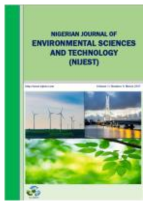
Nigerian Journal of Environmental Sciences and Technology (NIJEST)
www.nijest.com
ISSN (Print): 2616-051X | ISSN (electronic): 2616-0501
Vol 3, No. 1 March 2019, pp 30 - 40



Residents' Awareness and Aspiration for Smart Building Features: The Case of Okota, Lagos, Nigeria

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ABSTRACT

The study investigated the level of awareness and aspiration of residents for smart building features in Lagos, Nigeria. This is with a view to determining the extent of residents' level of familiarity and desire for smart homes in the country. Questionnaires were administered on 586 residents selected through systematic random sampling technique in the study area. Having identified the major streets in the study area, the first building along the major streets was selected randomly and every fifth building formed the subsequent unit of study. Data were analyzed with the use of frequency distribution, percentages, and measures of residents' aspiration index. The results showed that the awareness of smart building technologies was just fair in the study area as almost half of the respondents (49.21%) were not aware of smart building features. The results also indicated that internet facility ranked highest as the medium of awareness for the residents who were aware of smart building features. It was revealed that the aspiration of the residents for smart features was above average (2.98 on a five-point scale). The results showed that the features mostly aspired were features relating to "security and safety" (CCTV, Intrusion detection system and fire detection and alarm), while those relating to building maintenance (Moisture and humidity sensor and building performance analytic devices) were the least category of smart features desired.

Keywords: Energy efficiency, Facility management, Satisfaction, Security, Smart building, Smart features

1.0. Introduction

The growth in recent years in popular interest in smart building globally has been substantial. The concern has been driven largely by technological advancement and the quest for a safe, energy efficient and sustainable environment (Sinopolis, 2010). The need to incorporate smart features in real estate development is of utmost importance particularly in developing economies that are confronted with severe environmental challenges. Insecurity and energy crisis which are prevalent in most parts of the world could be alleviated by incorporating smart features in buildings.

In order to mitigate the severe environmental problem that has impeded economic growth and development in developing countries, adopting smart technology becomes imperative. The benefits of incorporating smart features in building design are enormous. Smart buildings are designed to guarantee energy conservation; greater systems' functionality; security of lives and properties, and health and productivity of the occupants (Sinopolis, 2010; Buckman *et al*., 2014). However, barriers to development and investment of smart building particularly in Nigeria and other emerging nations are numerous. The most critical constraint to investing in smart is perhaps the knowledge gap. To date, there is dearth of studies outside the developed economies on smart buildings. This makes developers, investors, government and even NGOs hesitant in the agitation and formulation of policies relating to the development of smart buildings.

It is in the context of the foregoing that information on the residents' awareness and inclination for smart homes especially their degree of preference for specific features of smart building is particularly important in overcoming many of the constraints to smart building practices. This study therefore will begin to fill this gap in literature by investigating residents' inclination for smart homes in an emerging economy with particular reference to Lagos, Nigeria. Such information is expected to assist developers/investors, investment advisers and managers in the planning and managing the supply of smart buildings. It is also expected that the study will provide useful information for foreign investors targeting Nigeria and other emerging economies.

Relevant studies have been carried out on smart building in developed and some emerging economies. However, such studies have received very insignificant attention in Africa countries. In the United Kingdom, Chapman and McCartney (2002) investigated the perception of people with physical disabilities with a view to identifying appropriate technology to generate energy efficient building. Using Portsmouth smart homes as a case study, the authors employed focus group discussion and in-depth interviews to establish how smart technology might boost independence and quality of life of people with disabilities. The result showed that the respondents desired a home that can respond to emergencies and environmental changes and that will not stand out from neighbouring properties. Meanwhile, the survey above was specifically targeted at people with physical disabilities and tailored towards their peculiar needs.

Ma *et al.* (2005) discussed the potential trends and challenges of smart technologies. The study posited that the future world would be highly computerized and transmuted to a smart world. The paper also suggested that challenges exist in translating ubiquitous things to smart world and trustworthy services owing to both technical and real world complexities. Apart from the fact that the study did not consider the aspiration of the users, the paper also lacked in empirical evidence.

Taylor (2006) examined the benefits that integrated systems offer facility managers and owners who sought to security and overall performance of building. The study revealed that there was innovative technology emerging in the security market that offered major improvement for facilities and security managers and end users. Sabha (2006) investigated the impact of embedded smart sensor (ESS) technologies on users' performance. The study discovered that ESS would have wide ranging effects on office users' productivity depending on the utility of space and internal environment. Apart from the fact that the study focused on a developed economy (UK), the study did not investigate the extent of users' aspiration for smart building technologies.

Kim *et al.* (2009) sought to identify security technologies that were essential in making home network systems secure. The research model was designed to support basic functions of smart security technologies. The findings revealed that home network users could access services conveniently and securely. The study also revealed that security policy for home network required specialized rather than general specification. Apart from the fact that only one attribute of smart building was considered, the perception of users was not considered.

Linskell and Hill (2010) illustrated how smart technology can enhance the provision of supported living for people with complex needs and challenging behavior. The authors adopted an informal semi-structured approach to review the effectiveness of technological solutions that had been employed and interview a range of staff from a number of projects. The study concluded that smart home technology had been demonstrated to be effective in providing information that assist in reducing the level of direct supervision of individuals with complex needs and challenging behaviour. Apart from the fact that the study was carried out in a developed economy where implementation framework exists for a smart building, the opinion of residents who are the users was not explored.
Kadaouche and Abdulrasaq (2012) proposed a novel model for inhabitant prediction in smart houses. The model was designed to learn users' habits when they performed their daily activities, and then predicts the user. The findings showed that the users could be recognized with high precision which imply that each user had his own way of performing the activities. Apart from the fact that the study focused on a more matured market, the survey was based on blind user recognition in smart homes to predict users without personal information.

Sidawi and Deakin (2013) evaluated the potential of smart city technologies to promoting healthy lifestyles for diabetic patients in the Kingdom of Saudi Arabia. The authors reviewed the link between diabetes, unhealthy lifestyles and built environments and found that smart technology that was being developed in Saudi Arabia did not highlight the health related benefits of their design and layout.

Foray (2014) focused on the difference between smart specialization and smart specialization policy by constructing a conceptual framework based on historical evidence. The paper highlighted important design principles for the policy process that should help to minimize potential risks of policy failure and policy capture. Flores *et al.* (2015) sought to design and test the effective indoor navigation solutions for visually impaired people utilizing internal measurement units, the compass and barometer of a smart phone. The study discovered the possibility of guiding visually impaired some hundreds of meters using sensors of a smart phones under certain conditions. Aside the fact that the study focused on a developed economy, the aspiration of the users for the technology was not investigated.

Arditi *et al*. (2015) examined the perspectives of constructional professionals of the various features of smart buildings with a view to developing an index of smartness. The findings indicated that the designers and owners were more focused on energy issue than constructors, and those professionals with less years of experience gave greater attention to the subject of energy. Though, the paper sought the opinions of some key stakeholders in the supply of smart products, the perception of users who are the key stakeholders in the demand side was not addressed.

Wong and Leung (2016) sought to identify factors driving senior citizens to adopt smart home technology that support ageing-in-place in Hong Kong. The study employed structural modeling approach and found that strong government support and efficient back up supporting service and the design of user interface devices were the major factors influencing the adoption of smart home technology. Cooper *et al*. (2017) developed a model to harness occupancy sensing in a commercial hot-desking environment. The authors employed data from a commercial office environment in London to feed a discrete event stimulator and showed that sensor data can be used for desk allocation in a hot-desking environment with results that outweighs the cost of occupancy detection. The study also demonstrated that overall productivity of occupants increased as individuals were allocated desk of their preference. However, the focus of the paper is on office environment and not residential property which is the subject of this study.

Some more recent works include Yang *et al*. (2017) proposed and validated a new theoretical model that extended the theory of planned behavior. The study identified mobility, security/privacy, risk, and trust in the service provider as the major factors affecting the adoption of smart home services. The study was carried out in South Korea, a country in Asia continent, where socio-cultural background is different from what obtained in Africa. Hence, the result from this study is not completely adaptable to regions of different socio-cultural background as Nigeria.

Rana *et al.* (2018) examined the barriers to the development of smart cities in India. The authors employed Analytic Hierarch Process technique and discovered that 'Governance' was the most dominant category of barriers affecting smart city development in India. Aside the fact that the study focused smart city and not specifically on smart building, the opinion of the users was not sought. The same argument can be said of Leung (2018) who investigated the hotel stakeholders' perspectives of smart technology with a view to identify gaps between academia and hotel industry in Taiwan. With a focus on definition, expectation and barriers to implementation of smart technology, the authors conducted interviews on investors, managers, owners, technology suppliers and IT consultants. The result of the analysis suggested that the definition of smart hotel was never the same among all stakeholders.

Relative to emerging economy, Gonel and Akinci (2018) explored the potential of ICT use on finding solution to environmental problems in Turkey. The study found that Turkey had an ability to monitor and control data and that smart building was becoming popular with the use of ICT. Although, the study was carried out in an emerging economy, the aspiration of the residents to employ smart technology was not investigated.

Bullie *et al.* (2018) investigated the correlation between the efforts of an employ to comply with security policy and vulnerability. The authors conducted a penetration test involving security locks in the context of building security and found that installing additional key activators was not conducive to reducing vulnerability of handing over of keys to strangers.

Dritsa and Biloria (2018) considered the role of emerging technologies in the promotion of health and wellbeing by examining various technologies associated with smart health care. Specifically focusing on smart cities, physical sensing systems and geospatial data, the result showed that though the technologies had been explored, there was little consideration on the transition from the domestic to urban level. Wilson *et al*. (2017) evaluated the risks and benefits of smart home in the United Kingdom. The authors conducted a national survey of 1025 home owners a field trial of 42 smart home technologies' (SHTs) users and 62 SHT marketing materials. The results showed that the respondents had a positive perception of SHTs while identifying certain risks in the area of 'ceding autonomy and independence in the home for increased technological control'. The analysis also showed that SHT industry was insufficiently emphasizing measures to boost users' confidence on data security and privacy. The study was carried out in a developed economy where structure for smart technology exists. Hence the result from the study may not be completely adaptable to a developing nation as Nigeria. The same can be said of Hargreaves *et al*. (2018) which explored the use of smart home technologies in Loughborough, England. The researchers conducted experiment on 10 households and found that the technologies were both technically and socially disruptive; requires both adaptation and familiarization and demanding and time consuming to learn. The study also showed that there was little evidence that smart technologies would generate substantial energy saving.

In summary, there is the dearth of studies on the users' perspectives on smart building in emerging economy as Nigeria. The study is therefore important, more so, the world has become a global village, and with the incursion of foreign investors in Nigerian real estate market, there is the need to probe into users' awareness and aspiration for smart building.

2.0. Materials and Methods

In investigating the residents' inclination for smart building, the paper focused on both renters and owner-occupiers of residential properties in Okota, Lagos state of Nigeria. The study area was restricted to Okota, Lagos owing to researchers' familiarity with the area purposely to enhance easy data collection and high level of response.

Owing to the absence of the list of houses and with the decision to sample 20% of the buildings in the study area, the systematic random sampling technique was adopted. Having identified the major streets in the area, the first building along the streets was chosen randomly and every fifth buildings formed the subsequent unit of study. Questionnaires were targeted at the household heads. However, where this was not possible, any other person who was not below the age of 18 was targeted. All households in the selected buildings were sampled. Thus, a total of 586 residents in the area were selected. Data on respondents' social economic characteristics, awareness and aspiration for smart building were elicited through structured questionnaire.

In order to develop the questionnaire (research instrument), the authors first carried out extensive literature review to identify twenty five features of smart building as listed in Table 1. The validation of these twenty five items was subsequently carried out considering the perception of experts who are operating in the country. In determining the suitability and appropriateness of the instrument, the questionnaire was given to academicians and practitioners for review. Once this was done, the questionnaire went through refinement process in line with the suggestions of the experts. Furthermore, personal interviews were conducted with some residents (potential respondents) in form of pilot survey to identify the suitability of the instrument and likely difficulties and issues which could affect respondent's ability to provide accurate answers. All experts and potential respondents agreed that all questionnaire items are relevant and offered constructive suggestions for improvement. As a result, minor revisions were made before the final data collection was undertaken.

The residents were asked to rate each of the features using Likert's scale of *highly inclined*, *inclined*, *somewhat inclined*, *not inclined*, or *not at all inclined.* During the analysis, these ratings were assigned weight values of 5, 4, 3, 2 and 1 respectively. The residents' aspiration index (RAI) for each of the variables was arrived at by dividing the summation of weight values ((total weight value)

(TWV)) by the total number of respondents. The TWV is the addition of product of the number of responses to each of the variables and the weight values attached to each rating (see Afon, 2007; Oyewole, 2010; Oyewole and Komolafe, 2018). The residents' aspiration index (RAI) thus ranged between values of 5 to 1.

Table 1: List of smart building features identified from the literature

Smart Building Features	References
Video Surveillance (CCTV)	Wong *et al*. (2008), Sinopolis (2016), Wong and Leung (2016), Fabi *et al*. (2016), Fabi *et al*. (2016), Bhati *et al*. (2017)
Intrusion detection system	Sinopolis (2016), Fabi *et al*. (2016)
Fire detection and alarm	Wong et al.(2008), Wong and Leung (2016), Fabi *et al*. (2016)
Smart thermostat	Sinopolis (2016), Kirkpatrick (2016), SMUD (2017)
Wi-Fi	Sinopolis (2016), Kirkpatrick (2016), SMUD (2017)
Water reclamation device	Sinopolis (2016)
Automatic lighting system	Wong et al.(2008), Kirkpatrick (2016), SMUD (2017), Bhati *et al*. (2017), Fabi *et al*. (2016)
Sensor operator water fixtures	Batov (2015)
Access control	Buckman *et al.* (2014)
Smart meter for monitoring and measuring power to the building	Batov (2015)
In-building cell phone	Sinopolis (2016), Fabi *et al*. (2016)
Devices that maintain building system	Sinopolis (2016), Fabi *et al*. (2016)
Rain water harvesting appliance	Sinopolis (2016)
Water meter	Batov (2015)
Audio-visual	Sinopolis (2016), Wong and Leung (2016), Bhati *et al*. (2017)
Devices that monitor building system	Buckman *et al.* (2014)
Telecom and data system for communication network	Sinopolis (2016), Wong and Leung (2016)
Smart trackers for house keys	Sinopolis (2016)
Meter for measuring usage, specific spaces, tenants or electrical circuits	Sinopolis (2016)
Asset location devices	Sinopolis (2016)
Smart locks	Sinopolis (2016)
Digital signage (LCD or plasma display)	Sinopolis (2016), Fabi *et al*. (2016)
Moisture and humidity sensor	Sinopolis (2016)
Building performance analytic devices	Sinopolis (2016), Fabi *et al*. (2016)
Fault detection and diagnosis for HVAC	Wong *et al*. (2008), Cole and Brown (2009), Fabi *et al*. (2016)

This is expressed mathematically as:

$$TWV = \sum_{i=1}^{5} P_i V_i \qquad (1)$$

where:
TWV Total weight value
P_i Number of respondents rating a feature
V_i Weight assigned to each feature *i*.

The RII to each feature is arrived at by dividing TWV by the summation of the respondents to each of the five ratings of a feature.

This is expressed mathematically as:

$$RAI = \frac{TWV}{\sum_{i=1}^{5} P_i} \qquad (2)$$

where:
RII Residents' inclination index

P_i and TWV as defined previously.

The closer the RAI of a feature to 5, the higher the assumed residents' inclination for the feature. The mean of the RAI distribution was also computed. Furthermore the deviation about the mean of each feature was also calculated to measure the scatter about the mean.

The total response rate was 254 residents out of 586 (43.34%). Though the response rate was not too impressive, it seems adequate particularly in exploratory research in built environment (Arditi *et al*. 2015), also in developing countries such as Nigeria where people's apathy to field research is noticeable (Olaleye and Adegoke, 2009). The 254 responses constitute a large enough sample that allows statistical inference and leads to logical conclusion, particularly because people from all works of life (public servants, private sectors employees, traders, owner-occupiers and tenants) were properly represented.

3.0. Results

In presenting the results of the survey, the paper first examined the socio-economic attributes of respondents and their level of awareness since housing need and requirement is a function of one's social economic status and level of awareness.

3.1. Residents' socio-economic characteristics

The result of the analysis on residents' socio-economic characteristics such as gender, age, educational qualification, accommodation status and types of accommodation, religion, occupational profile among others are presented below.

3.1.1. Gender distribution of the respondents

The result of the analysis shows that 170 (66.93%) of the respondents were males while 84 (33.07%) were females. The finding indicates that more males were household heads. This result however is not unexpected since the culture and the tradition of the people in this part of the world confers headship on males as the head of their respective families.

3.1.2. Age distribution of residents

The response on the question pertaining to the age distribution of the residents showed that 1.57, 1.57, 11.81, 15.75, 57.49 and 11.81 percent were aged between 18 and 19, 20 and 29, 30 and 39, 40 and 49, 50 and 59, and 60 and above respectively. The analysis indicated that majority of the residents who were household heads aged between 50 and 59 years of age.

3.1.3. Educational qualification and occupational profile of the residents

In order to ascertain the educational qualification of the respondents, questions were asked that require the respondents to indicate their highest educational qualification. The result showed that 0.79, 35.43 and 63.78 percent had primary, secondary and tertiary education, respectively. Given this outcome, one may conclude that the majority of the respondents were highly educated. The response on occupational profile showed that 33.86, 21.26, 24.41, 14.96, and 5.51 per cent of the respondents were public servants, private sector employees, traders, consultants, and artisans respectively. The result indicated that the residents of the study area cut across all occupations and professional affiliations.

3.1.4. Accommodation status and types of accommodation of residents

The study enquired into the accommodation status of the residents in order to know those who were owner-occupiers and those who were tenants. The result showed that 80 (31.5%) were owner-occupiers while 174 (68.5%) were tenants. This results suggests that majority of the respondents were tenants. The finding is not unexpected since majority of residents in Nigerian major cities could not afford to own their own house owing to the inaccessibility of institutional sources of housing finance to most Nigerian households (Onibokun, 1985; Oyewole, 2010). The finding revealed that 35.43, 26.77, 15.75, 12.60, 1.57, and 7.87 per cent of the respondents lived in Block of flats, Bungalow, Detached House, Duplex, Mansion, and Semi-detached House, respectively. Given this outcome, one may conclude that the study area houses low, middle and high income members of the society.

3.2. Level and medium of awareness of smart building

In order to ascertain the residents' level of understanding of smart building, questions were asked that required the respondents to indicate their level of awareness of smart building technology.

The findings as indicated in Table 2 revealed that 42 (16.49%) of respondents are very much aware of smart building; 87(34.25%) slightly aware and 125 (49.21%) not aware of smart building. This result showed that the level of awareness of smart building features was just fair as almost half of the respondents (49.21%) were not aware of smart building.

Table 2: Tenants' level of Awareness of Smart Building

Level of Awareness	Frequency	Percentage
Very much aware	42	16.49
Slightly aware	87	34.25
Not aware	125	49.21
Total	254	100.00

On the medium of awareness, the result as revealed in Table 3 shows that greater percentage of the respondents were aware of the smart technologies through internet. Specifically, the finding revealed that 37.11% were aware through internet, 28.56% through television, 8.56% through friends and relations, 10.31% through estate agents, 10.31 through journals, and 5.15% through radio. From this finding, it is established that residents who were aware of smart building technology knew mainly through the medium of internet. The result is not unexpected owing to the scarcity of smart buildings in the country, and the global connectivity of internet technology which is popularly embraced by the Nigerian populace.

Table 3: Residents' medium of awareness of smart building

Medium	Frequency	Percentage
Estate Agent	13	10.31
Internet Website	48	37.11
Friend/Family members	24	18.56
Television	24	18.56
Radio	7	5.15
Brochure	13	10.31
Total	129	100.00

3.3. Residents' aspiration for smart building features

The degree of importance placed on each of the features, denoted by Residents Aspiration Index (RAI), is presented in Table 4. Also shown in the Table is the average RAI denoted by $\overline{\text{RAI}}$. This is obtained by summing up the RAI for each feature and dividing it by the number of identified features (n = 25). Thus the average RAI for all smart features was 2.98. Smart building features with RAI higher than $\overline{RAI}$ were *video surveillance*; *intrusion detection system; fire detection and alarm; smart thermostat; WiFi; water reclamation devices; automatic lighting system; and sensor operator water fixtures*. The implication is that the degree of aspiration for each of these features was higher than the aspiration derived from the aggregate aspiration for the smart building features. The deviations about the $\overline{RAI}$ for each of the features were 1.65, 1.41, 1.35, 1.15, 1.15, 0.92, 0.77 and 0.45 respectively.

Features with lower RAI than $\overline{RAI}$ were *access control; smart meter for monitoring and measuring power to the building; in-building cell phone; devices that maintain building; rain water harvesting appliances; water meter; audio visual; devices that monitor building systems; telecom and data system for communication network; smart trackers for house keys; smart locks; meter for measuring usage specific spaces, tenants or electric circuits; asset location devices; digital signage (LCD or Plasma); moisture and humidity sensor; building performance analytic devices; and fault detection and diagnosis for HVAC.* The feature with the highest RAI was *video surveillance (CCTV)* with an RAI of 4.63, while *building performance analytic devices*, and *fault detection and diagnosis for HVAC* ranked least with an RAI of 2.24.

Further analysis indicated that thirteen out of the twenty five smart features attracted RAIs above average (2.50 out of 5.00). The features are *video surveillance, intrusion detection system, fire detection and alarm, smart thermostat, WiFi, water reclamation devices, automatic lighting system, sensor operator water fixtures, access control, smart meter for monitoring and measuring power to the building, in-building cell phone, devices that maintain building and rain water harvesting appliances.* The implication of this is that the degree of aspiration of residents for the aforementioned features was above average.

The feature of smart building with the highest RAI was *video surveillance (CCTV)* with a RAI of 4.63, and seconded by *intrusion detection system* with a RAI of 4.39. The degree of aspiration expressed by residents for "video surveillance" and "intrusion detection" could be attributed to the ability of the devices to enable residents to monitor and control their security system (Kirkpatrick, 2016). With the spates of security lapses in the country, the concerns of the residents and the degree of their aspiration for features relating to security of lives and property is not unexpected.

It is also interesting to note that the level of residents' aspiration for some other features such as *smart thermostat* (RAI = 4.13), *WiFi* (RAI = 4.13), *water reclamation* (RAI =3.90) *and automatic lighting system* (RAI = 3.75) ranked high. The degree of aspiration associated to these features could be explained by a number of reasons. The level of aspiration associated *with smart thermostat* and *automatic lighting system* for instance could be explained by residents' concern to conserve energy owing to the energy crisis bedeviling the study area. The degree of aspiration of residents for *WiFi* could be ascribed to residents' craves for internet. The rate at which the citizens were embracing the use of internet has resulted to the astronomical growth in the number of internet users in the country which according to Olowole (2018) has been ranked among the top ten in the world.

Table 4: Residents' aspiration for smart building features

Smart building features	TWV	RAI	RAI-$\overline{RAI}$	(RAI-$\overline{RAI}$)^2	Ranking
Video Surveillance (CCTV)	588	4.63	1.65	2.72	1
Intrusion detection system	558	4.39	1.41	1.99	2
Fire detection and alarm	550	4.33	1.35	1.82	3
Smart thermostat	525	4.13	1.15	1.32	4
Wi-Fi	525	4.13	1.15	1.32	4
Water reclamation device	495	3.90	0.92	0.85	6
Automatic lighting system	476	3.75	0.77	0.59	7
Sensor operator water fixtures	435	3.43	0.45	0.20	8
Access control	374	2.94	-0.04	0.16	9
Smart meter for monitoring and measuring power to the building	333	2.62	-0.36	0.13	10
In-building cell phone	331	2.61	-0.37	0.14	11
Devices that maintain building system	329	2.59	-0.39	0.15	12
Rain water harvesting appliance	321	2.53	-0.45	0.20	13
Water meter	316	2.49	-0.49	0.24	14
Audio-visual	316	2.49	-0.49	0.24	15
Devices that monitor building system	312	2.46	-0.52	0.27	16
Telecom and data system for communication network	306	2.41	-0.57	0.32	17
Smart trackers for house keys	303	2.39	-0.59	0.35	18
Meter for measuring usage, specific spaces, tenants or electrical circuits	301	2.37	-.0.61	0.37	19
Asset location devices	301	2.37	-0.61	0.37	20
Smart locks	301	2.37	-0.61	0.37	21
Digital signage (LCD or plasma display)	296	2.33	-0.65	0.42	22
Moisture and humidity sensor	286	2.25	-0.73	0.53	23
Building performance analytic devices	285	2.24	-0.74	0.55	24
Fault detection and diagnosis for HVAC	284	2.24	-0.74	0.55	25

$\overline{RAI} = 2.98$

Also worthy of note are the smart building features that ranked low in the degree of residents' aspiration index. The two least smart features in order of their RAIs (based on ranking) are *building performance and analytic devices* and *fault detection and diagnosis for HVAC.* The low level of aspiration for these features might be as a result of what Tijani *et al*. (2016) termed "lack of maintenance culture" in the country. The result shows that the residents were not really cherish these features as the level of aspiration for these features was very low.

4.0 Conclusion

The study presented an assessment of the awareness and aspiration of the residents for features of smart homes in Lagos. The results revealed that majority of residents were slightly aware, while some were not even aware of smart features.

To promote the awareness and understanding of the smart features in Nigeria, sensitizing government agencies, developers and property users in particular is imperative. There is the need for widespread campaign by all agencies concerned with the advancement of smart buildings. Developers, investors and property managers and occupiers should be educated on the various elements of smart buildings to avoid what Allameh *et al*. (2012) termed “a mismatch between end users demands and smart home possibilities”.

The study found that residents aspired more for smart features directly linked to security. The implication of this is that residents were more interested in features associated with security of lives and properties such as “video surveillance”, “intrusion detection system” and “fire detection and alarm”. It is advocated that residents should be educated on the benefits of features that are related to health such as “devices that prevent occupant from chemical, biological, and radiological attacks” and “carbon monoxide alarm”. Educating the residents on the importance of health promoting features is fundamental to ensuring a sustainable future.

The study also established that the level of aspiration for features relating to property management was low. Most of the elements in this category of smart features such as “devices that monitor building systems”, “fault detection and diagnosis for HVAC” and “building performance analytic device” attracted RAIs of less than average. Raising the level of awareness of the importance of property management smart features is central to ensure sustainable building performance.

References

Afon, A.O. (2007). Informal sector initiative in the sub-system of urban solid waste management in Lagos, Nigeria. *Habitat International,* 31 (1), pp.193-204.

Allameh, E., Heidari, J.M., de Vries, B., Timmermans, H., Beetz, J. and Mozaffar, F. (2012). The role of smart home in smart real estate. *Journal of European Real Estate Research*, 5(2), pp. 156-170.

Arditi, D. mangano, G. and De Marco, A. (2015). Assessing the smartness of building. *Facilities,* 33(9/10), pp. 553-572.

Bhati, A. Hansen, M. and Chan, C.M. (2017). Energy conservation through smart homes in a smart city: A lessons for Singapore households. *Energy Policy,* 104 (1), pp. 230-239.

Batov, E.I. (2015). The distinctive features of “smart” buildings. *Procedia Engineering* III, pp.103-107.

Buckman, A.H., Mayfield, M. and Beck, S.B.M. (2014). What is a smart building? *Smart and Sustainable Built Environment,* 3(2), pp. 93-109.

Bullie, J., Montoya, L., Junger, M. and Hartel, P. (2018). Physical location of smart key activators – a building security penetration test. *Journal of Corporate Real Estate*, 20(2), pp.138-151.

Chapman, K. and McCarteny, K. (2002). Smart homes for people with restricted mobility. *Property Management,* 20(2), pp. 153-166.

Cole, R.J. and Brown, Z. (2009). Reconciling human and automated intelligence in the provision of occupant comfort. *Intelligent Buildings International* 1(1), pp. 39-55.

Cooper, P.B., Maraslis, K.,Tryfonas, T. and Oikonomou, G. (2017). An intelligent hot-desking model harnessing the power of occupancy sensing data. *Facilities*, 35(13/14), pp.766-786.

Dritsa, D. and Biloria, N. (2018). Towards a multi-scalar framework for smart healthcare. *Smart and Sustainable Built Environment*, 7(1), pp. 33-52.

Fabi, V., Spigliantini, G., and Corgnati S.P. (2016). Insights on smart home concept and occupants' interaction with building controls, *Energy Procedia* III (2017), 759-769, *8th International Conference on Sustainability and Buildings* SEB – 16, 11-13 September, 2016, Turin, Italy.

Flores, J.V.Z., Rasseneur, L., Galani, R., Rakitic, and Farcy, R. (2016). Indoor navigation with smart phone IMU for the visually impaired in university buildings. *Journal of Assistive Technology*,10(3), pp. 133-139.

Foray, D. (2014). From smart specialization to smart specialization policy. *European Journal of Innovation Management*, 17(4), pp 492-507.

Gonel, F. and Akinci, A. (2018), How does ICT-use improve environment? The case of Turkey. *World Journal of Science, Technology and Sustainable Development*, 15(1), pp. 2-12.

Hargreaves, T., Wilson, C. and Hauxwell-Bardwin, R. (2018). Learning to live in a smart home. *Building Research and Information*, 46(1), pp.127-139.

Kadaouche, R. and Abdulrasak, B. (2012). Novel model for inhabitants prediction in smart houses. *International Journal of Pervasive Computing and Communications*, 8(3), pp. 250-263.

Kim, G.W, Lee, D.G., Han, J.W., Lee, S.H., and Kim, S.W. (2009). Security technologies based on a home gateway for making smart home secured. *Internet Research*, 19(2), pp. 209-226.

Kirkpatrick, H. (2016). Smart home features that families want in their next home, retrieved at https://www.inman.com on December 3, 2017.

Leung, R. (2018). Smart hospitality: Taiwan hotel stakeholder perspectives, *Tourism Review*, https://doi.org/10.1108/TR-09-2017-014.

Linskell, J. and Hill, J. (2010). The role of smart home technology in enhancing supported living for people with complex needs and challenging behavior. *Journal of Assistive Technologies*, 4(4), pp. 24-35.

Ma, J., Yang, L.T., Apduhan, B.O., Huang, R., Barolli, L. and Takisawa, M. (2005). Towards a smart world and ubiquitous intelligence: A workthrough from smart things to hyperspaces and UbicKids. *International Journal of Pervasive Computing and Communications*, 1(1), pp.53-68.

Olaleye, A. and Adegoke, O.J. (2009). Home owners' perception of insurance of real estate in Lagos, Nigeria. *International Journal of Housing Markets and Analysis*, 2(2), pp. 179-189.

Olowole, T. (2018), 2018 Internet Statistics – Users And Social Network, *WebClick Online Marketing Agency* retrieved on 17/12/2018 @webcliclick.com.ng

Onibokun, A. (1985). Housing in Nigeria, *NISER*, Ibadan.

Oyewole, M.O. (2010). Housing development finance through cooperative societies: The case of Ogbomoso. *International Journal of Housing Markets and Analysis*, 3(3), pp. 245-255.

Oyewole, M.O. and Komolafe, M.O. (2018). Users' preference for green features in office properties. *Property Management*, 36(4), pp. 374-388.

Rana, N.P. Luthra, S., Mangla, S.K., Islam, R., Roderick, S. Dwivedi, Y.K. (2018). Barriers to Smart Cities in India context. *Information Systems Frontiers*, https://doi.org/10.1007/s10796-018-9873-4.

Sabha, G. (2006). A critical review of the impact of embedded smart sensors on productivity in workplace. *Facilities*, 24(13/14), pp. 538- 549.

Sidawi, B. and Deakin, M. (2013). Diabetes, built environment, and (un)healthy lifestyles: The potential of smart city technologies. *Smart and Sustainable Built Environment*,2(3), pp. 311-323.

Sinopolis, J. (2010). *Smart building systems for Architect, Owners and Builders*, Butterworth-Heinmann, London.

Sinopolis, J. (2016). *Advanced Technology for Smart Buildings*, Artech House, London.

SMUD (2017), What makes a house a smart home? Retrieved at https://www.smud.org on December 3, 2017.

Taylor, M. (2006). Integrated building systems: strengthen building security while decreasing operating costs. *Journal of Facilities Management*, 4(1), pp. 63-71.

Tijani, S.A., Adeyemi, A.O. and Omotehinse, O.J. (2016). Lack of maintenance culture in Nigeria: The bane of National Development. *Civil and Engineering Research*, 8(8), pp. 23-30.

Wilson, C., Hargreaves, T., and Hauxwell-Baldwin (2017). Risks and benefits of smart home technologies. *Energy Policy*, 103 (1), pp. 72-83.

Wong, J., Li, H., and Lai, J. (2008). Evaluating the system of intelligence of the intelligent building systems: part 1:development of key indicators and conceptual analytical framework. *Automation in Construction*, 17(3), pp. 284-302.

Wong, J.K.W. and Leung, J.K.L. (2016), Modelling factors influencing the adoption of smart-home technologies, *Facilities*, 34(13/14), pp. 906-923.

Yang, H., Lee, H., and Zo (2017). User acceptance of smart home services: an extension of the theory of planned behavior. *Industrial Management and Data Systems*, 117(1), pp. 68-89.