment if water is not stored for long is used for flushing toilets.

There are Low wattage light bulbs purposely efficient to reduce energy usage and they variably contribute to less heating of room and less energy consumption.

Motion sensors on lights reduce energy usage on unnecessary lighting when the occupants are not in the building.

Door sensors were avoided because no energy would be required for normal doors but sensor door consumes energy. Peradventure, doors for disability can be opened by switches for comfort, with little or no support to the disabled.

External blinds were used on windows to prevent overheating in summer as reviewed. Planting deciduous trees with a good landscape provide shading in the summer and would allow for heat gain in the winter.

The location of structure within buildings but other than virgin environment would provide protection from wind, thereby reducing heat loss and the draughts and the effect on the environment is its attraction for other buildings to spring-up.

Conclusion

Design process help in setting reasonable objectives at the designing process stage for the purpose of solving a problem (Gero, 1998). Conceptual frameworks may be composites involving notions from various domains of inquiry (Knight, 2005). The concept of porosity was transferred from medicine; biology and organic chemistry in to new urban context hence, aid air and light circulation, better accessibility, visibility and better communication between interior and exterior spaces of building. In order to create new buildings and adapt existing ones to be fit for the 21C, need to be environmental friendly. Performance analysis and energy prediction, the architectural design, available resources and with the empirical construction

knowledge will help master builders not to construct inefficient buildings whose energy performance falls far below that which we need to achieve (RAEng, 2007). Government set out in Building a *Greener Future* (DCLG, 2007) that all new homes must be zero carbon from 2016 (UK Green Building Council, 2019). As steps to achieving this target, energy efficiency standards for new homes are to be improved, through Building Regulations, by 25% in 2010 and 44% in 2013 relative to current 2006 standards. *The Proposals for amending Part L and Part F of the Building Regulations* (DCLG, 2009) make it clear that a similar trajectory in Figure 2 for carbon reduction will apply to non-domestic buildings. In the UK, the 2006 revision to Part L of the Building Regulations (DCLG, 2006) in itself required a 25% reduction in carbon emissions over the previous standard.

In a bid to mitigate climate change and secure future energy supplies for the purpose of urban development which are masterpiece or massive building with the minimum environmental, social and economic impacts, we must fundamentally popularize green architecture that is, protection of nature, ecology and environment; and to be able to sustain it (Fadamiro, 1998; DCLG, 2007; RAEng, 2010). RAEng (2010) opined that the association of energy with heating, cooling, lighting and ventilating commercial buildings accounts for two thirds of the carbon emissions. Building must possess such features to optimize physical characteristics of buildings and their systems to balance these energy demands, exploit natural energy and minimize the reliance on artificial energy for environmental friendly in 21C. The Heritage Place building, Ikoyi has positive and less impact on the environment with the low energy consumption and emission, from the design stage to construction stage with less exploration of materials (sand, stone, granite and water) for concrete work of the frame structure (less massive concrete), natural ventilation and lighting to reduce burning of fuel to power plant and appliances, storm water collection to reduce effect of flooding (Akintola, 1978), green planting reduces effect of sunlight and global warming (Fadamiro, 1998; DCLG, 2007), among others. Heritage place Ikoyi shows that sustainability, environmental friendly design and construction in urban center is feasible in Nigeria.

Energy efficient design can be achieved with collaboration, inter-disciplinary knowledge between the architects, engineers and other related professionals from the onset of the project. By the time the building design has been sketched, the major opportunities for energy conservation which previous studies have shown to have negative impact on the environment would have been captured and mitigated. Hence, the man build-up environment would be guaranteed to be friendly.

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