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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
[illegible]	.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	[illegible]
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
[illegible]	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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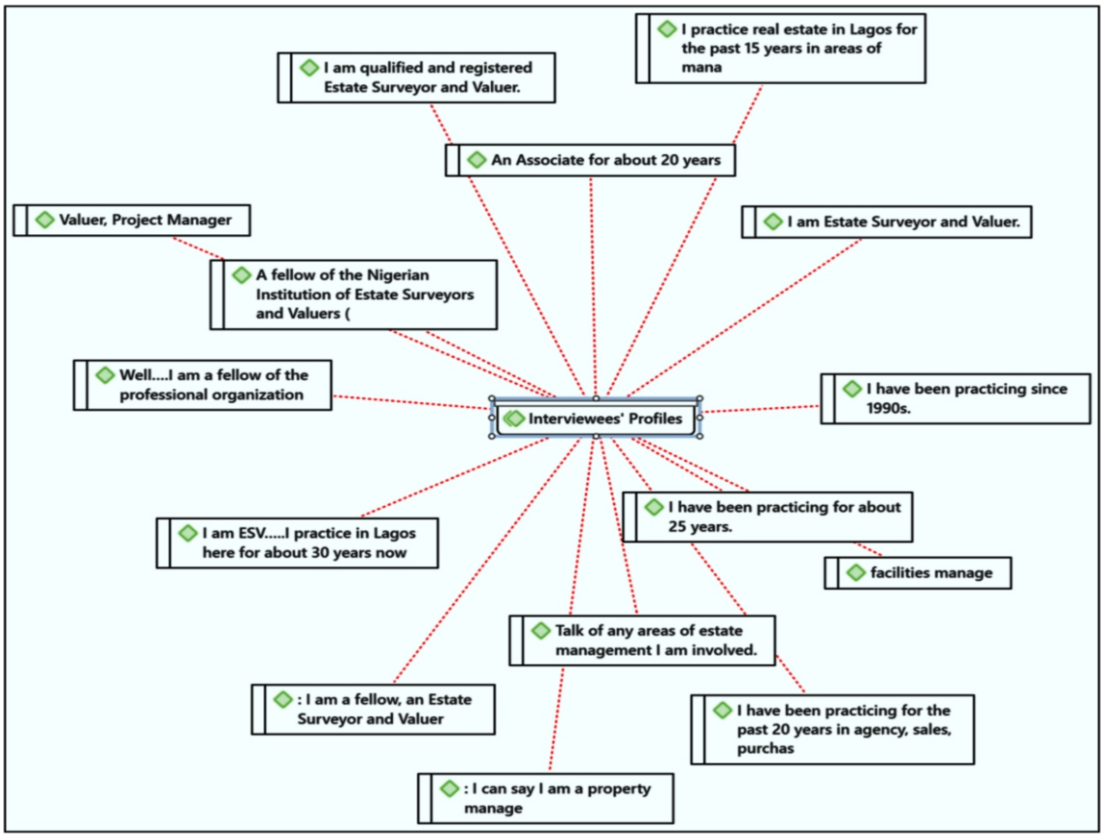
APPENDICES

Appendix 1



Appendix 2