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Compliance to Health and Safety Measures in Selected Construction Firms in Lagos, Nigeria

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Abstract

Non-compliance to safety measures remains one of the factors that endanger construction sites. As one of its contributions to work on enhancing the safety and health of workers and improving project quality delivery, this study examined the level of compliance to health and safety among construction firms in Lagos State, from the perspective of workers. The study adopted a survey research design. The sample size for the study was one hundred and twenty (120) skilled artisans who were randomly selected from among foreign and indigenous construction firms in the state. The research instrument was a questionnaire that collected relevant data, with descriptive and inferential statistics being used for the data analysis. It was found that only 22% of the firms made provision for PPE, in the light of legislative requirements on standards. Moreover, out of three workers, one was afraid to report incidents/accidents while the fraction of workers that wished to report were unaware of the officials to report such matters to. Consequently, a similar percentage of workers was worried that there would be a penalty for reporting safety issues. Regarding contractors' safety policy review, while one out of every three contractors bore their responsibilities under the safety policy, one out of every four contractors was requested to make some amendments. It was thus concluded that workers are not encouraged to report any incident or accident confirming a low level of compliance between the two firms. It is therefore suggested that there should be strict enforcement of measures for improving safety and health practices on construction sites, in addition to motivating workers on incident/accident reporting and specifying the right line of safety actions. Furthermore, risk assessment for work operations should be enhanced to minimise the percentage of work that is halted or executed unsafely.

Keywords: Accident; Compliance; Construction firms; Health and safety; PPE

1.0 Introduction

A key change in the world of work has been the 'virtualisation' of work, leading to an increased demand for 'flexibility' in work organisation, working-time arrangements, and telework (Skibniewski, 2014; Robelski et al., 2019). Despite the unprecedented changes in how people

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interact at work or conduct work activities as a result of the huge development and spread of digitalisation technologies, the nature of construction activities and the uniqueness of the sector continues to demand the use of skilled labour (Eze, Sofolahan & Siunoje, 2020). Therefore, the occupational health and safety of workers remain critical factors, hence the emergence of studies in the area. Although the conclusion and direction of research in the several studies differ, there is a seeming convergence of opinions on the importance of safety and health principles and management, with emphasis on compliance (Izudi, Ninsiima & Alege, 2017). Safety and health compliance, that is, observance of established safety standards and regulations, concerns occupational safety and health and significantly controls the rate at which construction sites are associated with injuries and accidents (Tanko & Anigbogu, 2012). Safety health and compliance should thus be an integral aspect of project management and must be given high priority by construction participants to ensure occupational well-being.

Concerning construction sites, different aspects of occupational safety and health have been researched. Charehzehi and Ahankoob (2012) and Sanni-Anibire et al. (2018) reported that failure to adhere to required safety procedures as well as to take precautions against hazards such as using safety wear is common on project sites. According to Sanni-Anibire et al. (2018), this situation persists because the safety culture has yet to be imbibed. Besides the common failure to use personal protective equipment (PPE), non-compliance of workers to other work procedures and rules is equally prevalent (Sanni-Anibire, et al., 2018). The use of PPE serves as an important measure to safeguard workers from exposure to occupational hazards. However, workers will be motivated when they realise the risks inherent in the non-use of PPE (Izudi, Ninsiima & Alege, 2017; Wong, Man & Chan, 2021). To avert such risks, a few management practices have emerged, including safety policy, safety plan, adequate safety implementation, proper monitoring systems, high levels of safety awareness, workers' knowledge and commitment, and safety managers' support (Shamsuddin et al., 2015; Awwad, Souki & Jabbour, 2016; Okoye, Ezeokonkwo & Ezeokoli, 2016; Adebiyi et al., 2020).

Consequently, given the size, contributions and importance of construction workers in achieving project objectives in Lagos State, this study investigated issues to do with skilled workers on a specific number of safety management practices, namely: the provision of personal protective equipment, safe work practices, safety and health policy, contractor's review policy and workers' level of safety awareness. The study is necessary because site workers are at the forefront as regards issues of compliance with safety and health requirements. In a Nigerian context, Ijaola et al. (2021) observed that construction professionals are aware of the implications of non-compliance to safety and health but differ in six areas of its implication. The present study, therefore, has two objectives which are the level of compliance of selected construction workers based on the selected safety and health factors and their organisations' level of compliance to health and safety. The practical implication of this study is that the importance of ensuring the necessary communication and engagement with skilled workers is seen as a useful factor in engraining a culture of safety and health compliance while the relevant professionals will be able to evaluate the ills of non-compliance to safety measures and mitigate against such.

2.0 Safety Compliance Factors

The literature contains various behaviour-related factors that contribute to employees' safety compliance in the construction industry. Some of these are Management and Organisational Commitment, Knowledge and Effective Safety Training Safety Leadership and Communication, Safety Management System and Guidelines as well Personal Protective Equipment (PPE). These are highlighted below.

Management commitment to safety as a critical component of the safety climate covers workers'

perception and the degree to which managers value and support safe work. The safety climate represents either the perception of individual employees (the psychological climate) or shared employee perception (the group climate) regarding safety procedures, practices, and behavioural norms on aspects of safety (Vrenderburgh, 2002; Umeokafor et al., 2014). Construction managers and safety personnel must communicate to employees about safety issues in their order of priority. The circumstances surrounding workers' behaviour and the ultimate/likelihood of employee incidents, injuries and accidents, as well as workers' obligations and management expectations, are to be well communicated. This is important so that risks are reduced when workers identify what constitutes hazards and thus contribute positively to safety and health support (Vrenderburgh, 2002; Ismail, Doostdar & Harun, 2012).

Good leadership quality energizes employees to prioritize safety measures in the workplace. Such quality transforms good intentions into positive actions and turns a group of individuals into a formidable team. With the right leadership qualities coupled with the ability to communicate what is required, safety management objectives become easy and thus a model for a safe work environment can be built (Apraku et al., 2020; Windapo, 2011).

Effective safety training is important to educate workers on increasing safety awareness. Through training and re-training, the likelihood of accidents occurring reduces while specific task-related accident-mitigating strategies are developed (Kheni et al., 2010; Kolawole, 2014; Awwad, Souki & Jabbour, 2016). With adequate training, accidents are reduced, costs are put within control and lives are saved. Without this, the economic cost of lack of training becomes obvious in the form of non-compliance by workers with H&S legislation. This is so because compliance with the requirements on safety can only be applied to achieve better results when knowledge of the requirements is known. Thus, the level of commitment to H&S legislation will be high when managers have adequate knowledge and awareness of H&S regulatory requirements. This will inevitably improve workers' awareness of the requirements of H&S; that is, the knowledge of health and safety will translate to compliance with minimal enforcement. Consequently, having the proper information with regular awareness will more likely improve the work environment and will in turn boost project delivery. In summary, awareness of possible risk factors through education (and/or training), as well as knowledge on how to reduce such risk factors among workers, will enhance site safety (Shamsuddin et al., 2015; Agbede et al., 2016; Awwad, Souki & Jabbour, 2016; Okoye, Ezeokonkwo & Ezeokoli, 2016).

The importance of a safety management system and guidelines cannot be ruled out. This is of utmost importance in the construction sector as the information required for the entire project cannot be obtained fully at the beginning of any project. Communication that is effective, clear and understood in any format thus becomes imperative. Thus, carrying the employees along, talk about safety and advice on safety matters improve safety motivation and encourage employees' safety behaviour. Therefore, reinforcement of positive motivation is encouraged by many safety practitioners to maintain and improve workers' good safety behaviour, and this is enhanced when incentive schemes are carried out to motivate workers (Zin & Ismail, 2012). As a result, an organisation that creates and maintains good quality employer-employee relationships will benefit from higher levels of employee motivation, commitment, and job satisfaction, which in turn impacts positively on the intention to stay, hence performance. Therefore, management systems such as proper risk assessments, reporting systems, safety plans, clear delegation of responsibilities, provision of adequate resources and ensuring that full information is disseminated to workers are necessary to ensure compliance of workers to safety regulations (Muhammad, 2006; Windapo & Oladapo, 2012; Wong & Soo, 2019).

The Safety and Health Act 1994 provides the legislative framework to promote and encourage high standards of safety and health at work. Thus, the primary aim of the Act is to promote safety

and health awareness and to instil a safety culture in the workforce (Zin & Ismail, 2012). This is key as a worker's poor perception of compliance with safety requirements could lead to negative behaviour and correlate with poor safety performance which carries enormous negative consequences to the individual and the organisation as a whole (Othman, 2012: Zekri, 2013).

Towards the enhancement of safety behaviour, the provision and use of Personal Protective Equipment (PPE) come to the fore. Whether the causes of accidents are viewed from the perspective of unsafe conditions or unsafe behaviour, the use of safety wear is crucial. Personal protective equipment comprises protective headgear, footwear, and protective clothing. When there is suitable protective equipment, safety performance will be improved by preventing injuries/accidents that would otherwise impede work progress (Charehzehi & Ahankoob, 2012; Zekri, 2013; Umeokafor, et al., 2014). PPE, though often considered the most routine of all the facets of health and safety measures, is the last on the hierarchy of controls, although it is the first personal line of defense against most hazards (Tanko & Anigbogu, 2012). A viable construction firm should therefore educate workers on the factors that may hinder the use of PPE while making the necessary provisions that follow the prevailing legislations and guidelines (Wong, Man & Chan, 2021).

3.0 Research Approach

After a thorough review of the literature on issues of safety and health compliance, factors that enhance compliance such as safe work behaviour, personal level of knowledge and awareness on safety and health requirements, contractors' attitude on issues relating to a safe work environment, contractor's policy on safety and health, as well as the use of PPE, were selected. Each of these six variables had between four and seven sub-variables that were used to assess the main variables.

From these, a survey research instrument was developed in the form of a structured questionnaire, which was administered to skilled construction artisans who were purposively selected from indigenous and expatriate firms. With the purposive sampling technique, respondents are identified that could provide the required data. Thus, copies of the questionnaire were purposively distributed among workers who were currently working on sites and who had spent at least six months with their firms and were willing to take part in the survey. One hundred and thirty-three (133) copies of the questionnaire were administered to the artisans, while 120 (representing a 90% response rate) was achieved. These duly filled, returned, and usable copies of the questionnaire were then assessed using descriptive and inferential statistics. This is the part reported in this study. The results are as presented.

4.0 Findings

4.1 Survey Results

Respondents' Characteristics

The characteristics of the workers are presented in Table 1.

Table 1: Respondents' Demographics

	Frequency	Percentage
Gender		
Male	109	91
Female	11	9
Total	**120**	100
Age		
< 30 years	13	11
31-40 years	45	38
41-50 years	35	29
51 years and above	27	23
Total	**120**	100
Educational Qualifications		
Trade test/Technical	49	41
ND	30	25
HND	32	27
B.Sc., B.Eng, B.Tech	9	8
Total	**120**	100
Experience in the present firm		
Below 5 years	11	9
6-10 years	26	22
11-15 years	44	37
16-25 years	29	24
Above 26 years	10	8
Total	**120**	**100**
Category of Firm		
Expatriate	35	29
Indigenous	85	71
Total	**120**	**100**
Firm Years of Establishment		
1-5 years	10	8
6- 10 years	57	48
11-15 years	23	19
16-25 years	14	12
Above 26 years	16	13
Total	**120**	**100**
Projects at hand		
Yes	103	86
No	17	14
Total	**100**	**100**

Amongst other information, Table 1 shows the frequency distribution of respondents by gender. As indicated, 109 respondents, corresponding to 91%, were male, while 11 respondents,

corresponding to 9%, were female. On average, the result shows that more males in the industry were willing to provide answers to the items on the questionnaire. On age, more than 60% of the skilled workers were in the age bracket of 30 to 50 years. This is an indication of their vibrancy in contributing to construction activities in the firms. As regards educational qualifications, all the skilled workers are educated, implying that they have a broad understanding of the terms of reference and the questions on the research instrument.

On experience in their present firms, only 9 percent of the workers had spent up to 5 years. Experience of above 5 years is a good reflection of the worker's aligning with what is obtainable in the firms. In the firms' category, it can be deduced that there are three indigenous firms to one expatriate firm. This is a reflection of the distribution of construction firms in the study area. On firm years of establishment, just like the workers' level of experience in the firms, over 90% of the firms have been operating for over five years. This implies that they have gone beyond the teething period in business history and are thus able to do justice to issues of health and safety compliance. Likewise, the firms with ongoing construction works are above 70%.

Review of Contractor's Safety Policy

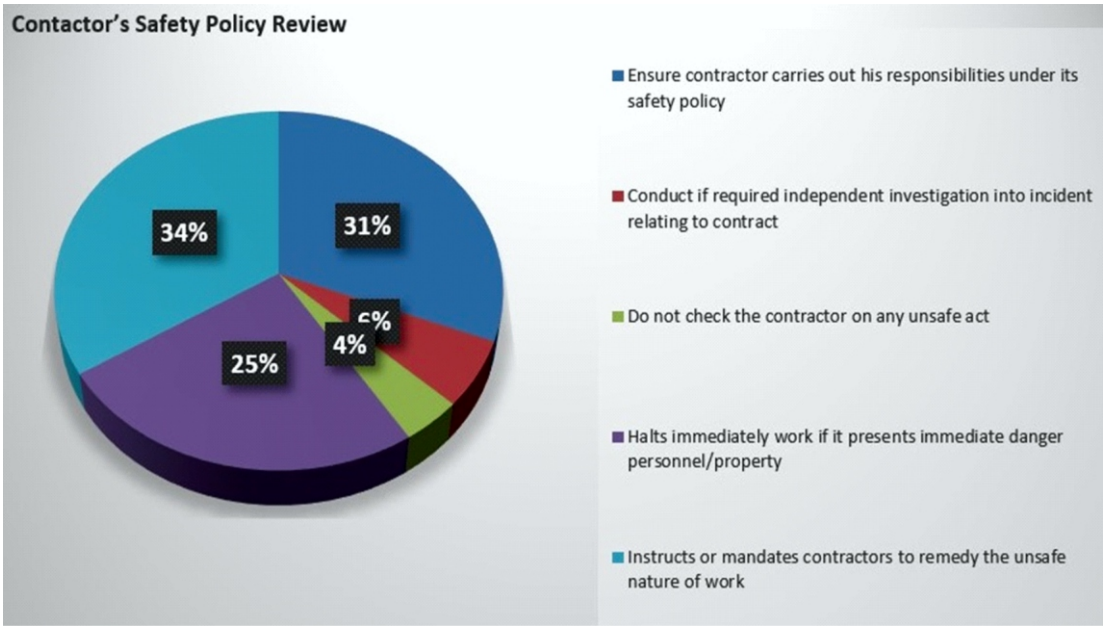

Figure 1: Contactor's Safety Policy Review

Figure 1 shows that only a third of the contractors carry out their responsibilities as stated in the safety policy. More than 30% of the contractors are mandated or instructed to remedy or rectify unsafe work. Thus, we found 25% of contractors whose work was altered. This result implies that only 1 of every 3 contractors operate within the bounds of the safety policy.

Incident/Accident Reporting

Figure 2 reveals that almost half of the respondents agreed that the firms stipulate that every incident or accident should be reported. Yet, approximately 2 out of 3 workers are afraid of reporting an incident/accident or are in the dark about whom to meet when an accident occurs or worried that they would be penalised when a case is reported. This implies that more work needs to be done in sensitising the workers towards incident or accident reporting.

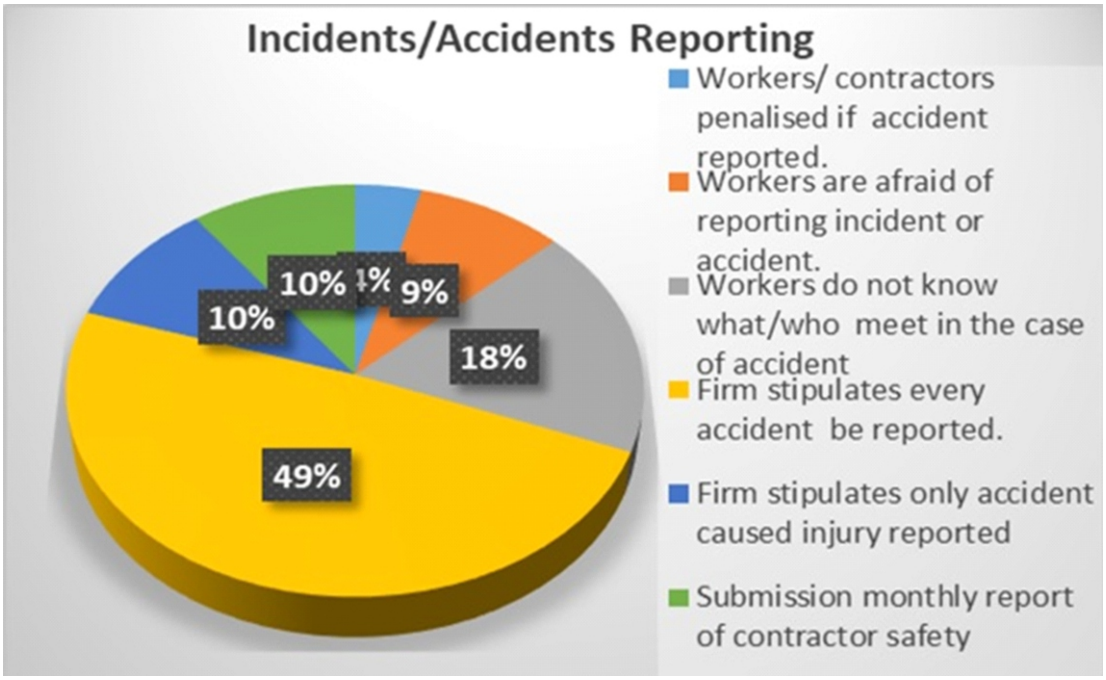

Figure 2: Incidents/Accidents Reporting

PPE Provisions

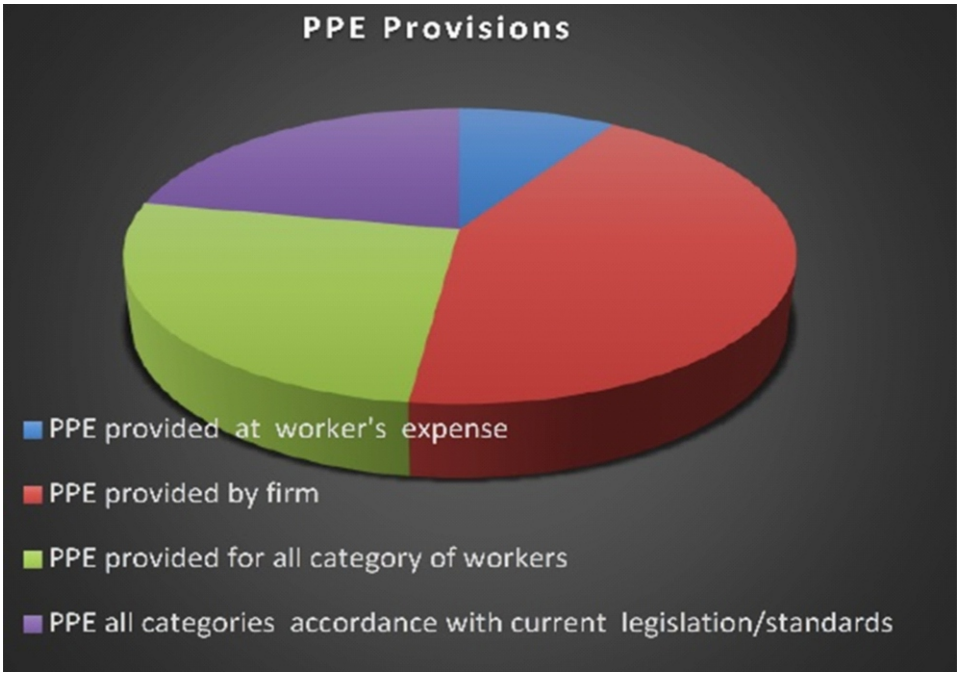

Figure 3: PPE provisions

Figure 3 depicts that although the firms score well on PPE provision at a percentage of 90, only 22% of them make provisions for PPE for all categories of workers, following current legislation and standards. This implies that most of the firms are yet to comply with current legislation and standards in the provision of appropriate PPE.

Level of Safety Awareness by Personnel

Figure 4: Level of safety awareness by personnel

Figure 4 depicts the level of safety awareness by personnel. Most of the contractors, subcontractors, and employees are bound by the health and safety requirements and are notified of and abide by safety requirements as set out in the contract.

Rectification of Unsafe Working Conditions

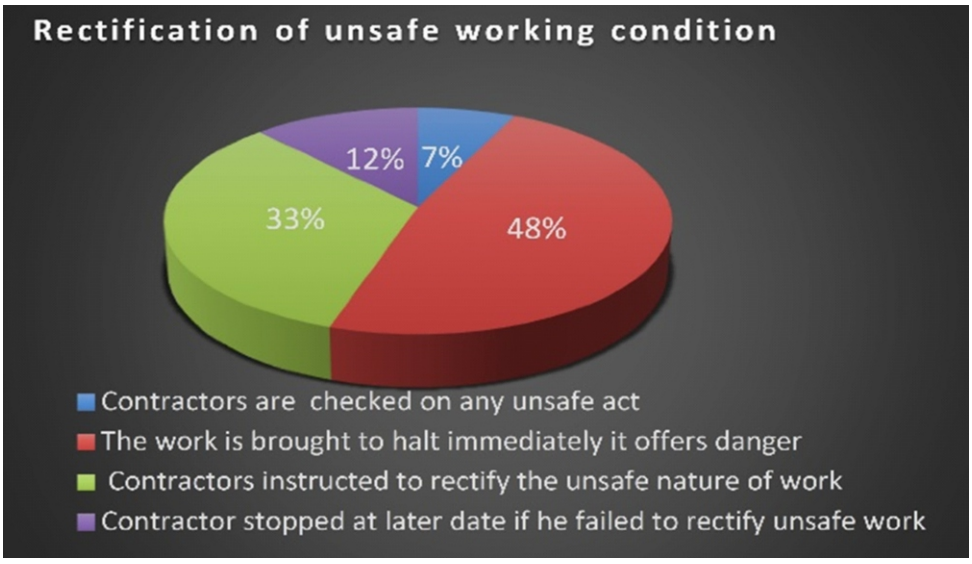

Figure 5: Rectification of unsafe working conditions

Figure 5 revealed that close to half of the firms adopt the method of stopping any work that has an inherent danger. Only 7% of the firms nipped the danger in the bud.

Presence of Safety Policy

As regards safety policy in the firms, over 50% of the workers agreed that the expatriate firms have a safety policy that is well known to the workers. In the case of the indigenous firms, more than 60% of the workers submitted that though there is a safety policy, it is not made known to most of the workers.

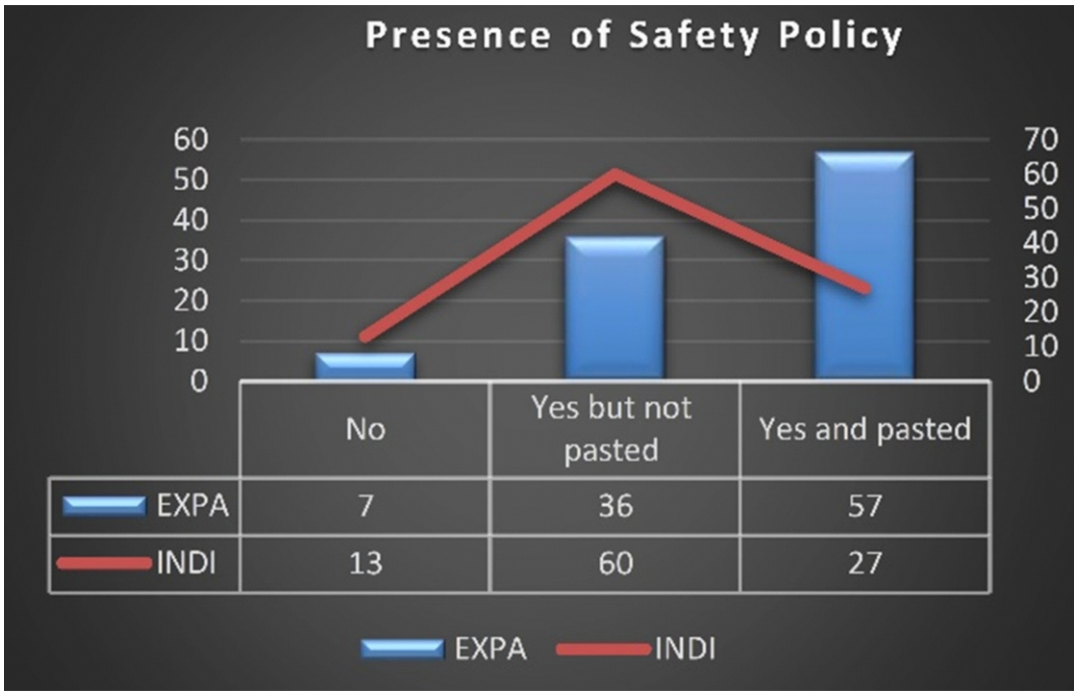

Figure 6: Presence of Safety Policy

4.2 Test of Hypothesis

To test for differences between the two sets of firms, a hypothesis was set out as shown below. The result of the independent T-test is set out in Table 2.

H_0: There is no significant difference in the level of compliance with Health and Safety requirements between foreign and indigenous construction firms in Lagos State

H_1: There is a significant difference in the level of compliance with Health and Safety requirements between foreign and indigenous construction firms in Lagos State.

Table 2: Independent T-test comparison of foreign and indigenous construction firms in terms of the level of compliance with Health and Safety requirements

Variables	Category	N	Mean	SD	T	df	Sig.	pv
Construction Firms in Lagos State	Indigenous Firms	85	4.200	0.985	3.173	118	0.00	<0.05
	Foreign	35	3.342	1.969				
Total		120						

Significant- P < 0.05

Table 2 reveals the closeness of the means for the foreign and indigenous construction firms, in terms of the level of compliance to Health and Safety requirements (Indigenous Firms/Level of compliance to Health and Safety requirement Mean = 4.200, SD = 0.985) and (Foreign Firms/Level of compliance to Health and Safety requirement Mean = 3.42, SD = 1.969); in other words, the difference between the two groups was negligible at 0.05. The t-test results indicated a calculated t-value of 3.173 as against a critical value of 1.96, given 118 degrees of freedom at a 0.05 alpha level. Since the calculated t-value is higher than the theoretical t-value of 1.96, we accept the alternative hypothesis and conclude that there is a significant difference in the level of compliance with Health and Safety requirements between foreign and indigenous construction firms in Lagos State.

4.3 Discussion of Findings

This study investigates the level of compliance with health and safety between selected indigenous and expatriate construction firms. The study evaluated levels of compliance between the firms using six safety and health management practices; it also tested a hypothesis about the level of compliance of the firms. These practices are the provision of personal protective equipment (PPE), level of safety awareness among the workers, incident/accident reporting, rectification of unsafe working conditions, review of the contractor's safety policy, and the presence of safety policy. Regarding the provision of PPE, although the majority of the firms made provisions for PPE, only 22% of them did so based on existing legislation and standards; in other words, only one of every four workers had the appropriate PPE. On incident/accident reporting, two out of three workers were afraid of reporting incidents/accidents or were in the dark about whom to meet when an accident occurs or worried that they would be penalised for reporting a case. This result implies that workers are not encouraged to report any incident or accident. For the rectification of unsafe working conditions, three-quarters of the firms either got instruction on rectification of unsafe working conditions or stopped any work that has inherent danger. For the assessment of the level of safety awareness, most of the workers were bound by existing health and safety requirements, since they were adequately notified of safety requirements as set out in their contract. Only a third of the contractors carry out their responsibilities as stated in the safety policy. For the contractors' safety policy review, while one out of every three contractors carried out their responsibilities under the safety policy, out of every four contractors, one was requested to make some amendments. As for the presence of a safety policy, most firms had safety policies but only a few of them made such policies available to workers.

On PPE, only a quarter of the workers had the ideal type suitable for the work they are doing. A previous study in Uganda (Izudi et al., 2017) revealed that the use of PPP was not only low but also related to the workers' previous knowledge. This indicates that workers would do better in the use of PPE if they had previous knowledge of the negative effects of non-use. As regards the assessment of the level of safety awareness, the majority of the workers were bound by the health and safety requirements in their contracts. Nevertheless, it was found that more than 50% percent of work was done in an unsafe environment or unsafe manner. This agrees with Ijaola et al.'s (2021) study that found that the level of accidents is high despite professionals' understanding of the implications of non-compliance. This implies that management needs additional effort to show that contract requirements on safety and health are adhered to with real evidence on work practices. This result is closely related to that showing that only 30% of the contractors carried out their responsibilities on safety requirements as set out in the contract. In summary, workers posted high scores as regards the level of awareness of safety requirements, although it was also found that PPE usage was poor, unsafe work conditions were preponderant and the culture to report injuries or accidents was almost absent. These findings are similar to those found by Adebiyi et al. (2020) where workers' knowledge level was average and level of compliance was low.

5.0 Conclusion

Starting from issues of safety policy, the studied firms had written safety policies. At least, a quarter of the indigenous firms had their safety policy pasted, while more than 50% of the expatriates also had theirs pasted. With the safety policies pasted, and every person being bound by the health and safety requirements as stipulated, one-quarter of the contractors were still called back to correct unsafe work. This seemed to leave a gap between the policy and the condition of work, being indicative of management and/or workers doing more to reduce unsafe work conditions, as safe work practices are a precondition for zero accidents. Therefore, as regards the first objective of this study, which is on compliance, the level of compliance to safety and health is low based on the percentage of works that are rectified or halted. As regards the test for difference between the expatriate and the indigenous firms, the expatriates had a larger percentage on policy. However, the level of compliance with safety and health between the two sets of firms was negligible. Given this study's focus on the workers' perspective and the consequent neglect of management's view, it is perhaps not possible to be definitive on the actual level of compliance. This observation is a limitation of the study. Nevertheless, as the level of compliance between the two firms is low, both sets of firms need to motivate their workers on incident/accident reporting by working on their policies to enable the right line of action in the case of an occurrence. This will enhance workers' commitment and thus make safety everyone's business, through a bottom-top approach. Moreover, risk assessment for work packages/operations before their commencement would minimise the percentage of works that are executed unsafely or halted. Overall, the research shows a moderately good outlook on the implementation of five of the six safety and health management practices, though compliance with incident/accident reporting is poor.

Finally, a few recommendations are made. Personal Protective Equipment (PPE) should be provided based on legislation and standards or best practice. Aside from this, workers need to be encouraged and motivated to report accidents. This will aid compliance statistics and data and will show where additional efforts on H & S are required. Additionally, the adoption of safety videos can be used with the H & S requirements to minimise incidents/accidents. Workers should not be afraid but realise safety is the job of everyone. In addition, adherence to H & S requirements as well as close monitoring and inspection will be required to detect unsafe work conditions. Consequently, contractors need to abide by H & S rules as stipulated in the H & S policy. Furthermore, there should be continuous training and retraining on H & S. Finally, all incidents/accidents should be reported; currently, most construction firms require workers to report only incidents/accidents that cause injury to personnel or damage to plant, materials, or equipment.

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Strengthening Community Asset Resilience: Evidence from Gidan Kwano, Minna Nigeria

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Abstract

In sub-Saharan Africa, urbanisation has been inevitable and dynamic in addition to coming with numerous challenges relating to land use development and management. One way to tackle the issues is through community support resilience structures in terms of community asset development and management; however, this solution remains poorly understood. Therefore, with a view to providing information that can help in strengthening community land use development and management, this study assessed community asset resilience in Gidan Kwano within Minna metropolis, Niger State, Nigeria. The study employed a mixed-method research approach wherein data was collected with the aid of a questionnaire and Key Informant Interviews in Gidan Kwano (GK) community. The Modified Sustainable Livelihood Framework (SLF) was adopted to test the community asset vulnerability context. It was discovered that the stresses and shocks of urbanisation trends in GK community have been rising, with considerable impact on the community asset. Therefore, the study highlights the need for a far-reaching intervention that will strengthen community asset resilience, stressing the need for the provision of functional infrastructures, the need for stronger corporate social responsibility from neighbouring institutions such as the Federal University of Technology Minna and the enforcement of relevant codes to mitigate the vulnerability contexts in Gidan Kwano. This model can also be applied in communities facing similar challenges.

Keywords: Asset; Community; Land management; Land use; Resilience

1.0 Introduction

Without a doubt, unrestrained and unguided urbanisation has negative effects on community assets in most rural settlements, thus posing grievous challenges on land use development and management. This is a global imperative. Incidences of land use infiltration and conflict have assumed drastic dimensions in our cities and have extended to adjoining rural areas with consequential negative outcomes for community assets. According to Malabanan and Visco

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(2021), unguided urbanisation poses serious risks to community members owing to rapid population growth and difficulties encountered in the management of community assets. Ernston et al. (2010) observed that urbanisation may lead to high levels of vulnerability for community members because of shocks and trends deriving from the process. Consequently, city planners and land managers are increasingly obliged to examine probable vulnerability contexts in the administration of settlements, especially those adjoining major cities, so that they can be better prepared for future risks that may result from shocks and stresses.

Community assets are those shared or communal resources that are available to every community member and can be leveraged upon to promote social cohesion and inclusiveness, thus enhancing physical development as well as the health and total well-being of the citizenry (Dociu & Dunarintu, 2012). A major community asset of the aboriginal Gidan Kwano (GK) people of Minna is land, which according to Nuhu (2008), was initially seen as a gift of nature but has now transformed into an object of inordinate commercialisation.

Regarding the diverse socioeconomic activities that occur on urban land, Salihu et al. (2021) observed that these are mostly guided by official policy. In addition to such policies on land apportionment for various uses, however, other factors may alter or shape the apportioned spaces. Thus, a foremost challenge for city planners in sub-Saharan Africa is ineffective management of unprecedented population explosion, rental exuberance, land use infiltration and contestation as well as inability to withstand shocks and stresses from a host of human actions (Ankeli, 2020; Ankeli et al., 2019). Over the years in Gidan Kwano, community assets have undergone series of extensive transformations requiring measures for reducing vulnerability to shocks, stresses and other forms of exposure to risk.

Globally, concerted efforts are being made to resolve land development and management issues. Some of the interventions are in the areas of disaster management, air quality/smoke emission control, climate change issues and similar challenges. Etinaya (2018) reported that the endorsement of the Sendai Framework for Disaster Risk Reduction by the United Nations General Assembly (and its adoption by 187 nations), the adoption of the Sustainable Development Goals (SDGs), as well as the adoption of the Paris Climate Change Agreement in 2015 and the New Urban Agenda (NUA) Quito Declaration on Sustainable Cities and Human Settlements for all in 2016, were directed at achieving SDG goal 11, which aims to ensure that cities and other human settlements are safe, inclusive, resilient and sustainable. Moreover, the SDG Hub has identified sustainable land management as a means of empowering nations to recover their lands, fast-track social transformation inclusiveness, reduce resource-reuse conflicts and withstand natural catastrophes and socio-political crisis. This position aligns with the argument by Koliou et al. (2018) and Patel and Nosal (2016), who suggested that resilience should not only seek to restore functionality but also correct the prevailing political, social and economic structures that may have heightened exposure and constrained capacity to withstand crisis.

In the context of Nigeria, earlier studies on city resilience focused on the 'big' cities (e.g., Lagos) as well as other specific industrial and commercial hubs, with little or no attention paid to agrarian communities such as GK and its community assets. As such, little reliable and relevant information exists on community asset disaster resilience resulting from shocks and stresses, hence, the need for this study which assesses asset vulnerability indices and resilience practices in GK with a view to recommending policy actions for strengthening its land administration resilience and adaptive capabilities. The key research questions are: What are the sources of vulnerability in the community? What is the capacity of the community to contextually checkmate its vulnerability?

GK is an agrarian community that hosts the Federal University of Technology, Minna, Niger

State, Nigeria. The community was selected for the study because of its rapid urbanisation rate and proximity to Minna, the state capital. No doubt, the university is the major reason for the massive influx of people to the GK community, leading to land value appreciation as well as land use infiltration and contestation. These factors have posed serious challenges to community land asset development and management, thus worsening the effects of shocks and stresses on community members.

2.0 Literature Review

Empirical and theoretical studies conducted in both advanced and emerging nations reveal significant levels of concerted global efforts by researchers on issues of vulnerability and resilience. Rapidity in the development of a human settlement (a homestead, village or city) depends greatly on its vulnerability context and resilience. In the context of the Philippines, Malabanan and Visco (2021) assessed perceived resilience in community urbanisation of the cities of Cabuyao in Laguna Province in the Philippines, where Barangay Casile and Barangay Sala are located, using the modified sustainable livelihood framework (SLF) based on factors such as community asset, vulnerability context and interventions. The study found that despite the advantages of urbanisation, the intensity of the impact of urbanisation was differently felt within different timeframes in the cities studied. Xiaolin-Lao (2021) evaluated the rights, responsibilities and public nature of affordable housing and their role in the property management services of Chinese communities. Thus, the author explored solutions for misalignment in the responsibilities and rights that could increase property resilience in community governance and improve community resilience. The study examined affordable housing management from the resilience perspective in urban and rural Chinese communities and found that insufficiency of funding for managing affordable housing has aggravated property service issues.

Furthermore, Dociu and Dunarintu (2012) observed that urbanisation processes have severe effects on the socioeconomic standing of a community and warned that poorly managed urbanisation will have severe consequences for the environment. Thus, their study recommended the need for government and policymakers to adopt strategic plans and measures rooted in sustainable development that could help in mitigating the negative impact of urbanisation processes. On their part, Molua and Kagwanja (2015) reviewed the criticality of land in the enhancement of improved livelihoods. They also assessed the institutional requirements for building resilience and sustainability for agricultural land management in the Central African sub-region. The study further examined the comprehensiveness of the principles that enhance agricultural land management in cases of large-scale land investments. They found that the promotion of land management resilience and sustainability requires the encouragement of land policy development and implementation as a package of intertwined procedures for effective land administration. It is important to note that none of the reviewed studies addressed the need to strengthen the community assets resilience of a suburb such as Gidan Kwano.

3.0 Concept and Theory

Researchers have adopted several theories and concepts in the study of vulnerability and resiliency, including the concept of soft and hard resiliency, the sustainable livelihood framework, the social exchange theory, as well as the concept of rewards and recognition, among others. Norris et al. (2008) described community resilience as “a process of linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance.” Chandra et al. (2010) proposed a five-component salient resilience framework that can be adopted for studying resilience in any field. The suggested resilience components are psychological and physical status with respect to the population's welfare; the community's socioeconomic resources; enhancing preparedness, recovery through infrastructure provisions and the involvement of social networks. Malabanan and Visco (2021) stated that the three major components of resilience study in the

Sustainable Livelihood Framework are the hazard trends, community network to recover from the hazardous impact and innovative trend using governmental programmes/policies for the mitigation of the negative effects of hazard experienced.

The Sustainable Livelihood Framework (SLF) as adopted and used for this study is an effective framework that has been deployed for evaluating community resilience in the Philippines and Sudan by Malabanan and Visco (2021) and Osman-Elasha et al. (2005). It is a framework that promotes understanding of the strategies governing community assets, policies and institutions (Saxena et al., 2016). It was employed by Malabanan and Visco (2021) in the assessment of communities' livelihood resilience as a holistic approach on the effectiveness of interventions on community livelihood through the numerous data collection methods available. The current study adopted the three factors considered by Malabanan and Visco (2021), viz: vulnerability context, networks and interventions in the assessment of GK asset resilience. These factors were modified, decrypted and characterised into SLF components as presented in Figure 1.

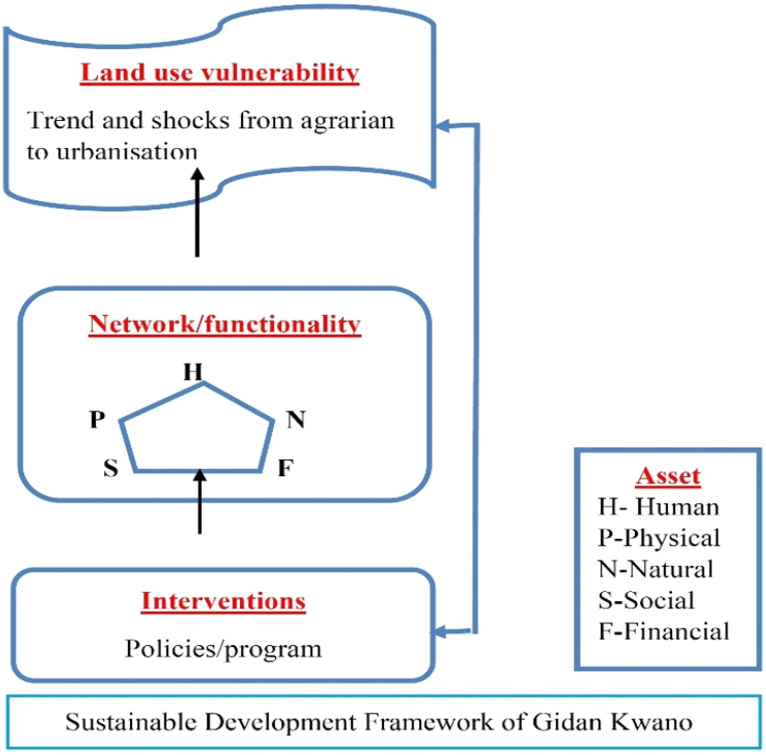

Figure 1: Modified Sustainable livelihood framework

Source: Adapted from Malabanan and Visco (2021)

The framework shows the components of vulnerability context, network and interventions. The components of land use vulnerability context are the trends of stresses/shocks induced by urbanisation including unguided and uncontrolled actions and developments that affect/disturb the community assets, which are usually engendered and exacerbated by the community network/functionality. Another factor that propels/activates community network/functionality are the interventions that come through policies/programmes. The current study, therefore, adapted and tested the five Malabanan and Visco (2021) community network categorisations, viz: the social, the human, the physical and natural assets in the study area, and finance. The contextualisation of SLF to this study further supports the need to evaluate the vulnerability

context, capacity and interventions of the GK community in terms of land use management and development that could mitigate the undesirable effects of urbanisation by improving the community assets that support human life and the overall standard of living.

4.0 Methodology

The study adopted a survey approach employing a mixed research strategy, with Key Informant Interviews (KII) conducted with the Dagaci (District Head) and the Mai-anguwas (neighbourhood heads). The study group visited the Dagaci to intimate him of their intentions before the formal submission of letters requesting a meeting with the stakeholders (see Plate 1). The stakeholders meeting provided the researchers the opportunity to access the target population for reliable data on the influence of urbanisation trends on the community's assets and other information relating to the history of GK, land boundaries and subdivisions of community land. In addition to the KII, a questionnaire was administered to landowners in the community. The purposive sampling technique was utilised for the selection of the property owners. In all, 310 property owners were identified, with some of the property owners/investors having more than one property in the study area.

However, information from the Abuja Electricity Distribution Company (AEDC) revealed that only 234 properties, representing 75% of the property owners in GK, actually registered/metered their properties. The study therefore adopted and used the figure from AEDC as the sample size for data collection. The AEDC figure was considered to be an adequate and reliable representation of the study population (Krejcie & Morgan, 1970 in Salihu et al., 2021). A structured questionnaire was used in the collection of empirical data relating to the GK community asset vulnerability and resilience, while data on GK historical background and other qualitative data were obtained using the unstructured questionnaire. The data was analysed by aggregating/triangulating the results. The structured questionnaire was designed to measure the community assets by asking the respondents to rate the variables on the bases of a psychometric scale through respondents' affective and cognitive proficiencies, using a quantitative measuring scale of frequencies and percentages. Changes in community asset and the understanding of resilience were further interpreted using descriptive analyses.

The Relative Importance Index was used to determine the relative importance of the variables and the prioritisation/ranking of factors from respondents' perceptions on the community asset vulnerability to hazard. The community asset vulnerability to hazard was generated as weighted indices based on a 5-point Likert-type scale. Percentages and degrees of the frequency of occurrences of the variables, aggregate weighted scores [Σw] and the mean scores [$\frac{\Sigma fx}{N}$] were calculated to determine the perception of the respondents. The formula used by Ankeli et al. (2020) and Somiah et al. (2015) was adopted and used for calculation of the RII. The formula is presented as:

$$\mathrm{RII} = \frac{\Sigma W}{A * N}$$

5.0 Findings and Discussion

5.1 Gidan Kwano Vulnerability Context

The Context of Vulnerability in GK is urbanisation due to its hosting of the Federal University of Technology, its proximity to Minna Township and subsequent land value appreciation leading to increase in family spending. GK is said to be one of the fastest growing suburbs in Niger State, thus making it a major factor for the high-level exposure of the community to vulnerability. The vulnerability context adapted from previous literature and their exposure to hazards in GK is discussed below.

The study observed that GK was exposed to physical hazard because of the taking over of land by

the university as well as the existence of housing shortage and the absence of other critical infrastructures that are necessary for the functioning of the community. The few available but overstretched infrastructures in the community were provided by the university and private property investors. For instance, GK has no hospital or standard maternity home except a primary health centre visibly functioning below capacity (see plate 2); most times patients are referred to hospitals in Minna Town. Besides, there is no recreation centre in GK, even as the existing police station can best be described as an outpost. As part of the traffic challenges posed by the ever-busy Minna-Bida Highway, road crashes are frequent around the University gate during peak hours. In the area of social vulnerability, women and children as well as the elderly and youth are in serious need of health services and educational infrastructure, especially at the primary and secondary levels. Social vulnerability affects the human vulnerability, as the community has low levels of educational attainment and employment capacity.

In terms of the natural hazard, the study observed that the urbanisation rate of GK, owing to the relocation of the university from Bosso to Gidan Kwano, has led to more demand for land, resulting in land use infiltration/contestation. Commercial and residential land uses have taken over GK land use from previous agricultural land use. The formerly agrarian community has been transformed to a hustling and bustling residential/commercial university neighbourhood with a high influx of migrants. Expectedly, there has been substantial loss of farmland and farm produce as agricultural land rapidly gives way to residential and commercial land uses, which further increases environmental pollution from waste dumps.

The study further found that the establishment of the university led to changes in the design, quality and type of buildings in the community, given the preferences of migrants. The income levels of some families have also risen, as property owners rented out extra rooms while others sold part of their land. The presence of students in the community has also boosted business while influencing the lifestyle of youthful indigenes who would have ordinarily been content to remain on the farm. On the negative side of things, many poor elderly farmers and youths lost their land but were not found to be employable by the university owing to their low academic background. Inevitably, this led to a serious impact on family spending, thus exposing the community to financial hazards.

Plate 1: Stakeholders' meeting at the Dagaci's Palace

Source: Picture taken during authors' field survey (2022)

Plate 2: The only health centre in Gidan Kwano

Source: Picture taken during authors' field survey (2022)

5.2 Respondents' Perception on Gidan Kwano Community Assets Exposure to Hazard

Quantitative data were later collated and analysed. Secondary data obtained from previous literature were subjected to tests in order to determine respondents' level of understanding of the issues. This was achieved with frequency distribution tables and the relative importance index. A frequency distribution table allows for the summarisation of categorical data collected and the use of more complex techniques that can reveal the hidden characteristics of the relative abundance of each of the vulnerability contexts through percentage rates and the degree of their exposure.

Table 1 shows the frequency, percentage and the degree of vulnerability context and their hazard to GK community Asset. From the table, the vulnerability context involved community loss of farmland (39%), loss of crops (39%) to the Federal University of Technology Minna, land use incursion/infiltration (35%), increasing crime rate (35%) and family spending (35%), among others. The table also reveals that resilience undertaking in GK was discovered to be hampered by low educational attainment (13%), the cultural inclinations of GK indigenes and inefficient institutional support mechanisms by the government.

Table 1: Vulnerability Contexts and their Hazard to GK Community Assets

Vulnerability Context	Frequencies	Percentages	Degree
Physical Vulnerability			
Land/Building Use	80	34.8	125
Power (Electricity)	70	30.4	110
Water Supply	50	21.7	78.1
Telecommunication (GSM)	30	13.0	47
Total	**230**	**100**	**360**
Social Vulnerability			
Health Services	70	30.4	110
Educational Attainment/culture	30	13.0	47
Crime Rate	80	34.8	125
Night Life	50	21.7	78.1
Total	**230**	**100**	**360**
Human Vulnerability			
Unemployment Rate	50	21.7	78.1
Working age/Population	60	26.1	94.0
Traffic Control	75	32.6	117.3
Security Management	45	19.6	70.6
Total	**230**	**100**	**360**
Natural Vulnerability			
Loss of Farm Land	90	39.1	140.8
Loss ofCrops	90	39.1	140.8
Waste Management Problem	25	10.9	39.2
Noise Pollution	25	10.9	39.2
Total	**230**	**100**	**360**
Financial Vulnerability			
Family Spending	80	34.8	125
Income Disparity	50	21.7	78.1
Poverty Incidence	50	21.7	78.1
Economic Empowerment	50	21.7	78.1
Total	**230**	**100**	**360**

Source: Authors' field survey (2022)

However, the perceptions of the respondents on the categorised vulnerability context, as calculated using mean scores and the RII formula as shown in Table 2, revealed that natural asset vulnerability ranked first among all the other factors, having a mean score of 1,058 and RII of 2.7363. The gradual transition of GK from an agrarian community to a semi-commercial/residential university neighbourhood had severe consequences on the community's agricultural land spaces and uses. The university took a substantial portion of the community's land, leading to serious effects on annual crop production capacity. Apart from distorting the traditional lifestyle of indigenes, migrant influx to the community came with environmental pollution from the generation of excess waste. There was no noise or waste management plan or any organised/formal noise or waste control/management system in the community (a risky situation for the health of residents in both short and long term).

Physical vulnerability ranked second with an RII of 2.3517 and a mean score of 909. However, findings from the field revealed that the community's major sources of water supply are boreholes, deep wells, streams and *mairuwa*/water vendors (see Plate 3), with implications on

community health. Electricity supply to the community is from the public mains but epileptic, thus affecting productivity. Respondents further noted that the quality and types of building improved significantly with relatively exorbitant rent compared with rent on similar properties in nearby areas. The community witnessed some element of improved standard of living and economic progression, especially in the area of household income and socialisation. Despite the progression, however, the negative impact of the trend on community assets was monumental and dangerous. To buttress this, the respondents argued that the increase demand for accommodation resulting in the increase number of houses and other land use developments came with noise pollution and other environmental challenges.

Social Asset vulnerability was also considered by respondents as a risk factor, ranking third with an RII of 2.3189 and a mean score of 899. However, it was observed that the change in the social asset of the community has slightly improved the literacy rate/knowledge of GK residents, particularly that of the youths, owing to improvement in educational services in GK. Despite the merit of the urbanising rate of GK, all previous resilience efforts were hampered by rigid cultural inclinations as manifested in the ineffective application and adjustment of the recommended resilience actions heightened by inefficient institutional support mechanisms. This finding agrees with Nuhu (2011), who asserted that a vivacious affiliation exists between man and land as entrenched in the African society's dynamic culture. Furthermore, cases of crimes due to improved social factors orchestrated by migrants and others outside GK have been on the increase and have a negative impact.

Plate 3: Water Vendors (*mai ruwa*) supplying water to Gidan Kwano residents

Source: Picture taken during authors' field survey (2022)

Human asset ranked fourth with an RII of 2.2207 and a mean score of 859. GK household spending increased because of migrant influx. Some of the GK residents that were thrown out of their agribusiness because of loss of their land picked up work with the university, took up commercial motorcycle riding (*Okada/bike)*, became point of sale (POS) operators, phone repairers or entered into other petty businesses. Of course, many remained in abject poverty. This development has increased the number of vehicles with attendant traffic challenges, insurgency, banditry and other security issues.

Regarding financial asset vulnerability, respondents averred that the financial asset of the

community improved with reduced incidences of poverty, as the residents could venture into diverse forms of petty trade to serve the large population. However, the presence of these businesses attracted criminals and other forms of insecurity to the community. This supports the assertion of Ankeli (2022) and Nuhu et al. (2022) that unguided population explosion exacerbate criminality despite its merit of developmental attractions.

Table 2 is a summary of the mean scores and relative importance indices of the vulnerability context on GK community asset.

Table 2: Relative Importance Index (RII) on Gidan Kwano Community Asset Resilience

Vulnerability Context	**5**	**4**	**3**	**2**	**1**	**∑w**	$\frac{\sum fx}{N}$	**RII**	**Ranking**
Physical Vulnerability									
Land/Building use	98	120	0	9	5	993		0.8560	
Electricity/water	86	65	40	30	11	881		0.7595	
Telecommunication services	79	71	32	29	21	854		0.7362	
Total/Mean							**909**	**2.3517**	2nd
Social Vulnerability									
Health services	48	105	39	24	16	841		0.725	
Educational Attainment/culture	78	89	30	20	15	891		0.7681	
Crime/Nightlife	120	64	20	20	8	964		0.8310	
Total/Mean							**899**	**2.3241**	3rd
Human Vulnerability									
Employment Opportunity	89	100	20	13	10	941		0.8112	
Traffic/Security Management	99	64	25	15	29	885		0.7629	
Working age/population	67	60	10	50	45	750		0.6466	
Total/Mean							**859**	**2.2207**	4th
Natural Vulnerability									
Loss of Farmland	165	50	10	7	0	1069		0.9216	
Loss of Crops	150	65	17	0	0	106 1		0.9147	
Waste/Noise Management Problem	140	70	20	2	0	1044		0.9000	
Total/Mean							**1,058**	**2.7363**	1st
Financial Vulnerability									
Income Disparity	55	87	69	11	10	862		0.7431	
Family Budget/spending	60	60	50	30	32	782		0.6741	
Poverty Incidence	70	80	50	15	17	867		0.7474	
Total/Mean							**837**	**2.1646**	5th

Source: Authors' field survey (2022)

6.0 Community Interventions (Policies, Programmes and Projects)

In an attempt to tackle social vulnerability, incessant crime and other insecurity incidences, the GK community and Bosso Local Government Area of Niger Sate had on several occasions-imposed curfews on the community and embarked on anti-drug campaigns, among other measures. Furthermore, community members also participated in the school feeding and free

education programmes of the government. Other policies meant to protect community assets included ban on sale of alcoholic drinks, setting up local vigilante outfits to complement the effort of the police, and designing agricultural programmes for fertilizer and seedling distribution.

To mitigate the inadequacy of hospital/maternity services in the community, the community resorted to alternative medicine to complement the dysfunctional primary health centre. Besides, indigenes were allowed to make use of the acquired university land for farming on a temporary basis for a small fee. Thus, unemployed youth were kept engaged, thus mitigating their natural and financial vulnerabilities. Another curative approach adopted by the university on traffic was the introduction of road signs and speed bumps/breakers around the university gate. The university and GK community vigorously involved her staff and local vigilante in controlling traffic and ensuring proper parking around university gate area. Moreover, the school management was in constant dialogue with real estate investors as well as AEDC and telecommunication network providers as part of efforts to provide stable services to tackle physical and human vulnerabilities.

Plate 4: Local Security (Vigilante/Yanbanga) Post built by the community

Source: Picture taken during authors' field survey (2022)

Table 3 offers some innovative resilience procedures that can strengthen GK community assets.

***Table 3:** Resilience-strengthening interventions and required actions

Asset	Current Intervention	Required Actions
Physical	Boreholes, water vendor, power, buildings, and internet problems	*Evaluation and creation of awareness on the state of ground water and sustainable usage *Alternative power sources and efficient energy usage *Improve telecommunication services * Enforcement of building code and slum upgrade *Rent control laws
Social	*Temporary maternity and hospital *School feeding program *Unorthodox medicine *Curfew and restriction of the use of some products *Local traffic control volunteers *High illiteracy rate/defective learning structure, migrant influx	*Permanent standard maternity hospital in GK *Free and compulsory education for all children * Traffic light and speed bumps/zebra crossing sign *Education inspectorate taskforce * Comprehensive records of migrants *More scholarship programs for GK indigenes in FUT and structured/module learning and certified craftsmanship training
Human	*Letting of farmland to GK indigene by FUT Management *Security Patrol *Yanbanga/local vigilante	*Enhance FUT social community responsibility *Fusion of technology in learning to get the GK indigene ready for the fourth industrial revolution. *Provision of security van and surveillance cameras at strategic locations
Natural	*Agricultural programmes (seeds and fertilizer distribution) * Bush and waste burning *Open defecation and waste disposal system *Tree cutting and drought	* Modern farming techniques *Waste segregation/control and management strategy *Erosion control and provision of public toilets *Tree planting/greening campaign *Training and seminars on disaster/drought Management and avoidance.
Financial	*Private individual financial efforts *Employment from FUT	*Cultivation of funders through crowd funding and/or cooperative societies * Women and Men empowerment programme *Social investment

Source: Authors' field survey (2022)

7.0 Conclusion

This assessment of GK community asset resilience offers valuable insight regarding strengthening community land development and management. It was observed that the stresses and shocks of urbanisation trends have been rising in the GK community, with enormous impact on community assets. In order to provide information on the numerous challenges facing our cities and that could help in strengthening community land use development and management, the study assessed community asset resilience in Gidan Kwano through a mixed-method research approach. The Modified Sustainable Livelihood Framework (SLF) was adopted to test

the community asset vulnerability context. It was discovered that the stresses and shocks of urbanisation trends in GK community have been on the rise, with considerable impact on the community asset.

Therefore, in addition to the need for far-reaching interventions that will strengthen community asset resilience in the event of adverse urbanisation effects, the study recommends the provision of functional infrastructures. This can be conveniently achieved through public private partnership initiatives, site and services scheme among others. The involvement of the Federal University of Technology Minna in more corporate social responsibilities efforts in the community could help in taking away vulnerabilities from the streets. The study further recommends the enforcement of health, building and traffic related codes to mitigate the vulnerability contexts in GK.

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Resilience of Buildings at the Operational Stage: Understanding Property Managers' Perceptions of Barriers to the Installation of Vertical Greenery Systems

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Abstract

Heat generation and carbon emission have been identified as major elements of climate change reality that pose a threat to humanity through activities in the built environment. Thus, a topical discourse in the built environment research agenda is adopting building resilience as an adaptive measure against vulnerabilities. Recent studies indicate the incorporation of vertical greenery systems (VGSs) as a potential approach for minimising the effect of heat generation and energy moderation. Consequently, using a mixed-method approach, this study examines barriers to the installation of VGSs at the operational stage (property management stage) in Lagos. Preliminary interview sessions were held with eleven (11) estate surveyors and valuers (ESVs), followed by the administration of a research questionnaire to 282 ESVs. Analysis showed that lack of building regulations, low awareness about green walls and their benefits, poor knowledge of the construction industry and emphasis on sustainability were the main barriers to the installation of VGSs. It was concluded that policy plays a crucial role in ensuring use of the technology in the drive for a paradigm shift in property management practice.

Keywords: Building Resilience; Climate change; Property management; Vertical greenery systems

1.0 Introduction

The real-estate environment and living conditions are inextricably linked, implying a broad obligation for cities to pursue sustainable development goals (Schwarz-Herion, 2020; Pauleit, 2021). In that regard, the management of carbon emissions is a primary objective of climate-

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change campaigns and actions in sub-Saharan Africa (Kotir, 2011). Nigeria has three distinct climate zones: a tropical monsoon climate in the south, a tropical savannah climate in many of the country's middle-belt regions, and a Sahelian hot and semi-arid climate in the country's north. As a result, a gradient of decreasing precipitation exists between the south and the north. Nowadays extreme weather conditions expose societies to high degrees of vulnerability, particularly in urban areas. Vulnerability does not exist in a static state; it evolves over time (Intergovernmental Panel on Climate Change [IPCC], 2014). For example, different ambient temperature is generated by building walls, leading to detrimental effects on household health.

In a dense metropolis, rising temperatures signify urban vulnerability, which the IPCC describes as having three components: exposure, sensitivity, and adaptive capability. Within the context of vulnerability, resilience refers to an individual stakeholder's capacity to respond (bouncing back, adaptation, and transformation). Golz et al. (2015) argued that strengthening the resilience of buildings to better withstand vulnerabilities has emerged as an important focus in European research on resilient cities. The goal of resilience in property creation and management is to be able to avoid the risks associated with vulnerabilities through the use of adaptive solutions. In this study, resilience is conceptualised as the capacity of individuals, communities, institutions, businesses and systems (individuals, communities, institutions, businesses and systems) to survive, adapt and thrive in the face of stress and shocks, as well as to transform when circumstances dictate. Researchers in the developed and industrialised world point to the direction of alternative approaches to environmental protection and eco-efficient as well as eco-friendly methods of preserving the natural environment (Avilova et al., 2020). Perseverance and a commitment to ensuring property adaptation and transformation to avert heat generation and energy consumption crises constitute the value of VGSs (Pérez et al*.,* 2014). According to Wang et al. (2016), VGSs refer to the installation of green vegetation permanently or temporarily on or against the surface of a building's internal or external wall (known also as façade).

The promotion of sustainability exemplifies resilience in an age of climate-change realities and serves as a catalyst for the deployment of VGSs on buildings. The installation of VGSs contributes to passive cooling and the regulation of temperature (Bustami et al*.,* 2018). When it comes to the largest temperature drop obtained on the wall and substrate surfaces, VGSs have the highest cooling efficiency. According to Wong et al. (2010), VGSs can significantly reduce the thermal resistance of building facades in tropical regions, hence reducing cooling load and energy costs. In terms of the smallest daily range of typical wall-surface temperature variation, VGSs have the greatest capability. VGSs add aesthetic value, help to mitigate the growing problem of air and noise pollution while bringing nature closer to humans (Wong et al., 2010). However, several studies have shown the existence of barriers to the installation of VGSs as countries are characterised differently in terms of weather conditions and maintenance culture.

In property management parlance, escalating climatic variations and their negative impact on building components necessitate the implementation of sustainable building practices (Komolafe, Oyewole & Kolawole, 2016). This reaffirms the professional practice of property management (repair and maintenance) as one that recognises that real-estate lifecycle and obsolescence theory underpin sustainability concepts and features in an existing building (Rodi et al., 2015). In both greenfield and brownfield situations, studies reveal stakeholders' willingness to incorporate sustainability features (Oyewole, Ojutalayo & Araloyin, 2019; Oyewole, Komolafe & Gbadegesin, 2021). Investors and developers embrace the concept of sustainability in commercial real estate (Oyewole & Komolafe, 2018). During the operating and post-construction phases, the management of building components is essential (Ogunba et al., 2021). Komolafe, Oyewole and Kolawole (2016) elaborated on the scope of adoption in the current Nigerian setting. According to Oyewole, Komolafe and Gbadegesin (2021), sustainable real estate extends beyond new construction (greenfield) to (brownfield) maintenance,

renovation and repair. During the operating phase (when a property is occupied and undergoing maintenance, repair and refurbishment), VGSs can serve as a sustainable element that transcends ornamental and protective functions. However, previous research has shown that there are obstacles to the installation of VGSs, as countries differ in terms of weather conditions and maintenance practices.

It is worth noting that the use of VGSs is a component of the sustainable development goals (SDGs). VGSs help to conserve energy (Dahanayake & Chow, 2017). According to Pérez, Coma, Martorell and Cabeza (2014), conserving energy and controlling the temperature offer substantial respite from severe environmental health impacts. Based on how much the wall and substrate surface chilled, Wong et al. (2010) found that living wall (grid and modular, vertical interface, mixed substrate) and living wall (modular panel, vertical interface, inorganic substrate) are the most effective in cooling. As it pertains to the built environment, sustainable cities and climate-change action, the preceding empirical data address SDGs 11 (sustainable cities and communities) and 13 (limit and adapt to climate change)

Therefore, the post-construction resilience of buildings entails the incorporation of sustainable property elements in both the substructure and superstructure of existing structures. For instance, in Heywood, Greater Manchester (United Kingdom), a simulation of Forster resonance energy transfer (FRET) implementation on a building scale, in conjunction with a demonstration of flood damage to buildings, demonstrated the potential of the extended approach (Golz et al., 2015). Thus, VGSs are recognised as a comparable approach to building facades, particularly in the face of more severe weather. In the case of properties under the management portfolios of real-estate firms, the concept relates to property managers' and property owners' perspectives. Against this backdrop, the research examines property managers' perception of the barriers to the installation of VGSs on buildings to address thermal problems at the operational stage of buildings.

2.0 Literature Review

Past studies have identified various barriers to the installation of VGSs on buildings. Lack of awareness and understanding of the benefits that come with green walls is a major barrier to the installation of VGSs (Wong et al., 2010). However, beyond awareness, the literature also identifies barriers to the installation of VGSs. Notable among these barriers is climate change, which is a common threat to the world. Hopkins and Goodwin (2011) noted that the three climatic factors to consider in the design of green living walls are orientation, wind, and temperature and humidity levels. Derkzen et al. (2017) conducted a study on green infrastructure and concluded that awareness of climate impacts and understanding of the benefits of green infrastructures tend to influence people's preferences on the measures for green infrastructure. The general consensus remains that people are willing to support climate adaptation through green infrastructure as long as the green infrastructure is multifunctional (i.e., comes with recreational and aesthetic benefits).

As plants rely on light for food, it is important to ensure that sufficient natural light is available within buildings. As a result, when choosing plants for living walls, the expected light conditions must be assessed. Plant light needs are quantified in terms of quality, quantity and duration. To be sure, the wavelength or colour of light determines its quality for plants. According to Smith et al. (2010), the length of light represents the amount of time per day that a plant is exposed to light, whilst the quality of light is measured in lux. One of the disadvantages of living walls and their upkeep is the lack of sufficient light.

Another issue concerns the maintenance of VGSs. A suitably selected plant that is provided with a well-designed system needs to be well maintained to flourish (Riley, 2017). Wong et al. (2010) noted that constant clearing of the residue of dead leaves and periodical replacement and

trimming cannot be avoided and could prevent building owners from adopting VGSs. Moreover, cost of maintaining VGSs could be why many building owners choose to ignore the option of incorporating them in their buildings. For example, Leong et al. (2021) found that the major barrier to the installation of VGSs in Malaysia is the high cost of construction. In the same vein, Terblanche (2019) identified lack of standard installation costs and maintenance as major barriers to the installation of VGSs.

As part of maintenance, it is argued that the need for water for VGSs is unsustainable (Rosenblum, 2013). This is because there is extremely high shortage of water in some countries (Muller, 2017), thus rendering maintenance of VGSs largely unsustainable. Examples of such countries include Qatar, Israel, Lebanon, Iran, Libya, and Botswana (Dormido, 2019). While systems can be developed to reduce the overconsumption of water by harvesting rainwater and/or recycling water (Loh, 2008; Francis et al*.,* 2014), these systems are not available in all buildings in countries that hardly experience water crises. This is because it is expensive to collect and filter recycled irrigation water (Stanghellini et al*.,* 2005) as done, for example, in Sydney, Australia's *One Central Park* project and *The Rubens at the Palace* in London (Nouvel & Beissel, 2014; Hasek, 2018).

While it is understood that VGSs improve air quality, there are worries about additional insects and the pain of pollen allergies. According to Rosenblum (2013), the installation of VGSs may result in an increase in insect and pollen levels. The author argued that the installation of VGSs could increase the quantity of plants, thus making them a haven for unwanted organisms, a source of illnesses and a 'portent of doom'(Rosenblum, 2013). VGSs may be a possible harm to the facade on a microscale owing to plant growth. Moreover, when suckers and tendrils are eventually removed, they can harm the facade's surface and create a pattern of markings (Francis et al*.,* 2014). Rainwater products may get obstructed and severe growth may pull gutters and other fixtures off the wall (Francis et al*.,* 2014). On a macroscale, there will be additional vegetation loadings on the structure of the system (Ottelé et al*.,* 2011). Furthermore, considerable competition exists on the usage of building exteriors (Weinmaster, 2009), thus suggesting that the building's exterior is underutilised since the façade might be monetarily enhanced by adding glass to offer solar access to the interior. Alternatively, as shown in Beijing's GreenPix wall, a building's façade may be used for advertising signs and other multimedia images.

Poor design also results from issues of lack of policy and standards for green exteriors, leading to unfavourable outcomes (Weinmaster, 2009). Consequently, developers are often reluctant to take major risk by using vertical vegetation because of the potential for poor designs. Another stumbling block is the installation of VGSs without adequate technical knowledge of their requirements (Terblanche, 2019). According to Azari (2014), construction project crews are sometimes unaware of the technical specifications and operations required for green technologies, especially when such technologies are novel. Under such circumstances, there is a higher risk of error and delay during the construction stage.

Overall, VGS installation on buildings faces several barriers including lack of awareness and understanding of its benefits, climate-change constraints, maintenance cost issues, unsustainable water use, concerns about insects and pollen allergies, potential harm to building facades, and a lack of policy and standard for green exteriors. These barriers highlight the need to develop appropriate policies and standards, in addition to undertaking effective education and awareness campaigns to promote the benefits of VGSs. While VGSs have the potential to improve air quality, enhance the aesthetic appeal of buildings and contribute to climate-change adaptation, it is essential to address these barriers and challenges to ensure the widespread adoption and success of VGSs. Table 1 presents the summary of the barriers to the installation of VGSs.

Table 1: Barriers to the installation of VGSs

Barriers to VGS installation	Source
Lack of awareness and understanding of benefits	Wong et al. (2010
Climate change	Hopkins and Goodwin (2011), Derkzen et al. (2017)
Insufficient light	Smith et al. (2010)
Maintenance cost issues	Wong et al. (2010), Terblanche (2019), Leong et al. (2021)
Unsustainable water use	Stanghellini et al. (2005), Loh (2008), Rosenblum (2013), Francis et al. (2014), Muller (2017)
Increase in insects and pollen levels	Rosenblum (2013)
Harm to facade	Francis et al. (2014), Ottelé et al. (2011)
Lack of policy and standard for green exteriors	Weinmaster (2009)
Lack of technical knowledge	Azari (2014), Terblanche (2019)

3.0 Research Methods

Investigating emerging developmental events require a pragmatic and exploratory strategy of inquiry that is capable of revealing concealed information (Onwuegbuzie et al*.,* 2009; Collins et al*.*, 2013). The study combined semi-structured interviews and questionnaire administration in the collection of data. In other words, this is a mixed-method strategy that employed a qualitative-quantitative approach. Following a similar path, this study began with a series of preliminary interviews with Estate Surveyors and Valuers, who specialised in property management, to gather qualitative data on the barriers to the adoption of VGSs at the operational stage of buildings in Lagos. The respondents were senior property management professionals based on their years of experience and membership status. In qualitative research, the sampling frame and sample size are irrelevant because the semi-structured interview process must be halted at the point of saturation (Abdul Majid et al., 2018). The interview procedure was therefore halted after eleven (11) respondents owing to frequent repetition of similar opinions at the ninth turn of the interview (see Fusch & Ness, 2015). The structured interview was informed by narrative and analytical approaches that included thematic analysis of *a priori* and *a posteriori* themes. Context, important elements and comprehension of VGSs usage were used as a priori codes. The *a posteriori* codes corresponded to the various dimensions of the VGSs that comprise the investigation's constructions. A computer-assisted qualitative data analysis software (Atlas.ti) was used to examine the transcripts obtained following a thorough coding cycle that generated approximately thirty-nine (39) codes with accompanying comments and memoranda. The interview findings, together with those from the existing literature, resulted in the development of a quantitative survey instrument.

The researchers then proceeded with administration of the structured questionnaire based on a sampling frame of 282 Estate Surveying and Valuation Firms as contained in the Lagos Nigerian Institution of Estate Surveyors and Valuers' 2017 directory of ESVFs. The targets were heads of management departments and senior management staff of each organisation mentioned in the directory and situated in Lagos. One property manager was selected using the random sampling technique. With the aid of the SPSS software, the analysis of the quantitative data was done using statistical analysis techniques such as frequencies and percentage, mean, standard deviation and one-sample t-test. Moreover, the Cronbach's Alpha coefficient was derived to test the reliability of the research questionnaire. The next section analyses and discusses the data collected with the questionnaire.

4.0 Analysis and Discussion of Results

Out of the 282 copies of the research questionnaire administered to property managers, 121 copies (representing approximately 43%) were retrieved and found to be useful for data analysis. The following subheadings represent the qualitative and quantitative analysis and discussion of the results.

4.1 The Qualitative Phase

The qualitative aspect of the study established the groundwork for addressing a major research objective, i.e., identifying barriers to VGSs adoption. The profile of each interviewed professional is depicted in Appendix 1, together with their practical years of experience and their unique code IDs. Appendix 2 depicts visualisation networks with nodes representing a wide variety of barriers.

As shown in Appendix 1, respondents have significant experience in the field, as evidenced by their extensive years of professional property management activities. Apart from traditional property management, respondents indicated having experience in construction management, project management, facility management, building contracting and other aspects of the built environment. Appendix 1 highlights the professional backgrounds of the respondents, most of them possessing robust profiles on property management.

Appendix 2 shows the network of barriers to the adoption of VGSs as unravelled during the interview session. The barriers include matters relating to financial responsibility, maintainability of VGSs, policy and regulatory roles, awareness and willingness, roles of technical skills for managing VGSs and understanding contexts of sustainability in the built environment.

To elicit robust responses on the barriers, the researchers developed a questionnaire survey instrument with constructs for measuring the financial responsibility of managing VGSs, standard and policy issues, lack of public awareness, lack of technical education and perception of the conflicting nature of VGSs with other building facades.

4.2 The Quantitative Phase

The researchers conducted a reliability test on the listed items (construct) in the survey instrument, with Table 2 providing details of the outcomes.

Table 2: Test of Reliability of Data

Barrier to VGSs installation	Cronbach's Alpha
The cost of maintaining VGSs will increase the outgoings of a property	.724
Lack of technical knowledge of its installation	.727
Possible increase in insect and pollen	.734
.....	.748
It competes with other components installed on the building façade	.757
Lack of policy, standards, and regulations enforcing its installation	.724
Lack of approaches to increase the implementation of vertical greenery	.752
Lack of public awareness and understanding of its benefits	.724
The temperature/humidity levels, orientation, and wind direction in this part of the world affect the growth of VGSs	.738
Snakes are everywhere in Lagos and VGSs are areas where they can hide	.738
Better enforcement of green building policies and standards	.739
Living walls often have unsustainable water usage	.723
Lack of standard costs for the installation of VGSs	.726
Lack of emphasis on sustainability by professionals in the construction industry	.737

Cronbach's alpha was used to measure the internal consistency or average correlation of items in the questionnaire to determine its reliability. Cronbach's alpha is a measure of dependability linked with the variance explained by the real score of the construct (the listed items) and it has a

value between 0 and 1 (Datt & Chetty, 2016). Cronbach's alpha confirms the reliability of components retrieved from dichotomous data: the higher the score, the more dependable the scale (Tavakol & Dennick, 2011). Implicit in Table 2 is the fact that all the featured fifteen (15) items fall within the appropriate reliability test threshold value, i.e., between 0.724 and 0.752. The overall value of the coefficient is 0.749, which is above 0.7. According to Datt and Chetty (2016), an instrument and its survey items become reliable if the value of the Cronbach's alpha is between 0 and 1.

Having determined the reliability of the constructs, the report next provides the profiles of the respondents in Table 3 and why they are considered appropriate respondents for the research questions in the validated instrument.

Table 3: Background information (N = 121)

Variables	Total	Composition
Gender	121	
Age (years)	120	<31 – 6 (5.0%), 31 -40 – 23 (19.2%), 41-50 – 50 (41.7%), 51 -60 – 33 (27.5%), Above 60 – 8 (6.7%)
Years of property management practice	120	1-5 – 9 (7.5%), 6 -10 – 15 (12.5%), 11 -15 – 25 (20.8%), 16 -20 – 71 (59.2%)
Educational qualification	115	HND – 15 (13.0%), B.Sc./B.Tech. – 34 (29.6%), M.Sc./MBA – 32 (27.8%), PGD – 30 (26.1%), PhD – 4 (3.5%)
Professional qualification	118	Probationer/graduate – 16 (13.6%), Associate – 72 (61.0%), Fellow – 29 (24.6%), Past president – 1 (0.8%)

The results from Table 3 show that 102 (84.3%) were male, while 19 (15.7%) were female professionals within the active age bracket (31-60 years). The background information relating to their educational qualifications indicate that 34 (29.6%) of the property managers had a bachelor's degree, 32 (27.8%) had a master's degree, 30 (26.1%) had a postgraduate diploma, 15 (13.0%) had a Higher National Diploma (HND), while only 4(3.5%) had a Ph.D. in Estate Management. It implies that the respondents do not only possess practical experience but also hold adequate prerequisite theoretical and academic knowledge in the field of Estate Management. Indeed, the results show that the professionals possessed appropriate educational background and were therefore considered to be equipped to give useful responses necessary to make valid generalisations. In terms of practical property management experience, 71 (59.2%) of the property managers (ESVs) had between 16 and 20 years of practical experience, 25 (20.8%) had between 11 and 15 years of experience, 15 (12.5%) had between 6 and 10 years of experience, while only 9 (7.5%) had between 1 and 5 years of experience. This suggests that the respondents possessed substantial years of industry experience, which was deemed appropriate enough for them to respond to all research questions. In terms of professional qualifications in Estate Management, the majority of the respondents were professionally qualified. For example, 72 (61.0%) were Associate members, 29 (24.6%) were Fellows, 1 (0.8%) was a past President, while only 16 (13.6%) were probationers/graduates. The information included in the demographics is viewed as important enough for consideration in assessing the credibility and eligibility of the respondents in expressing a related opinion on the issues raised. Subsequently, Table 4 outlines the professionals' challenges in adopting VGSs in the management of real estate.

Table 4: Barriers Confronting VGSs Adoption in the Operational Stage of Real Estate

Barriers to VGSs installation	N	Mean	Std. Deviation	Ranking
Lack of approaches to increase the implementation of vertical greenery	107	3.04	1.440	1st
Lack of policy, standard, and regulations enforcing its installation	107	2.83	1.526	2nd
Lack of public awareness and understanding of its benefits	118	2.78	1.321	3rd
Lack of technical knowledge of its installation	110	2.76	1.471	4th
	96	2.73	1.651	5th
Better enforcement of green building policies and standards	97	2.70	1.542	6th
Snakes are everywhere in Lagos and VGSs are areas where they can hide	117	2.65	1.191	7th
Living walls often require an unsustainable water usage	114	2.58	1.382	8th
Lack of emphasis on sustainability by professionals in the built environment	118	2.56	1.337	9th
The temperature/humidity levels, orientation, and wind direction in this part of the world adversely affect the growth of VGSs	92	2.54	1.346	10th
Possible increase in insects and pollen	118	2.53	1.325	11th
It can cause damage to building façade	120	2.52	1.243	12th
The cost of maintaining VGSs will increase the outgoings on a property	119	2.39	1.335	13th
Lack of standard costs for the installation of VGSs	115	2.24	1.152	14th

The results in Table 4 show that *lack of approaches to increase the implementation of vertical greenery* ranked first among the barriers to VGS installation, with a mean score of 3.04. The second-ranked barrier (mean score = 2.83) was *lack of policy, standards and regulations enforcing VGS installation*. In the same vein, *lack of public awareness and understanding of its benefits* ranked third with a mean score of 2.78; the fourth barrier was the *lack of technical knowledge of its installation,* with a mean score of 2.76. These responses, among others, indicated respondents' agreement on barriers to the installation of VGSs in Nigeria. At the bottom, the barriers that ranked lowest were *the cost of maintaining VGSs will increase the outgoings on a property* (mean score = 2.39) and *lack of standard costs for the installation of VGSs* (mean score = 2.24). This signifies that the respondents disagreed that they are significant barriers to VGS installation.

The results in the foregoing paragraph corroborate the findings of Weinmaster (2009), who attributes poor design to l*ack of policy and standard for green exteriors*. In the same vein, *lack of public awareness and understanding of the benefits of VGSs* is revealed as a second significant barrier, thus signifying property owners' unwillingness to install VGSs at the operational stage of their real estate. In tandem with the findings of Terblanche (2019), *lack of technical knowledge is also a significant barrier to the installation of VGSs*. This suggests the need for training and capacity building in the installation of VGSs. As the table indicates, other key barriers identified centered on issues relating to the sustainable development agenda as it affects the built environment. On the other hand, the least barriers identified include *fear that VGSs can cause damage to building façades*, *the cost of maintaining VGSs would increase the outgoings of property*, and *the lack of standard cost for the installation of VGSs*. These results are similar to those of Weinmaster (2009), Rosenblum (2013) and Terblanche (2019).

To understand the differences in the mean scores of the responses, the one sample t-test was used and the results are presented in Table 5.

Table 5: One Sample T-Test

Barriers to VGSs installation			**Test Value = 3.00**			
	Mean	**St. Dev.**	**t**	**df**	***p*-value**	**Mean Difference**
The cost of maintaining VGSs will increase the outgoings on a property	2.39	1.335	-5.014	118	.000*	-.613
Lack of technical knowledge of its installation	2.76	1.471	-1.685	109	.095	-.236
Possible increase in insects and pollen	2.53	1.325	-3.891	117	.000*	-.475
It can cause damage to building façade	2.52	1.243	-4.258	119	.000*	-.483
It competes with other components installed on the building façade	2.73	1.651	-1.607	95	.111	-.271
Lack of policy, standard, and regulations enforcing its installation	2.83	1.526	-1.140	106	.257	-.168
Lack of approaches to increase the implementation of vertical greenery	3.04	1.440	0.269	106	.789	.037
Lack of public awareness and understanding of its benefits	2.78	1.321	-1.811	117	.073	-.220
The temperature/humidity levels, orientation, and wind direction in this part of the world adversely affect the growth of VGSs	2.54	1.346	-3.254	91	.002*	-.457
Snakes are everywhere in Lagos and VGSs are areas where they can hide	2.65	1.191	-3.182	116	.002*	-.350
Better enforcement of green building policies and standards	2.70	1.542	-1.909	96	.059	-.299
Living walls often require unsustainable water usage	2.58	1.382	-3.253	113	.002*	-.421
Lack of standard costs for the installation of VGSs	2.24	1.152	-3.781	109	.000*	-.473
Lack of emphasis on sustainability by professionals in the built environment	2.56	1.337	-3.581	117	.000*	-.441

The study further analysed the level of significance of the mean rating of the barriers to adoption of VGS. The result of the one-sample t-tests as presented in Table 5 shows that most of the mean ratings were significant at $p < 0.05$. The results show that factors such as *the cost of maintaining VGSs will increase the outgoings on a property* (*p-value* = 0.000), *possible increase in insect and pollen* (*p-value* = 0.000) and *lack of standard cost for the installation of VGSs* (*p-value* = 0.000) were significant factors that relate to barriers arising from costs of installation and maintenance. Another significant factor relates to the presence of snakes in the neighbourhood (*snakes are everywhere in Lagos and VGSs are areas where they can hide – p-value* = 0.002). In addition, barriers relating to environmental and building factors were also significant at the *p-value* < 0.05, which factors are as follows: *It can cause damage to building façade*; *the temperature/humidity levels*; *orientation and wind direction in this part of the world adversely affect the growth of VGSs*; and *living walls often require unsustainable water usage*. The last significant factor influencing the adoption of VGS relates to lack of emphasis on sustainability by professionals in the built environment, this has a *p*-value of 0.000.

5.0 Conclusion

This study investigated property managers' and perception of adoption of VGSs, as well as barriers to adoption of VGSs at the operational stage (property management stage) in Lagos, using a mixed methods approach. Lack of building regulations, awareness of green walls, understanding the benefits that come with green walls, knowledge of the construction industry, and inadequate emphasis on sustainability were the main barriers identified. The role of policy in motivating the use of VGSs is imperative for a paradigm shift in property management

practice. Other key factors include VGS competition with other components installed on building façades and the need for better enforcement of green building policies and standards in the Nigerian built environment. However, there is fear that snakes may hide in VGSs. Furthermore, some property managers noted that living walls tend to use water unsustainably. Yet other responses identified issues of lack of emphasis on sustainability by professionals in the construction industry, the unfavourable temperature/humidity levels as well as orientation and wind direction in this part of the world, and lack of standard costs for the installation of VGSs. The view was also expressed that there might be an increase in the incidence of indoor insects and pollen owing to adoption of VGSs.

The findings of this study have practical implications for the adoption of Vertical Greening Systems (VGSs) at the operational stage in property management. The identified barriers provide valuable insights into the challenges in the incorporation of VGSs. One of the key implications is the need for building regulations that specifically address the implementation of VGSs The absence of such regulations creates uncertainty and hinders its widespread adoption. Policymakers and regulatory bodies need to play a significant role in promoting the use of VGSs by developing and enforcing green building policies and standards that provide clear guidelines for their implementation.

Another practical implication is the importance of increasing awareness and understanding of the benefits associated with green walls among property owners and property managers. Educating them about the advantages of VGSs, such as improved air quality, thermal insulation, and aesthetic enhancements, can help overcome resistance or scepticism towards their adoption. Efforts needs to be made to disseminate information about the positive social, environmental and economic impacts of VGSs, as well as practical guidance on their installation and maintenance.

Furthermore, addressing concerns raised by property managers is crucial for promoting the adoption of VGSs. This includes addressing fears about the presence of snakes or potential issues related to water usage and sustainability. Providing reassurance and demonstrating effective pest management strategies can alleviate concerns about indoor insects and pollen. Moreover, developing standardized cost estimates for VGS installation can help property managers in budgeting and decision-making processes.

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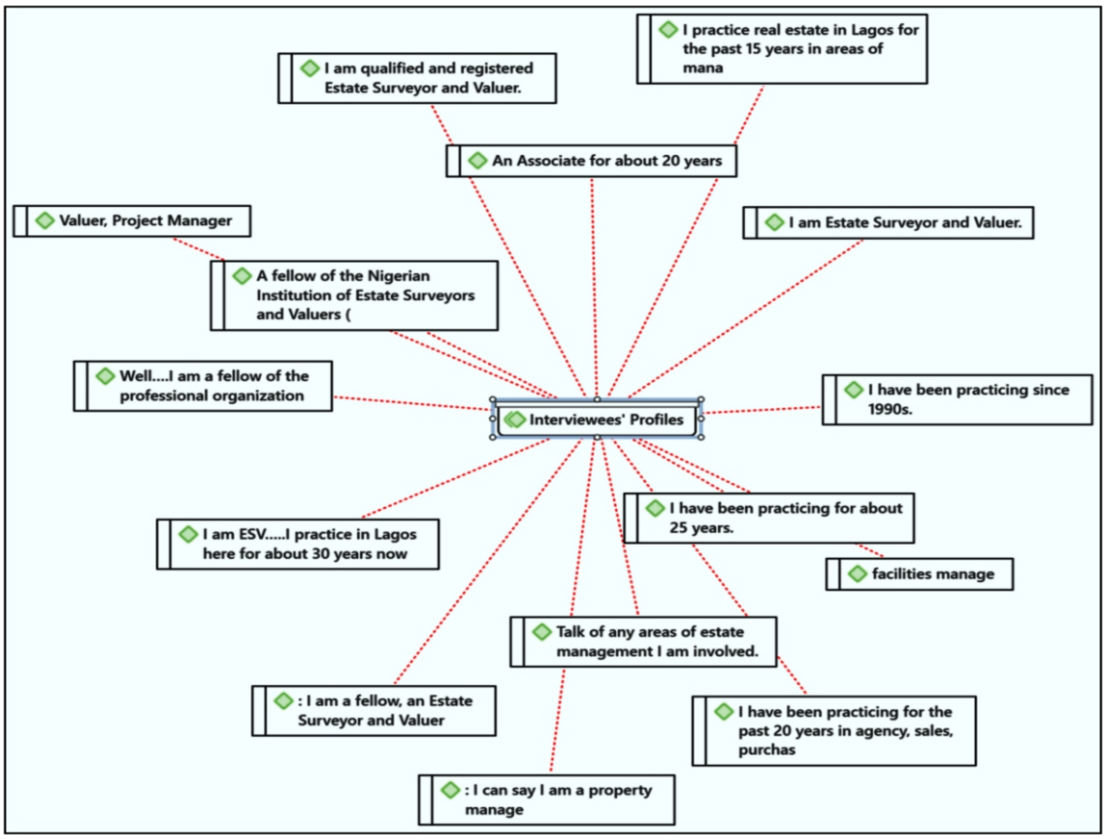
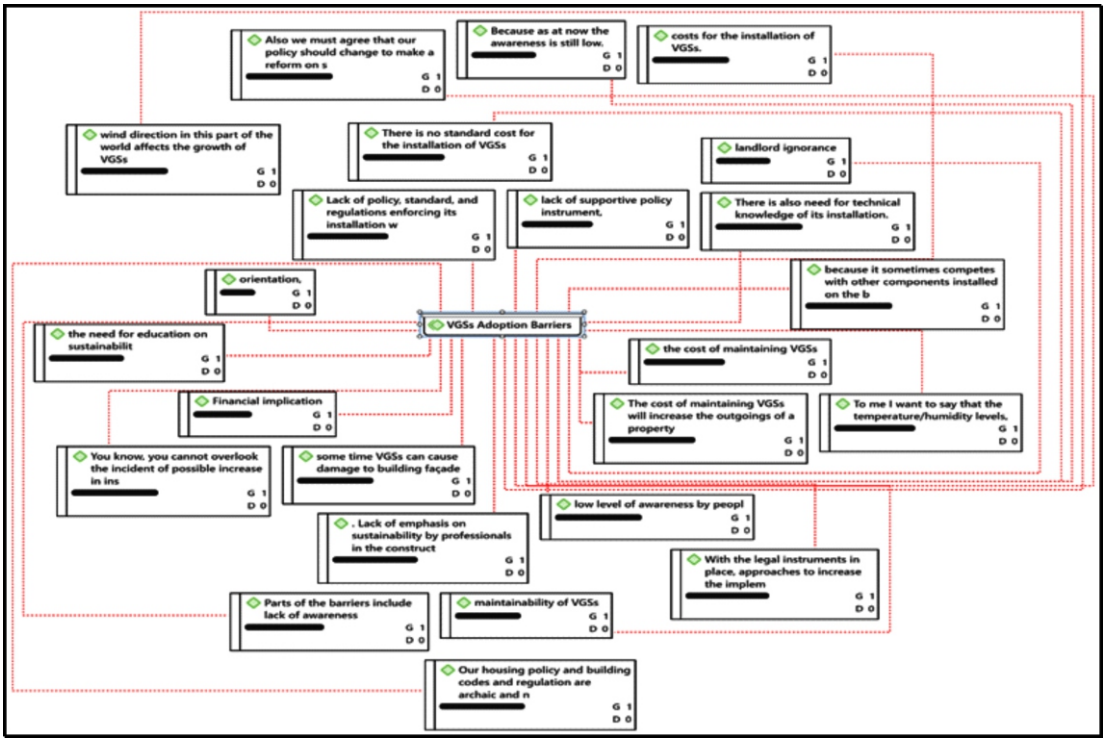
APPENDICES

Appendix 1



Appendix 2



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Climate Resilience and Global Polyethylene Bag Pollution: Exploring Synthesis of Biodegradable Plastic Bags from Cassava (*Manihot esculenta*) as a Solution

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Abstract

Plastic bags are polymers of ethylene and are used in almost every aspect of everyday life across the globe for a variety of functions. After their use and disposal, plastic bags have no end-of-life time because of their non-degradable nature, leading to environmental contamination and pollution. As a way of disposing them, thermal treatment is employed but this leads to emissions that increase the concentration of greenhouse gases in the atmosphere, eventually contributing to the climate crisis. Therefore, synthesis of biodegradable plastic bags offers an environment-friendly alternative for conventional plastic bags. A biodegradable plastic bag prototype was synthesized using renewable raw materials with lower carbon footprints. Among such materials was starch obtained from wasted cassava, glycerin and vinegar which served as plasticizers to make the bag flexible and less brittle. The use of renewable raw materials (cassava) with lower carbon footprints in the production of biodegradable plastic bags can therefore be considered as instrumental in reducing plastic bags waste contamination and pollution of the environment thereby contributing towards achieving climate-resilient cities.

Keywords: Biodegradability; Climate resilience; Greenhouse gases

1.0 Introduction

Plastic bags are polymers of high molecular weight processed from petroleum-based raw materials called ethylene (Ismail et al., 2016). These are used in almost every aspect of life worldwide for storing, carrying and, packaging of a wide variety of items and materials (Kaewphan & Gheewala, 2013). Waterproof plastic bags are quite thin and easy to carry, they are also strong, and hold their shape under normal use.

Through chemical reactions, ethylene is obtained from crude oil in a process that emits greenhouse gases such as carbon dioxide which contributes to climate change (Kaewphan &

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Gheewala, 2013). Plastic bags are non-degradable in nature because they cannot be broken down by microorganisms in the environment when disposed (Sanyang et al., 2016). Consequently, burning and sending them to landfills is resorted to, which contributes to environmental contamination and pollution.

The Impact Forecast estimates that during the production, use and disposal of plastic bags, for every ton, about 3,299kg of carbon dioxide is emitted into the atmosphere resulting into 329,900 million kilograms of carbon dioxide emitted into the atmosphere every year from the 100 million tons of plastic bags used. Whereas for every ton of biodegradable plastic bags, during their production, use and disposal, about 1,189kg of carbon dioxide is emitted; thus in every ton, about 2,110 kg of carbon dioxide emissions are saved, hence contributing severely to climate change.

Muralikrishna and Manickam (2017) define environmental pollution as contamination of the physical and biological components of the earth or the atmospheric system to such an extent that normal environmental processes are adversely affected. Therefore, plastic bags, when disposed, contaminate the physical and biological components of the environment through increased concentration of greenhouse gases (Jones et al., 2013).

Greenhouse gases are gaseous compounds that can emit ultraviolet radiation within a certain thermal infrared range (Fouladi et al., 2020). They can trap the earth's emitted radiation which otherwise escapes back to space to make the earth more habitable through temperature regulation. Thus, high concentrations of greenhouse gases in the atmosphere increase the amount of trapped heat (Borduas & Donahue, 2018). Among the greenhouse gases in the atmosphere are carbon dioxide and, methane which are emitted during the disposal of plastic bags (Yoro & Daramola, 2020).

The United Nations (2018) defines climate change as a long-term shift in temperature and weather patterns that are driven mainly by human activity the burning of fossil fuels. The earth being a complex interconnected system, it is inevitable that changes in one area would influence changes in all other areas hence the need for global climate resilience actions.

The Centre for Climate and Energy Solutions (n.d.) defines climate resilience as the ability to anticipate, prepare for and respond to hazardous events, trends or disturbances related to the climate. It involves how climate change creates-new or alters current-climate-related risks and taking steps to better cope with the risks. To be sure, switching from use of fossil fuels and their products to renewable raw materials and their products, such as biomass-based products with lower carbon footprints, will aid in reducing emissions, leading to climate resilience (Chen, 2013).

Biodegradable plastic bags are synthesized using renewable raw materials. Such bags can serve the same purpose as conventional plastic bags (Wahyuningtyas & Suryanto, 2017). Biodegradation is an irreversible change creating significant change in the structure of a material, thus resulting in the loss of its properties as caused by biological activities such as enzymatic action. Renewable raw materials include agricultural products such as starch extracted from cassava (Jain & Tiwari, 2015). Biodegradable plastic bags are environmentally friendly and can be used as manure or even processed into fertilizers that aid in the increased production of agricultural products thereby aiding food security while boosting production of the raw materials for biodegradable plastic bags.

In most cities in the developing world, almost all aspects of everyday life involve use of plastic bags, most of which are non-reusable and non-degradable after disposal. Plastic bag waste is either collected and incinerated at specific garbage collection centres in an open environment or it is collected and burnt at unapproved places; sometimes such waste is sent to landfills or disposed in water bodies. Whatever the method of disposal, the result is emission of greenhouse gases into the atmosphere.

Given this background, this study contributes to the process of achieving climate-resilient cities through control of plastic bag waste environmental contamination and pollution by explaining the synthesis of biodegradable plastic bags using agricultural products like cassava (Mooney, 2009).

2.0 Literature Review

Today, plastic bags are used almost everywhere and have replaced many conventional materials and products (Geyer et al., 2017). Indeed, global plastic bag production has increased significantly despite vast quantities of the product being discarded daily (Alam et al., 2018). Given their lightness, strength, cheapness and easy handling, plastic bags are one of the most common products worldwide (Kaewphan & Gheewala, 2013).

According to the statistics supplied by Word Counts in 2022, more than five trillion plastic bags are used per year, with a total of 160,000 being used in a second and over 700 being used per year by an individual. In 2015, plastic bag waste accounted for 47% of plastic waste generated globally. If current production and waste management trends continue, roughly 12,000 metric tons of plastic waste would be in landfills or the natural environment by 2050 (Geyer et al., 2017).

Less than 1% of used plastic bags are recycled and the rest is thrown into the environment, never to degrade (Sanyang et al., 2016). The common approach to eliminating such plastic waste is by destructive thermal treatment that itself degrades the environment, leading to negative externalities on human and nonhuman life (Khan & Ghouri, 2011). During the process of eliminating plastic bag waste material, emissions of massive amounts of carbon dioxide occur with other toxic chemicals also being released into the atmosphere (Verma et al., 2016; Yoro & Daramola, 2020). No doubt, two major dangerous greenhouse gases are carbon dioxide and methane being emitted into the atmosphere (Kaewphan & Gheewala, 2013).

As emissions continue to rise, the Earth has become warmer by about 1.1^{o}C than it was in the late 1800's (United Nations, 2018). Limiting global temperature rise to not more than 1.5^{o}C will therefore help in avoiding the worst climate impacts and maintain a livable climate, since the climate change negatively impacts human health (Jung et al., 2018).

Accordingly, transiting to biodegradable plastic bags is now a necessity for the Earth's survival (Jones et al., 2013). Such plastic bags are made from plant materials, which are natural, renewable, abundant and of low cost (Dai et al., 2009).

Globally, projections on the monetary value of biodegradable plastic bags are expected to move from $ 1,470.5 million in 2017 to $2.052.2 million by end of 2022. This is based on worldwide governmental action on minimizing the effect plastic pollution.

Biodegradable plastics can be developed from starch, given its favorable thermoplastic properties, biodegradability, abundance and cheap cost (Shafqat et al., 2021). Moreover, the agricultural waste from which starch can be extracted has been identified as a cheap and renewable raw material alternative (Jain & Tiwari, 2015). This starch is mainly from agriculture wastes like cassava, which has a short life due to postharvest physiological deterioration (Zainuddin et al., 2018).

Worldwide, about 278 million metric tons of cassava were produced 2018, 61 % was from Africa (Tafesse. et al., 2021). More than one-third of cassava produced globally is wasted owing to post-harvest physiological deterioration, hence the abundance of the agricultural waste from which starch can be extracted for use in synthesis of biodegradable plastic bags (Jain & Tiwari, 2015).

During their production, plasticisers are added to increase the plasticity of the material as well as their mechanical properties. They play significant role by forming hydrogen bonds with starch by disrupting the strong interaction between intra and intermolecular hydrogen bonds in starch, improving processing properties and flexibility (Dai et al., 2009). When disposed in the environment, biodegradable plastic bags absorb moisture from the air and microorganisms break it down by biological means in a period between 3-6 months (Momani, 2009).

Therefore, the prevalent use of plastic bags today leads to negative externalities on the climate as well as on urban systems and populations. This calls for the need to promote climate resilience through use of biodegradable plastic bags (Tyler & Moench, 2012).

A number of campaigns have been launched in different countries to reduce excessive use of plastic bags, with some of them having failed and regulations suspended owing to opposition from users. Such regulations have included an outright ban on plastic bags, ban of plastic bags below a specific thickness and size, and imposition of an environment levy on plastic bags (Saidan et al., 2017). The switch to an alternative will therefore contribute to implementation of policies on environmental justice.

3.0 Methodology

The research was done in Kampala, Uganda's capital and largest city. Kampala was selected because it is one of the highly populated districts in Uganda with a high rate of plastic bag use, especially for grocery shopping. According to the National Environment Management Authority, at least 600 tons of plastic bags are consumed every day in Uganda and afterwards disposed of irresponsibly. In the city about 150 tons of waste are generated every day, with only 40% of plastic waste collected and 60% left in the environment, thus causing pollution from eventual burning in an open environment (Monitor, 2022).

3.1 Research Design

The research design was experimental in nature. A prototype for a biodegradable plastic bag was developed from cassava. The cassava was processed and starch was extracted before being used as the main raw material. Other ingredients (glycerin and vinegar) were added to increase the plasticity of the material as well as its mechanical properties. Starch was extracted from cassava roots that were purchased from a market in the city. Glycerin and vinegar were also purchased from chemical stores in Kampala.

3.2 Procedure

Cassava roots were washed and cut into pieces, then grated in a mortar. Distilled water was added to the mortar and the cassava was ground carefully. Subsequently, the material was filtered into a clean beaker. The second and third steps were repeated twice to extract any extra starch. The mixture in the beaker was left to settle and the water decanted, leaving the starch settled at the bottom. Distilled water was then added to the starch extract, which was stirred gently and left to settle before being decanted to obtain starch that was free from all contaminants. Starch was added to water stirred to form a mixture, and this process was followed by addition of glycerin and vinegar. The mixture was stirred further for uniform mixing with application of moderate heat to form a paste that was sprayed on a smooth surface and left to dry in the sun for a period of 24 hours forming a bioplastic film.

4.0 Results

Wasted cassava roots (Figure 1) were grated to extract starch (Figure 2). After addition of distilled water, an emulsion formed to which glycerin and vinegar were added before being stirred to form a mixture. When moderate heat was applied, there was uniform mixing of the

content, which formed a paste that was sprayed on a smooth surface (Figure 3). This was then dried to form a bioplastic film (Figure 4).

The bioplastic film formed was flexible, not brittle, on folding. On disposal in open environment, the bioplastic film started to decompose after a period of four weeks. When dropped in water, after a period of two weeks it was observed to disintegrate.

Figure 1: wasted cassava roots

Figure 2: cassava grating to extract starch

Figure 3: Starch paste on aluminum foil for drying

Figure 4: Bioplastic film after drying

5.0 Conclusion

Nowadays many countries have introduced or are about to introduce policies banning the use of non-degradable plastic bags owing to the contamination and pollution they cause to the environment upon disposal. As part of efforts in this regard, this study focuses on synthesis of biodegradable plastic bags as an alternative to conventional non-degradable plastic bags. Thus, in the bid to achieve climate-resilient cities in the long term, it would be necessary to invest in renewable raw materials with lower carbon footprints (e.g., cassava) in the production of biodegradable plastic bags. Governmental and other authorities must therefore consider making informed decisions regarding environmental policies. It should be noted, however, that this study

did not test for the strength and thickness of the bioplastic film produced. It would also be necessary to determine whether other agricultural wastes, e.g., banana pseudo stems and maize kernels, are possible raw materials for biodegradable plastic bags. This study is an invitation for more elaborate processes to test the industrial efficacy of the production of bags from biodegradable raw materials on a wider scale.

There is a high demand for products which only satisfies the user's needs and actively reduce environment pollution, thus the high acceptability of biodegradable plastic bags. The production of biodegradable plastic bags also promotes bioeconomy and circular economy which of recent are at the forefront of industrial production towards mitigating climate change.

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Factors Influencing Adoption of Building Management System in Commercial Buildings in Lagos State, Nigeria

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Abstract

Against the backdrop of increasing technological innovation and rising demand for sustainability in the built environment, there is a clear need to explore the application of Building Management System BMS in the Nigerian real estate sector. Accordingly, this paper examined the concept of adopting Building Management System (BMS) in commercial buildings in Lagos State, Nigeria with a view to assessing performance on SDG 11 (Sustainable cities and communities) where issues around resilience in buildings is hosted. The study administered one hundred and eighteen questionnaires to facility managers of commercial buildings that have adopted BMS in five local government areas in Lagos State. The data were processed using the principal component (factor) analysis and regression correlation analysis tool. It was found that a range of social and cost factors influenced the adoption of BMS in the study area. Specifically, level of occupant comfort and ease of use of the system were the most significant factor while implementation cost and extent of energy savings also strongly influenced BMS adoption in the study area. The chapter offers suggestions on strategies to improve adoption of BMS and recommends awareness campaigns and the introduction of promotional incentives to the public on BMS.

Keywords: Adoption; Building management system; Factors; Sustainable development goals

1.0 Introduction

Nowadays the smart building concept has become quite fashionable among segments of the population, especially in terms of the long-term business opportunity that it represents (Simpeh & Smallwood, 2015). This growing embrace of 'building smartness' is a reaction to the negative environmental effects of the greenhouse emissions from conventional buildings that use high volumes of energy and, consequently, impede efforts to achieve the Sustainable Development Goal on resilient buildings (Awosode 2018; Ofori 2012). As a major component of smart cities, BMS has contributed immensely to achieving low energy consumption in buildings (Wigginton, 2002). According to literature, a number of factors have been identified to influence the adoption of BMS in the construction industry (Nguyen & Aiello, 2012).

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BMS is software/hardware that helps to control, monitor and manage the lighting, heating, ventilation, and air conditioning (HVAC), water supply, physical access and other related components of buildings (Shang, Ding, Marianantoni, Burke, & Zhang, 2014). Data can be gathered through these systems and used for evaluation, fault finding, bill and report generation and many other purposes related to building performance (Shang, *et al,* 2014). The component sub-systems of BMS also include utility and monitoring systems, fire and life safety systems, security and access control systems and the vertical transportation system, leading to significant energy savings, drastic reduction of CO_2 gas emission and improvement of appliance efficiency (Wambui, 2014).

Managers of commercial buildings are consistently faced with the challenge of competition and need to consistently upgrade their systems in order to meet customer expectations and taste while keeping an eye on profit (Janes & Wisnom, 2003). Having BMS in commercial buildings helps to cut costs in many ways (Trauthwein, 2012). However, owing to certain factors, not all commercial buildings have been able to adopt BMS in Lagos State, Nigeria's commercial hub (Cunningham, 2013). The choice of Lagos for this study is justified by the sheer number of technologically-driven businesses in the state (Awosode, 2018). The study identifies the various factors influencing the adoption of BMS in commercial buildings in five local government areas of the state. The aim is to examine the current performance of the system while seeking to improve it and promote its use to more people.

2.0 Literature Review

The Building Management System (BMS) is one of the recent technological innovations in the construction industry, and it appeals to users for different reasons (Faruque, 2019). According to Hankinson and Breytenbach (2012), acceptance of technological innovation in the construction industry may sometimes be constrained by issues such as conflicting building codes, fear of accepting new products by the professionals, lack of awareness, lack of experience of use, lack of local expertise, and level of availability of the innovation. According to Djokoto, Dadzie and Ohemeng-Ababio (2014), acceptance of innovation may be influenced by the belief system and culture in a society. As Du Plessis et al. (2002) found, the construction industry in developing countries such as Nigeria and South Africa may not place a high premium on technological innovation, hence the likely slow embrace of BMS.

Ben and Margaret (2014) examined the adoption of smart building devices in Nigeria and found that cultural and economic factors tend to influence their acceptance. According to the authors, automated doors in public buildings, use of closed-circuit television (CCTV) for security reasons and smart cards for accessing certain buildings were the most commonly adopted BMS features. However, the authors suggested that BMS will eventually be fully embraced in the country. At present, many professionals are not aware of BMS and most clients cannot afford the installation cost. As Dalibi, Feng, Shuangqin, Sadiq, Bello and Danja (2017) reported, green building technologies have not been embraced because of their high costs.

According to Wambui (2014), writing within the context of Kenya, BMS allows for energy efficiency, convenience, ease, security and safety achieved by automation of building components. Moreover, it allows for easy tracking and managing of building operations to maximise energy efficiency which offers cost benefits, and helps to promote resilience in buildings. The study identified three main factors with the most influence on the adoption of BMS in the study area, viz: comfort and ease of use of the system, level of awareness, and client's taste. Korani, Ghaderzadeh and Korani (2015) showed that in Iran BMS adoption was influenced by level of awareness and availability alongside cultural and economic issues.

3.0 Methodology

The study utilised primary and secondary data. The primary data were sourced through a survey

of facility managers of commercial buildings adopting BMS in five local government areas of Lagos State, namely: Ikeja, Surulere, Eti-Osa, Lagos Island, and Ibeju-Lekki. A total of 169 commercial buildings were identified from the available maps and data retrieved from the Lagos State Ministry of Works. The study assessed 118 commercial buildings out of the sample frame, that is, 70% of the population. A questionnaire was designed to assess the impact of the factors influencing the adoption of BMS in the study area, using a five-point Likert scale showing the level of significance of the twenty (20) factors that were identified. The data were analysed using principal component (factor) analysis and regression correlation analysis.

4.0 Findings

Table 1 presents the result of the test of sample adequacy for factor analysis. The Kaiser-Meyer-Olkin (KMO) value of 0.801 obtained indicates that the sample is adequate. The result of Bartlett's Test of Sphericity ($\chi^2 = 690.808$, $P = 0.000$) revealed that the correlation matrix of the 20 factors is not an identity matrix. This further showed that the off-diagonal values are not zeros but ones.

Table 1: KMO and Bartlett's test of sample adequacy for the analysis of factors influencing adoption of BMS in commercial buildings

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.810**
Bartlett's Test of Sphericity		690.808
		190
		0.000

The communalities of the factors influencing the adoption of BMS facilities in commercial buildings were established for the purpose of determining the extent to which the underlying factors account for the variance of the 20 factors. The result in Table 2 shows that all the variables had communalities greater than 0.4, thus implying that the variables actually measured the underlying factors.

Table 2: Communalities of factors influencing adoption of BMS in commercial buildings

Factor	**Initial**	**Extraction**
Savings on maintenance costs	1.000	0.716
Energy efficiency	1.000	0.624
Technical compatibility of BAS and user needs	1.000	0.774
Comfort and ease of using the system	1.000	0.628
Changes in customer tastes, preferences and style	1.000	0.681
Global competition	1.000	0.543
Efficiency of building services equipment	1.000	0.617
Enhanced comfort for occupants	1.000	0.792
Friendly responsiveness of BMS on the environme	1.000	0.512
Provides safety and security	1.000	0.480
Low level of awareness	1.000	0.662
Lack of demand by building users/owners	1.000	0.688
High implementation cost	1.000	0.563
Availability of local expertise	1.000	0.618
Management strategies	1.000	0.650
Type of building	1.000	0.735
Age of organisation	1.000	0.713
Location of organisation	1.000	0.595
Number of floors	1.000	0.606
Employee expectation	1.000	0.730

Extraction Method: Principal Component Analysis

The principal components analysis is presented in Table 3. The components have Eigenvalues that were not less than one and rotation sums of square loadings that ranged between 1.686 and 2.740. These suggest that six components could be extracted to represent the underlying factors. The dominant one accounted for 31.701% of the observed variance with the Eigen value of 6.340. The second component accounted for 8.536% of the observed variance, with an Eigenvalue of 1.707. The third component accounted for 7.131% of the variance of the data set, with an Eigen value of 1.426. The fourth component accounted for 6.256% of the variance and had an Eigen value of 1.251. The fifth component accounted for 5.896% of the observed variance, with an Eigen value of 1.79, while the last component accounted for 5.117% of the variance of the data set, with an Eigen value of 1.023. The scree plot in Figure 1 shows inflections that rationalise retention of the six components.

Table 3: Total variance explained of factors influencing use of BMS in commercial buildings

Total Variance Explained									
Comp	**Initial Eigen value**			**Extraction sum of square loadings**			**Rotation sums of squared loadings**		
SN	**Total**	**% of variance**	**Cumul. (%)**	**Total**	**% of variance**	**Cumul. (%)**	**Total**	**% of variance**	**Cumul. (%)**
1	6.340	31.701	31.701	6.340	31.701	31.701	2.740	13.698	13.698
2	1.707	8.536	40.237	1.707	8.536	40.237	2.636	13.182	26.880
3	1.426	7.131	47.367	1.426	7.131	47.367	2.305	11.524	38.404
4	1.251	6.256	53.624	1.251	6.256	53.624	1.855	9.277	47.681
5	1.179	5.896	59.520	1.179	5.896	59.520	1.705	8.524	56.204
6	1.023	5.117	64.637	1.023	5.117	64.637	1.686	8.432	64.637
7	0.960	4.799	69.436						
8	0.785	3.924	73.360						
9	0.716	3.581	76.941						
10	0.651	3.256	80.197						
11	0.599	2.995	83.192						
12	0.562	2.809	86.001						
13	0.502	2.509	88.510						
14	0.485	2.423	90.933						
15	0.426	2.131	93.064						
16	0.382	1.908	94.972						
17	0.322	1.610	96.582						
18	0.255	1.277	97.860						
19	0.233	1.167	99.027						
20	0.195	0.973	100.000						

Extraction Method: Principal Component Analysis

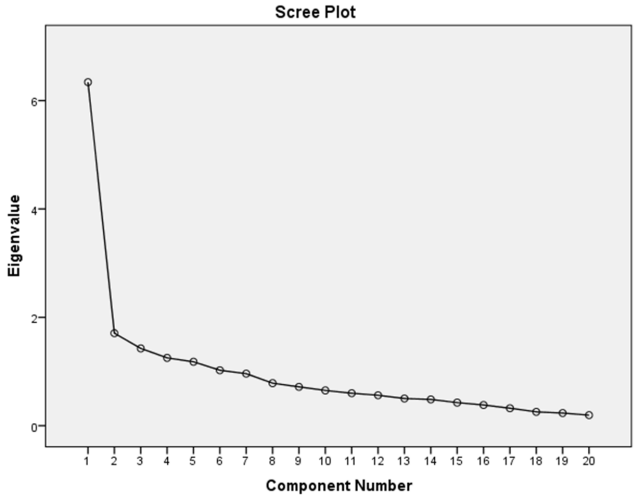

Figure 1: Scree plot of factors influencing use of BMS in commercial buildings

The component matrix of Table 3 presents the results of the Pearson's correlation analysis between the components and factors influencing adoption of BMS facilities in commercial buildings. All the factors considered were loaded into six components. Some of the variables were observed to measure more than one underlying factor, giving rise to cross loadings. An example of these variables is 'lack of demand by building users or owners.' In tackling this challenge, rotation of the component matrix using Varimax with Kaiser Normalisation method was performed.

Table 4: Component matrix of correlations between components and factors influencing adoption of BMS in commercial buildings

Factors	**Components**					
	1	**2**	**3**	**4**	**5**	**6**
Savings on maintenance costs	0.691	0.437				
Energy efficiency	0.592	0.338	-0.348			
Efficiency of building services equipment	0.427	0.414		-0.395		0.396
Comfort and ease of using the system	0.635	0.376				
Changes in customer tastes, preferences and style	0.595		-0.353	0.362		
Global competition	0.565					
Employee Expectation	0.550		-0.402			
Enhanced comfort for occupants	0.305	0.402		0.635		-0.347
Friendly responsiveness of BMS on the environment	0.366				0.455	
Provides safety and security	0.609		0.310			
Low level of awareness	0.355		0.366	0.468		0.425
Lack of demand by building users/owners	0.550		0.476			
Technical compatibility of BAS and user needs	0.679					
Availability of local expertise	0.683		0.301			
Type of building	0.699				-0.365	
Management strategies	0.545		0.342		0.482	
Age of organisation	0.471	-0.498			-0.452	
Location of organisation	0.598	-0.481				
Number of floors	0.485		0.321			-0.389
High implementation cost	0.630	-0.464				

Table 5 shows the results of the rotation performed using Varimax with the Kaiser normalisation method. (Data in bold indicate the dominant factor loadings.) Overall, seventeen (17) factors were extracted from the principal components. These factors were extracted and adopted for further analysis, since they have factor loadings that were not less than 0.5 after rotation of the component matrix was performed. Therefore, type of building (0.679), age of organisation (0.759), location of organisation (0.559) and number of floors (0.538) were factors that loaded into the first component. Loaded into the second component were savings on maintenance costs

(0.717), energy efficiency (0.698), efficiency of building services equipment (0.842) and high implementation cost. For the third component, friendly responsiveness to BMS on the environment (0.659), availability of local expertise (0.571) and management strategies (0.779) were loaded. Further, change in customer tastes, preferences and style (0.730) and employee expectation (0.695) loaded into the fourth component. Low level of awareness (0.752) and lack of demand by building users or owners (0.678) loaded into the fifth component, while comfort and ease of using the system (0.558) and enhanced comfort for occupants (0.839) loaded into the sixth component. This result suggests that the variables in components 1-6 were adequately correlated with the underlying factors represented by each component.

Table 5: Rotated component matrix of correlations between components and factors influencing adoption of BMS in commercial buildings

Factors	**Components**					
	1	**2**	**3**	**4**	**5**	**6**
Savings on maintenance costs		**0.717**				
Energy efficiency		**0.698**				
Efficiency of building services equipment		**0.842**				
Comfort and ease of using the system		0.413	0.332			**0.558**
Changes in customer tastes, preferences and style				**0.730**		
Global competition	0.325	0.490				0.429
Employee expectation				**0.695**		
Enhanced comfort for occupants						**0.839**
Friendly responsiveness of BMS on the environment			**0.659**			
Provides safety and security	0.395		0.333		0.339	
Low level of aware ness					**0.752**	
Lack of demand by building users/owners	0.341				**0.678**	
Technical compatibility of BAS and user needs		0.359	0.475	0.348		
Availability of local expertise			**0.571**		0.398	
Type of building	**0.679**	0.303				
Management strategies			**0.779**		0.322	
Age of organi sation	**0.759**					
Location of organisation	**0.559**		0.398	0.341		
Number of floors	**0.538**		0.335	-0.332		
High implementation cost		**0.687**		0.437		

Factors that loaded highly into components 1-6 were assigned unique names as shown in Table 6. Factors that loaded into components 1-3 were named organisational, cost and efficiency, and environmental factors respectively. Factors that loaded into the fourth, fifth and sixth components were customer expectation, awareness, and social factors respectively. These factors undergirded the variables in each of the six components. Figure 2 shows the various factors that were loaded into the six components.

The underlying factors were further subjected to descriptive statistical analysis. The results of the

mean item scores for these factors are presented in Table 6. The social factor (MIS = 3.65, SD = 0.992) ranked highest among the factors influencing adoption of BMS facilities in commercial buildings in the study area. The awareness factor (MIS = 3.55, SD = 0.884) ranked next, while customer expectation (MIS = 3.51, SD = 0.927) ranked third. The organisational factor (MIS = 3.32, SD = 0.861) ranked lowest. As the results show, the social, awareness and customer expectation factors were significant in influencing the adoption of BMS facilities in commercial buildings in the study area. This finding is similar to Wambui (2014), in the Kenyan context. About 88.3% of the respondents ranked comfort and ease of the system (social factor) as the highest. Regarding the overall opinion of the professionals, 91.7% suggested the need for more awareness as well as public enlightenment and advertisement on the benefits of BMS. Kim et al. (2007) found that social factors and customer habits have a positive impact on the adoption of smart devices.

Clearly, therefore, a major reason for BMS adoption is the comfort it provides; most technological innovations in buildings are meant to offer a more comfortable environment for occupants as a way to enhance productivity and promote a sustainable environment (Awosode, 2018). Thus, BMS is embraced by professionals in the built environment because it offers comfort, sustainability and energy efficiency.

The level of awareness of building owners on the benefits of BMS was also a factor influencing its adoption. Awosode (2018) identified level of awareness of green building technological devices as one of the significant factors that enhance their adoption. Customer taste and expectations are also leading factors influencing BMS adoption, since commercial buildings are competitive and their owners are profit-oriented.

Table 6: Interpretation of component factors influencing adoption of BMS in commercial buildings workers

Component Factors		**Factors (Interpretation)**	**MIS**	**SD**	**Rank**
1	Management strategies	Organisational	3.32	0.861	6th
	Age of organisation				
	Location of organisation				
	Number of floors Type of building				
2	Savings on maintenance costs	Cost and efficiency	3.38	0.909	5th
	Energy efficiency				
	Efficiency of building services equipment				
3	Friendly responsiveness of BMS on the environment	Environmental	3.40	0.883	4th
	Availability of local expertise				
4	Changes in customer taste, preferences and styles	Habit	3.51	0.927	3rd
	Employee expectation				
5	Low level of awareness	Awareness	3.55	0.884	2nd
	Lack of demand by users or owners				
6	Comfort and ease of using the system	Social	3.65	0.922	1st
	Enhanced comfort for occupants				

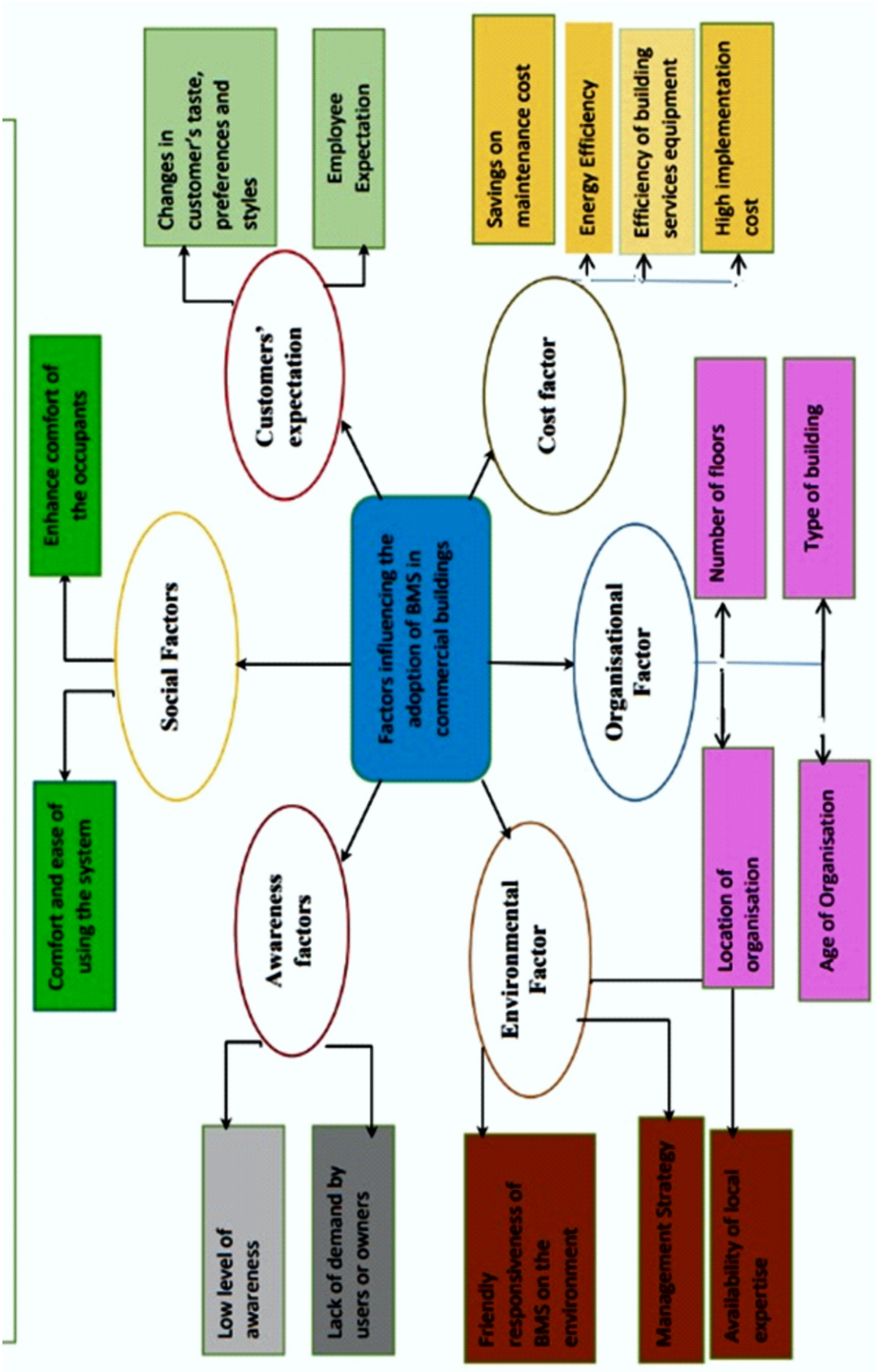

Figure 2. Model for Factors Influencing the Adoption of BMS in Commercial Buildings

Influence of Factors Motivating Adoption of BMS Facilities in Commercial Building Types on its Level of Adoption in the Study Area

Using multiple regression analysis, the researchers also examined the extent to which the factors motivating adoption of BMS facilities in commercial buildings influences their level of adoption in the study area. Factors influencing BMS adoption and the level of adoption constituted the independent and dependent variables respectively. At a 0.05 level of significance, we tested the null hypothesis:

> *Factors influencing the adoption of BMS facilities in commercial buildings will not have a significant influence on their level of adoption.*

With the multiple correlation coefficient (R) of 0.409 as indicated in Table 8, a good level of prediction of the level of adoption of BMS facilities and its influencing factors is suggested. A coefficient of multiple determinants (R^2) of 0.167 shows that 16.7% of variance in workplace violence can be explained by the influencing factors. This suggests that 16.7% of cases of BMS adoption in commercial buildings is attributed to the factors influencing its adoption.

F(6, 54) = 1.810 and p = 0.114 shows that the multiple correlation coefficient (R) is not statistically significantly different from zero. To determine the extent to which the factors influencing adoption of BMS facilities in commercial buildings influenced their level of adoption, their regression coefficients were further considered.

Regression coefficients 0.308, 0.176, 0.142, 0.036, -0.001 and -0.020 for cost and efficiency, as well as environmental, social, organisational, customer expectation and awareness factors respectively, as presented in Table 7, shows how the magnitude of effect of one factor varies from another. The cost and efficiency factor shows more influence on the level of adoption of BMS in commercial buildings in the study area than the other factors. Similarly, the environmental factor shows a stronger influence on the level of adoption of BMS in commercial buildings, in comparison to other factors. Therefore, given the regression coefficient of cost and efficiency factor, for instance, a unit change in cost and efficiency of a BMS facility, while keeping other factors constant, will yield a 0.308 change in its level of adoption. The result also shows that the cost and efficiency factor is the only factor with a regression coefficient (B) that is statistically significantly different from zero (p value = 0.018). Therefore, the null hypothesis is rejected for the factor, while the null hypothesis is accepted for the social, organisational, awareness, environmental and customer expectation factors (p values were < 0.05). The cost and efficiency factor showed a good level of significance across building types, since it is one of the major reasons why managers accept or decline adoption of BMS. There is either a setback on the implementation cost, as found by Johan and Rasmus (2012) on a hospital complex in Stockholm, or there is motivation to adopt the system because of future cost benefits and energy savings, as concluded by Kamali et al. (2014) on an office building in San Francisco, USA. The cost factor was also discovered by Awosode (2018) to have a strong influence on the adoption of automation in the facility management of high-rise buildings.

Table 7: Regression model for factors influencing adoption of BMS in commercial buildings

Model		S.E	B	Sig.	Df	R	R^2	F	P
								ANOVA	
	(Constant)	0.079		0.000	6	0.409	0.167	1.810	0.114
	Organisational	0.072	0.036	0.780	54				
	Cost and efficiency	0.069	0.308	0.018					
	Environmental	0.082	0.176	0.179					
	Customer expectation	0.075	-0.001	0.993					
	Awareness	0.069	-0.020	0.874					
	Social	0.078	0.142	0.262					

5.0 Conclusion

This study identified and examined the potential factors influencing adoption of BMS in Lagos State commercial buildings. It was found that facility managers attested to the high significant level of social factors (e.g., level of comfort derived and ease of use of the system) as well as awareness and customer expectation factors. The cost factor was found to show the strongest influence on the adoption of the system in the study area. Those who adopted BMS did so based on considerations such as savings on cost, profit maximisation, efficiency of building services appliances and savings on energy costs. Managers of facilities that are yet to adopt the system cite its high implementation cost. Against this backdrop, the study recommends creating motivating schemes to encourage adoption of BMS for government and business facilities. It is also suggested that there should be public enlightenment on BMS contributions to achieving resilience through energy efficiency in the built environment.

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Urban Fragility and the Aspiration for a Resilient City: Some Reflections on Jos Metropolis, Nigeria

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Abstract

Urban fragility is a phenomenon that is conditioned by an accumulation of risks factors leading to crises, disruptions and destructions of varying scales in urban areas. Urban resilience seeks to mitigate fragility or counter its effects. It is on this theoretical footing that this empirical study is conducted in Jos metropolis in north central Nigeria, a location that has over the years accumulated devastating risks factors in spite of efforts to achieve resilience. Accordingly, the study undertakes an analysis of the scale of urban fragility along with the initiatives taken to improve resilience and mitigate the effects of fragilities in Jos metropolis. To this end, a wide range of secondary source material pertaining to nature and sources of fragilities and their impacts on humans, properties and supply of services was collected and combined with observations and lived experience for critical analysis. The analysis confirms that locational exposure of Jos to natural disasters in form of rainstorms and flash floods, as well as the absence of mitigation strategies, was responsible for fragilities leading to deaths, loss of property and disruptions of the supply of utility services on a seasonal basis. Other fragilities resulting from poor local governance, environmental degradation and overstretching of resources also produce environmental and socioeconomic impacts. It is concluded that human activities and the absence of adequate regulations at the city level expose the urban population to hazards. Further analysis suggests that resilient initiatives were tailored at improving urban governance, the institutional framework and the legal as well as regulatory mechanisms. While these efforts quite aligned with resilient intentions, they were, however, affected by inconsistencies and delayed implementation. Appropriate recommendations for upturning this situation in Jos metropolis are offered in the study.

Keywords: Aspiration; Jos metropolis; Resilient city; Urban fragility; Urban resilience

1.0 Introduction

Fragility has multiple connotations and in this study it is conceptualised in three-folds: one, it describes those threats to human lives that are largely environmental, economic, social and political in nature; two, it describes volatility of communities to natural or human induced shocks and the capacity of state institutions to deal with those shocks; and three, it refers to the level of weakness,

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sensitivity or disruptibility of a community or state institutions in the face of either natural or human induced threats (Bosetti, Ivanovic & Munshey, 2016). In the urban context, fragility is viewed as a major challenge because cities are faced with growing pressures from the environment and rising tensions from social systems (Trovato, 2022). Fragility is conditioned by an accumulation of risks, with its intensity varying considerably across time and location. While some locations are subject to moderate fragility, others experience acute fragility to the point of collapse. Fragility affects small and big cities; as such, it is a challenge for both developing and developed cities (Muggah, 2016).

The idea of urban resilience resulted from growing concerns about urban fragilities and the need to mitigate risks, ameliorate stresses and shocks or even adapt to or transform fragile conditions into resilient ones (Shamsuddin, 2020). Resilience is the capacity of a system to continue functioning through adaptation and transformation when under stress (Flax et al., 2020). Accordingly, the concept of resilience has become relevant in the context of strengthening and improving systems, especially within the realms of disaster risk reduction, climate action and urban development (Flax et al., 2020).

This article provides a context-specific analysis of the sources of fragility and the aspirations for resilience in Nigeria's Jos metropolis of Plateau State, a location that has over the years accumulated risk factors that have continually devastated it in spite of government's efforts to achieve stability. The overall aim of the study is to undertake a context-specific analysis of the scale of urban fragility in Jos metropolis while also highlighting the initiatives taken by the city's authorities to improve on urban resilience and to mitigate the effects of fragilities. This aim is addressed by two broad objectives. Firstly, the scale of urban fragility in Jos metropolis is analysed. Secondly, the initiatives taken by city authorities to improve urban resilience and mitigate the effects of fragilities are scrutinised.

2.0 Literature Review

The concept of urban resilience has received considerable academic attention, hence the presence of numerous definitions and strategies on it in the literature. Despite the heterogeneity in the characteristics and definitions of urban resilience, consensus appears not to have been reached. This has led to the depth and breadth of urban resilience research being expanded and shifted from theoretical exploration to practical application. Consequently, the multidimensional nature of urban resilience has been recognised and indicators covering a wide variety of issues have been proposed, including self-help and state action (Kong et al., 2022). For instance, cities have stayed fragile because of limited government attention to improving infrastructure and a lack of commitment to assist vulnerable urban communities to build resilience to natural shocks. Nevertheless, urbanisation and competition for scarce resources and basic infrastructure have been on the increase, thus hampering the capacity of urban communities and government to cope with shocks and stress (Nop and Thornton, 2019).

The Intergovernmental Panel on Climate Change (IPCC, 2014) defined resilience as:

> *"the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation."*

Urban resilience has also been defined as:

> *"the ability of an urban system and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (Meerow et al., 2016:45).*

Meerow et al. (2016) note that "urban resilience" manifests as an urban system that can maintain

or rapidly return to desired functions in the face of a disturbance or that can adapt to change and quickly transform social and ecological systems that limit current or future adaptive capacity. This has hardly been absolutely obtainable in any city or urban system, hence the need for further efforts towards attaining urban resilience.

Urban resilience is highly dependent on socioeconomic development and urbanisation. Nop and Thornton (2019) suggested supporting livelihood improvement programmes, addressing land tenure insecurity and improving basic infrastructure in informal settlements in order to attain urban resilience, since these factors play a role in issues of urban fragility (Avis, 2016). Despite widespread efforts at curbing urban fragility through the creation of urban resilience, as noted in the introduction, there is still no universal solution, as underdeveloped, developing and developed cities have all been found to experience some level of fragility (Heinzlef et al., 2020). Strategies for building urban resilience in cities have been found to include analysing the benefits of the diagnostic phase of resilience planning, evaluating resilience goals to determine the most responsible stakeholders, understanding local barriers, identifying the need for trade-offs and adopting a broad systems approach (Fastiggi et al., 2021). More recently, however, Chen et al. (2022) found that even cities with many similar characteristics have different elements of attention for enhancing urban resilience owing to their differing priorities, economic development and governance backgrounds, hence our context-specific investigation of Jos metropolis.

Muggah (2016) identified the risk factors shaping urban fragility, including rapid urbanisation, income and social inequality, youth unemployment, homicidal and criminal violence, and climate threats. In addition, Avis (2016) attributed urban fragility to the failure of authorities to deliver basic services as well as to inaccessibility of basic services by the urban poor. Furthermore, a recent report (Corral et al., 2020) indicates that conflict situations are a major catalyst for fragility and that the prevalence of fragile and conflict-affected situations are on the rise. The report also confirmed that fragility and conflict-affected situations are the main reasons for the rise in global poverty. The study estimated that up to two-thirds of the global extreme poor would be living in fragile and conflict-affected situations by 2030. It is sadly noted that 43 countries with the highest poverty rates are in fragile and conflict-affected situations, and that most of these countries are in Sub-Saharan Africa. Therefore, it is advocated that global attention should be given to fragility and conflict in order to eliminate global poverty and create liveable spaces.

The literature on urban resilience reveals an important gap in terms of implementation of resilient strategies. Extant proposals on how to make cities resilient include the International Strategy for Disaster Reduction (UN/ISDR, 1999), the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR, 2015) and the UN office for Disaster Risk Reduction (UNIDR, 2017). These proclamations provide strategies and essentials for making cities more resilient, especially since they are meant to guide local government leaders. However, scholars such as Bush and Doyon (2019) and Shamsuddin (2020) have raised concerns over the challenge of implementation. Shamsuddin (2020) identified the fuzziness of the concept of urban resilience as well as the multiplicity of issues involved, leading to difficulty in its implementation. In addition, Shamsuddin observed that urban resilience implementation requires authorities to establish where implementation begins and ends, what to include or exclude, how to coordinate both government and non-governmental organisations, as well as how to adapt to changing socioeconomic and political conditions. These are critical implementation challenges that deserve academic attention. Furthermore, it is only through context-specific analysis that a location's resilience may be determined in relation to its fragilities. Accordingly, there is need for more context-specific analysis of urban resilience policies and their implementation.

3.0 Methodology

The data for this study was collected from Jos, the capital city of Plateau State. The study

adopts a multi-method approach involving use of documentary evidence, observations and the lived experiences of the researchers. Multiple methods may prove quite useful toward gaining a rich understanding of a complex phenomenon (Roller & Lavrakas, 2015) such as the idea of urban fragilities.

The record of documentary evidence collected, their sources and date of publication are outlined in Table 1. In all 12 newspapers (published between 2015 and 2021), one press statement (issued in 2022), and two news commentaries (published in 2012 and 2018 respectively), and three publications of the Plateau State Government were collected for analysis. The documents were sourced from the websites of their publishers during internet search starting from March 2022 to June 2022.

Table 1: Types and sources of documentary evidence used

Type of data	Source of data and publication date /date collected
Newspapers	Blue Print, 2016, April 5 Daily Trust, 2015, Jul 15 Daily Trust, 2019, July 3 Daily Trust, 2020, October 16 Daily Trust, September 5, 2018 Herald, 2019, July 11 Premium Times, 2015, September 29 Sundiata post, 2020, March 12 The Guardian, 2018, July 21 Vanguard, 2012, July 24 Vanguard, 2021, August 25 View Point, Nigeria, 2018, June 3
Press Statement	University of Jos, 2022, April 24
News Commentaries	BBC New, 2012, July 24 NAN, 2018, July 21
Documents from Plateau State Government	Statistics of conflicts in Plateau State (March 2022) Project executed by Plateau State Government (March 2022) Activities of Ministries, Departments and Agencies (March 2

Source: Author's compilation (2022)

The documents collected were subjected to content analysis. In this respect the focus was on the occurrences of rainstorms, flash floods, deaths recorded, quantum of property destroyed, and the interruptions to utility services in Jos metropolis. Others aspects of the analysis covered vulnerability, local governance, environmental degradation and its attendant consequences, and the resilient initiatives introduced by the authorities in Jos. The content analysis of the documents was enriched with data collected from observations for the discussion. Finally, the bits of evidence were triangulated before conclusions were reached. The results of the analysis were tabulated for easy visualization and reference.

4.0 Results and Discussion

4.1 The Scale of Urban Fragility in Jos

The scale of urban fragility in Jos metropolis is discussed in this sub-section, which corresponds with the first objective as presented in the introductory section. Risks and fragilities can arise either from location and exposure to hazards or from increased vulnerability due to poor local governance, environmental degradation and the overexploitation of resources (UNDP, 2010). The data obtained and analysed confirmed two risk factors (as presented in Table 2) that are often triggered by location and exposure to hazards in Jos metropolis. One of the risk factors is rainstorm or windstorm, which usually occurs at the first rains of April and May, and lasts all through the rainy

season. In the last decade, for instance, there were four occurrences of rainstorms and windstorms that caused different scales of destruction in Jos metropolis as shown in Table 2. Jos is considered a fragile city, given its exposure to these weather events. Furthermore, the location is susceptible to flash flooding that happens occasionally as a result of heavy rains causing overflowing of dams around Jos (a situation worsened by lack of drainage for rainwater). As outlined in Table 2, four incidences of flash flooding were recorded from 2012 to 2021 and these led to loss of property and human lives, as well displacement of settlements and interruption of livelihoods.

As seen in Table 2, rainstorms, windstorms and flash flooding have devastating effects on Jos metropolis. It is therefore surprising that local authorities have continued to ignore forecasts and warnings from the Nigerian Metrological Agency (NiMet) and the Nigeria Hydrological Services Agency (NIHSA), especially when such warnings affect Jos in particular and Plateau State in general (Yakubu & Eromosele, 2021). Thus, absence of local action in Jos is one of the reasons why rainstorms and flash floods have claimed lives and caused wanton destruction of property (see Table 2).

Table 2: Risks and Fragilities Arising from Location and Exposure to Hazards in Jos

Risks and Fragilities	**Recent Timelines**	**Impact**
Rainstorm and Windstorm usually at the inception of rains and through the rainy season	September 2015	Unrecorded deaths and injuries; power lines, vehicles and billboards destroyed; electricity and businesses interrupted; and unrecorded human settlements temporarily displaced (Ajijah, 2015)
	July 2017	Two deaths recorded, unrecorded houses destroyed and businesses interrupted ("Plateau: Rainstorm Kills 2", 2015)
	August 2018	Damage to electricity installation caused power supply interruption for Jos Electricity Distribution Company (JEDC) for several days ("Windstorm: Power Restoration", 2018)
	April 2022	Damage to public buildings and facilities (University of Jos, 2022)
Flash flood as a result of heavy rain lasting several hours, overflowing of dams, and lack of rain water drainage	July 2012	35 deaths, 200 houses destroyed, and 3,000 people left homeless (Obateru, 2012; BBC, 2012).
	July 2015	Unaccounted number of houses flooded ("Plateau: Rainstorm Kills 2", 2015)
	July 2019	Three deaths, nine houses destroyed and several flooded ("Flood Kills Family of 3", 2019)
	August 2021	Unaccounted number of houses destroyed or flooded (lived experience)

Source: Authors' compilation (2022)

As noted already, certain risks and fragilities arise from increased vulnerability due to poor local governance, environmental degradation and overstretching of resources. These findings suggest a need for authorities in Jos to develop an early warning system for natural and human-made disaster as it obtains elsewhere for example, in Pakistan (Mukhtar, 2018) and Jordan (Momani & Alzaghal, 2009), where governments have developed early warning systems for use at the city level. Broader examination of the literature (see Suárez et al. 2016; Zheng et al. 2018) suggests that city-level solutions, which are evidently lacking in Jos, are crucial to building city resilience. In building urban resilience, there is also a call (Rogers & Tsirkunov, 2011) for the adoption of people-centred early warning systems that incorporate risk knowledge, monitoring and warning service, dissemination and communication, and response capability. These are important aspects that city authorities in Jos need to pay attention to in order to realise the aspirations for a resilient city.

The information presented in Table 3 suggests that poor local governance alone is a major reason for lack of urban resilience in Jos. The evidence proves that poor local governance has consequences for urban resilience in Jos, including inadequate fire safety arrangements, poor enforcement of planning standards, ethno-religious conflicts, urban crime, inadequate electricity supply, poor enforcement of building regulations, and weak enforcement of traffic regulations. These failures have continuously produced a wide range of impacts as highlighted in Table 2.

Table 3: Vulnerability due to Poor Local Governance, Environmental Degradation and Overstretching of Resources in Jos

Sources of Risks and Fragilities	**Outcomes**	**Impact**
Vulnerability due to Poor Local Governance	Inadequate fire safety arrangement (NAN, 2018; Ozigis, Gajere, Emmanuel & Hyelpambuwa, 2013)	Incidence of fire disasters leading to deaths and loss of properties
	Poor enforcement of planning standards (Dung-Gwon & Jugu, 2017)	Unplanned settlements; overcrowded homes; fire disasters; and erection of buildings on surface and storm water drains
	Ethno-religious conflicts (PPBA, 2021)	Killings; destruction of properties; loss of social cohesion and city balkanization
	Gang rivalry and violence (Odey, 2016)	Killings; interruption of economic activities; theft; loss of nightlife
	Inadequate electricity supply, maintenance of installations, and surveillance *(Observation)*	Power outages; unauthorized electricity connection; deaths arising from electrocutions; vandalism of installation
	Ineffective healthcare system	Poor management of epidemics (Lassa fever, Cholera, COVID, etc.)
	Poor municipal waste management (Peter, 2016)	Uncontrolled discharge of waste; unpleasant odour, poor sanitation conditions
		Indiscriminate dumping of refuse, unpleasant odour; contamination
	Urban crime (Bako, 2018)	Armed robbery and theft
	Poor enforcement of building regulations (*Observation)*	Incidences of building collapse; substandard construction
	Weak enforcement of traffic regulations (*Observation)*	Traffic congestion; road traffic accidents
	Inadequate water supply (Agas, 2019)	Poor sanitation and hygiene conditions; outbreak of epidemics
	Inadequate road network (Oluwole, 2014)	Road traffic accidents; traffic congestions; loss of productive time
Vulnerability due to Environmental Degradation and Overstretching of Resources	Increase in urban population (PPBA, 2021; Akintunde, Adzandeh, & Fabiyi, 2016; Ryeshak et al. 2015)	Pressure on natural resources; over-exploitation of trees (for timber and heating), soil, stones, underground and surface water; destruction to environment during extraction and utilization; urban sprawl; deficiencies in delivery of basic services
	Deforestation and absence of afforestation programs (Agas, 2020)	Loss of vegetation; environmental erosion, damage to ecosystem; biodiversity loss; animal extinction
	Landfills	Reclamation of mining for use as building land; filling of ponds with wastes that contain hazardous chemicals; contamination of land and water bodies
	Absence of clean energy sources; Inadequate electricity supply and failure to develop renewable energy alternatives *(lived experience)*	Excessive emission of carbon monoxide from power generators and noise pollution; rising carbon emission from use of charcoal, firewood and kerosene for heating; air pollution

Source: (Authors' compilation, 2022)

4.2 Resilient Decisions and Actions in Jos

This sub-section addresses the second objective of the study, which seeks to establish progress, gaps and lapses in building resilience for Jos metropolis. Consequently, the analysis focuses on decisions and actions relating to the idea of resilient cities as documented by Shamsuddin (2020) and Meerow et al. (2016). Table 4 provides an outline of the thematic areas in which resilient actions and decisions are evident in Jos, one of which is disaster preparedness and prevention. Because this is a priority area, government has paid attention to it by establishing an agency corresponding with one at the federal government level. Similarly, conflict management and prevention has received due attention. As at the time of the study, the agency was implementing a strategic action plan that was formulated in 2018. However, there are no similar arrangements at the local government level, a situation that makes the task of peace building more difficult for the Plateau Peace Building Agency.

Another area of significant action concerns efforts made to strengthen the institutional framework for environmental protection and the management of natural resources, although there is inconsistency in the execution of plans and programmes. Examples include abandonment of the tree-planting scheme/campaign (Agas, 2020) and the failure to reclaim mining ponds while curbing further land degradation as a result of artisanal mining activities within and around Jos. Regarding critical infrastructure and services, some roads and overpasses are visible, as well as donor intervention in micro-infrastructure. These, however, are only made possible through huge domestic and foreign loans that are often poorly applied in the face of criticism for raising the state's debt profile. This is a potential threat to the sustainability of governance.

Currently, a robust institutional and legal framework exists for urban planning, development control and housing, as indicated in Table 4. Nonetheless, coordination is lacking in the area of urban planning and enforcement of building regulations. The Sendai Framework for Disaster Risk Reduction (UNISDR, 2015) particularly emphasised the need for coordination in building a resilient framework. However, successive governments have not managed to provide affordable housing in Jos. Taken together, these factors have exacerbated vulnerabilities for residents, thus exposing them to varying kinds of risks as observed in preceding discussions (see Tables 2 and 3). On a positive note, however, the ongoing transition to petroleum cooking gas, is quite commendable as far as the use of clean energy is concerned. Similarly, urban agriculture is gaining currency in Jos, thereby adding to the environment's green cover while also contributing to food sustainability. It also promotes waste recycling, as farmers use organic manure on their gardens (Wuyep, 2021). Moreover, more green spaces are emerging from private investment in commercial parks and gardens, bringing with it eco-friendly benefits. No doubt, these practices drive urban resilience for the city of Jos.

Table 4: Outline of Resilient Actions and Decisions in Jos

Thematic Areas	Decision and Action
Disaster preparedness and prevention	Emergency management agency created in 2012 for the purpose of building a culture of preparedness, prevention, response and community resilience to disaster (Plateau State Government, 2021a)
Conflict management and prevention	Peace building agency created 2015 and saddled with the responsibility of nurturing and promoting mutual trust (Plateau State Government, 2021a)
	Peace building agency formulated a roadmap for peace/strategic action plan from 2018 – 2022 (Plateau State Government, 2021a)
Strengthening Institutional Framework for Environmental Protection and natural resource management	Ministry of Environment was established in 1999 with a mission to preserve and protect the environment from both natural and human-made disaster
	Ministry of Mineral Development created in 2009 with a mission to regulate and coordinate mineral extraction and reclaim 4000 mining ponds that are scattered in and around Jos for economic use (Plateau State Government, 2021a)
	Environmental protection and sanitation agency established and saddled with the responsibility of ensuring safe, clean and orderly environment, and keeping the ecosystem at a state of equilibrium for healthy human habitation
	Ecological master plan developed in 2010 (Plateau State Government, 2021a)
	Annual tree planting campaign reintroduced as part of efforts to check deforestation (Agas, 2020).
Critical urban infrastructure and basic services	Community and Social Development Agency created in 2009 to implement a World Bank assisted community and social development program
	Beginning from year 2000, massive urban road infrastructure projects embarked upon, focusing on road expansion, road resurfacing, construction of storm drains and drainages, construction flyover bridges, solar power street lighting project (Plateau State Government, 2021b)
	Universal health coverage scheme introduced for state and local government workers (Plateau State Government, 2021a)
	Dredging and expansion of Dams, expansion of pipeline network for treated water, construction of new reservoirs for treated water.
Urban Planning, Development control and housing	Greater Jos Master was updated in 2009. Geographic Information System created
	Several agencies including Ministry of Lands & Survey, Ministry of Physical Planning, Ministry of Housing & Urban Development, Ministry of Works, and the Jos Metropolitan Board have been in existence and are saddled with statutory responsibilities (Plateau State Government, 2021a)
Use of clean energy as source of heating	Households are gradually shifting from the use of fossil fuels to liquefied petroleum gas, which is a clean cooking fuel (*observation and live experiences*)
Urban Agriculture and Green landscaping	Urban agricultural in Jos is increasing cover and recycling of waste as organic manure is utilised in growing plants (Wuyep, 2021; "How Jos Residents", 2020). Green spaces are increasing owing to private investment in commercial parks and gardens, which have eco-friendly benefits (*observation and lived experiences*)

Source: Authors' Compilation

5.0 Conclusion

This study analysed the scale of urban fragility in Jos metropolis and the initiatives taken by city authorities to boost its resilience status while mitigating the effects of fragility. To this end, the first line of analysis focused on the scale of urban fragility in Jos metropolis and the findings revealed two phenomena of concern. One, seasonal rainstorms and windstorms alongside flash flooding arising from heavy rains, dam overflows and lack of drainage channels are important

sources of risks and fragilities in Jos. These fragilities were found to account for human deaths, loss of property and disruptions to the supply of utility services on a seasonal basis. Consequently, it is concluded that the locational exposure of Jos city to natural disasters, coupled with poor natural disaster mitigation arrangements, is responsible for the risks and fragilities experienced on a seasonal basis. Two, further analysis reveals other dimensions of fragilities resulting from poor local governance, environmental degradation and overstretching of resources. These fragilities often produce a wide range of environmental and social impacts, including poor urban planning, shortage of infrastructure services and loss of vegetation, among others. It is concluded that human activity and the absence of regulations on the local scale combine to produce risks and fragilities that make urban populations vulnerable.

The second objective was concerned with the initiatives taken by relevant authorities to improve on urban resilience and to mitigate the effects of fragility. The analysis suggests that the actions and decisions of government aimed to improve the governance of resilience, the building of institutional frameworks and the formulation of legal and regulatory frameworks. While these efforts are consistent with resilient thinking and intentions (UNISDR, 2015), the initiatives were affected by inconsistencies despite strident calls (see UNDP, 2010; UN/ISDR, 1999; and UNISDR, 2015) for countries and their cities to adopt frameworks for disaster risk reduction and mitigation. This is an aspect that needs attention by Jos authorities in view of the recurrence of seasonal natural disasters in the city.

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