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Building Informatics: Exploratory Approach to Post Occupancy Narratives of Automotive Intelligent and Non Intelligent Building Components

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ABSTRACT: Intelligent building component application is gradually gaining grounds in developing countries.. The study therefore aim at carrying out an exploratory approach to post occupancy narratives of intelligent and non-intelligent building components of commercial office building using Lagos state Nigeria as case study with a view to enhancing components and accessory function performance. A sample size of 80 was adopted for the study, with respondents that made up of intelligent system building users, while relevant hypothesis were tested to trend validation. The study presented factors that influences integration of automated accessory in building and their performance, effectiveness of security system and access control, conventional automation application in building products among others. The study recommend innovation management, strategic operation management,, management of internal and external accessory environment, and stake holder management, as panacea to an effective automation integration of accessory components of intelligent and no intelligent building.

KEY WORDS: Intelligent, Occupancy, Automation Exploration.

I. INTRODUCTION

1.1 Concept of Intelligent and Non Intelligent Building

Intelligent buildings commonly refers to buildings that some of the components requires automation to function. Some of the components referred to in this context include electrical, mechanical and electromechanical components. Non- intelligent buildings refers to building that the components are not automated or are being operated through manual methods. Automated/intelligent building are usually control through a system often referred to as Building Management System (BMS). BMS has a subsidiary system often referred to as Building Automation Control System(BAC). BAC was described by Brooks et al. (2017) as the next phase on search for further development in building automation. BACS can be said to be an integral part of facility management, it is basically a subset of BMS (Makwana et. al, 2015), Microsoft (2016). The system assist in providing automatic control in administration of function of basic automatic components, it integrates some functions such as electricity, gas, heating, security and monitoring, water systems in building, BAC is expected to work as subsets of a larger system, send signals and communicate with each other and take instructions from a central command centre. Automated Building Systems have gone beyond the usual facility management and monitoring can be linked to the internet.

1.2 1.1 Automation Types in Building

In conventional construction, automation often arise sometimes on account of clients, who are now being aware about the need to be conscious of environmental interactions with building components, man and building interaction and interaction of building users with the various components designed to provide a conducive environment for end users. For instance, many building designs are not friendly with some individuals that are physically challenged. Automation components of building could be divided into the following groups: access control, circulation automation in building, security systems, automation for services in building among others. According to Makwana, Vyas, & Pitroda (2015) and Salikhov, Khanda, Gusmanov, & Mazzara (2017), Building access control system include features that assist in seamless operation of access points in building, e.g. doors, windows, gates, locks, safe, vaults, chambers among others. Some access control allows remote operation of the system without the user or operators having need to physical operate the systems. They operate through connections of sensors, valves, turbines, lights, etc. Circulation automation is a type of automation that affords the users to move I the two dimensions of space movements, i.e. vertical movement, horizontal movements. Intelligent tools like automatic scooters, chutes, automatic power bike allows horizontal movements in building while vertical movement is possible through equipment such as travellator, lift etc. The main goal of Intelligent Buildings (IB) is to satisfy the needs of the occupants while BACS focuses on facility management. (Brooks et al. 2017). IB is able to integrate meeting and adapting to the needs of the user while simultaneously managing the building service components efficiently. According to Makwana et.al (2015), an intelligent building isexpected to have the ability to stimulate performance of the occupant, cost of operation, manage energy savings while ensuring dynamic flexibility. It must be able to integrate the lighting, heating, air-conditioning systems, voice and data communication all at once (Makwana et. al, 2015).

II. SCOPE OF AUTOMATION IN BUILDING

2.1 Protective Hardware Protecting the Intelligent Building

In intelligent and non-intelligent buildings, some of the applications that are installed are often the main object of the intelligence functionality while many are majorly for security and comfort. Therefore the scope of automation in building covers the following areas: risk management, protection of ICT components, physical and environmental security, personnel security, operation continuity and security awareness (Makwana, Vyas, & Pitroda (2015) and Salikhov, Khanda, Gusmanov, & Mazzara 2017).

2.2 Security Risk management

The intelligent systems are often susceptible to security risks, there are a lot of issues of recent that surround the security of intelligent system architecture. There have been incidences of cyber-attack and database hacking going on around the globe, parasite programme are being attached to databases in order to siphon or transmit information from original source for fraudulent purposes which has constituted serious concern as regards the security integrity of intelligent systems. Therefore potential loopholes such as leaving intelligent system unchechecked for a long of time, allowing the systems to operate alone for a long period of time are some of the facts that could constitute threat to the system which could also lead to system integrity compromise, therefore an holistic risk management strategies is needed through carefully assessing the potential physical and cyber threats surrounding the building while taking into consideration the potential loopholes.

2.3 Information and Communication System Protection(ICS).

Information transmission and communication is very important in intelligent system protection architecture, there are measures often used of recent in achieving information and communication protection in building systems, some of them include, electronic password, data encryption, access restriction and access gate code among others. Also, information and communication system Isolation and partitioning of the network both internally and externally between the IBS and the O.S and even wider networks would assist in protecting ICS. For instance in Makwana, Vyas, & Pitroda (2015) and Salikhov, Khanda, Gusmanov, & Mazzara (2017).

2.4 Physical and Environmental Security

Ideally, environmental and physical surroundings of intelligent building system is paramount The components are usually made of silicon Nano tubes that are easily degrade as a result of extended exposure to adverse weather condition. Signal blurring also could be on account of faulty components. Therefore, at installation stage, the following need to be considered: the impact of sun, moon and wind element on the system, chemical fumes incursion, direct exposure to naked fire etc. Albeit, in all cases, ensure layered protection where possible while control and monitoring of access to various IB components should be established.

2.5 Continuity of Operations and Personnel Security

In ensuring continuity of operation and efficiency of security system, the system modules and platforms are often interconnected to robust databases thereby protecting Life of equipment and system from damage. Also, for effective protection and monitoring, personnel are issued security identification number and codes. Sometimes it could be in a optical recognition format, facial and biometric identification system, voice and ocular identification among others. Therefore, there is a need for ensuring emergency power source availability, elimination of redundant networks, continuous maintenance of existing systems and ensuring personnel vetting, of operators of the system as well as third parties or vendors.

III. RESEARCH METHODOLOGY

3.1 Research Design

The research was carried out using quantitative research method, quantitative research method involved the use of structured questionnaire developed in Likert scale 1 to 5. As a result of the nature of the research, the problem solving approach (practical research) data collection was engaged. Survey design method was used in this context to procure the sample and population frame. The study population comprises of the construction firms while the sample includes clients, unskilled site workers, builders, architects, mechanical engineer, service engineer, cost expert and contractors who are undergoing or have undergone a construction project in the recent past within Nigeria. The category of professional are selected due to the study's main theme 'ICT' and 'construction payment'

3.4 Instrumnent of the Research

3.5 Primary Data In the context of this study, survey design method was adopted while purposive sampling method was deployed in data sampling. Therefore with the aid of purposive sampling method, fifty (50) samples were picked using purposive sampling method. Similarly, primary data was collated through questionnaire approach designed in Likert Scale calibrated on scale 1 to 5. The questionnaire was distributed to respondents at selected locations.

IV. DATA PRESENTATION

4.0 The Current State of Practice in Office Building Components Accessory Application

In this section, current state of practice in intelligent and non-intelligent buildings was profiled and presented.

Table 1 The current State of Practice in Office Building Components Automation

S/N	Parameters	Mean	RAI	Rank
i.	Intelligent Fire system	4.27	0.85	1st
ii.	Internet Infrastructure	4.17	0.83	2nd
iii.	Intelligent Building Security System	4.09	0.81	3rd
iv.	Indoor Air Quality processing Units	3.97	0.79	4th
v.	Access control and Monitoring	3.95	0.79	4th
vi.	Intelligent water supply systems	3.89	0.78	6th
vii.	Intelligent HVAC System	3.88	0.78	6th
viii.	Intelligent Automated Lighting Systems	3.83	0.76	8th

ix.	Energy and Occupant comfort Monitoring	3.65	0.73	9th
x.	Automated Parking system	2.76	0.55	10th

The existing areas of applications in intelligent building system are presented in Table 1 Some of the aspect of practice include fire system, building security system, air quality, access control and monitoring, plumbing system, Heating- Ventilating and Air-conditioning system (HVAC), lighting system, energy and occupant comfort monitoring and automated parking system.

Intelligent Fire system (RAI 0.85) top the list of the profiled intelligent system found in the sampled buildings. It consist of automatic smoke detector, impact detector and spark alarms that operates with the aid of sensitive sensors. One of the reasons that could be adduced as responsible for being ranked 1st is on account of increased fire attacks that is happening all over the world. Fire destroys building components and also can render the building unfit for habitation thereby corrupting the structures' integrity. Therefore adequate precaution is necessary to ensure fire safety of a building. Similarly, Internet Infrastructure (RAI 0.83) was ranked second, internet facility compliments the effectiveness of an intelligent system, some facilities works best with Wi-Fi presence, therefore internet facility should be highly provided for an effective output.

Also, there are intelligent building systems in some selected buildings, the component provides comfort, mobility and accessibility to occupants and users. Therefore, Intelligent Building Security System-IBS (RAI 0.81) was ranked 3rd Automatic systems are being used as part of security architecture in intelligent buildings. Security systems are being used in monitoring of internal parts of building, building surroundings, theft detection, burglar alarm, perimeter fence security points and close circuit monitoring cameras (CCTV) among others. This view was supported in Brooks, Coole, Haskell- Dowland, Griffiths & Lockhart (2017).

Similarly, there are gadgets that enables recreation of indoor air quality, they sieves dust and particles from buildings and enables oxygen rich air to flow unhindered within building space therefore, Indoor air quality conditioning system (RAI 0.79) and Access control and monitoring (RAI 0.79) were ranked 4th respectively. The following are found to be present in sampled intelligent buildings, they includes: Intelligent water supply, Intelligent HVAC System, Intelligent Automated Lighting, Energy and Occupant comfort Monitoring and Automated Parking system. The view above is supported in Cociorva, Iftene (2017) and Brooks, Coole, Haskell-Dowland, Griffiths & Lockhart (2017).

4.1 Satisfactory Level of Users in Non-Intelligent and Automated Internal Service Components of Intelligent Building

Table 2 Satisfaction Level of Commercial Building Users about Mechanical and Electrical Components

S/N	M&E components	Mean [In Telligent]	RAI	Rank	Mean [nonintell	Rank
i.	Smart/Energy efficient lift control systems	4.26	0.85	1st	-	-
	Plumbing System					
ii.	Office space ventilation system	4.17	0.83	2nd	4.12	1st
iii.	Automated Power supply	4.15	0.83	2nd	4.11	2nd
iv.	Automated Doors	4.14	0.83	2nd	4.08	3rd

v.	Automated Lighting Systems	4.11	0.82	5th	-	-
vi.	Telecommunication and data usage	4.08	0.82	5th	-	-
vii.	Photosensitive windows	3.74	0.75	7th	4.07	4th
viii.		2.75	0.55	8th	-	-

Source: Author's Field Survey (2019)

The satisfaction level of users in order of ranking was presented in Table 2. Smart/Energy efficient lift control systems (0.85) was ranked 1st, The trio of Plumbing System (0.83), Office space ventilation system (0.83) were ranked 2nd, Automated Power supply (0.83) and Automated Doors (0.82) were ranked 5th while Automated Lighting Systems (0.82)Telecommunication and data usage (0.75) and Photosensitive windows (0.55) were ranked 5th, 7th and 8th respectively. The most basic items to the users appeared in ranking in order priority, for instance transportation system, plumbing system, ventilation system, lighting and access control are rated high in order of satisfaction. This is consistent with submissions in Atayero, Ademu-Eteh, Popoola, Takpor, & Badejo, (2017), Brooks, Coole, Haskell- Dowland, Griffiths, & Lockhart (2017).

4.4 Effectiveness of Building Intelligent System [Security System and Access Control in Building]

Table 3 Effectiveness of Intelligent security systems and Access monitoring and control.

S/N	Effectiveness Indicators	Mean	RAI	Ranking
i.	Consciousness of being safe at work or office	3.92	0.78	1st
ii.	Nobody gets access to the office when locked	3.76	0.75	2nd
iii.	Prompt alertness on occasion of security breach in the building Detection of	3.48	0.69	3rd
iv.	unauthorized entry attempt by the door	3.39	0.68	4th
v.	Unbroken work hour continuity	3.39	0.68	4th
vi.	Safety of workers properties during working hour at the office	3.38	0.68	4th
vii.	Alarms are made at any attempt at illegal entry	3.35	0.67	8th
viii.	The system does not recognise users as an authorised personnel sometimes	3.09	0.62	9th
ix.	Strange objects can be used to gain access	2.48	0.49	10th

Source: Author's Field survey (2019)

Consciousness of being safe at work or office (0.78), Nobody gets access to the office when locked

(0.75), Prompt alertness on occasion of security breach in the (0.69), Detection of unauthorized entry attempt by the door (0.68), Unbroken work hour continuity 0.68), Safety of workers properties during working hour at the office (0.68), Alarms are made at any attempt at illegal entry(0.67), The system does not recognise users as an authorised personnel sometimes (0.62). Strange objects can be used to gain access (0.49). This toes the line of submission in Alshami, Kepuska, (2016); Amusan, Opeyemi, Ebuoluwa, Omuh 2019); Salikhov, Khanda, Gusmanov, & Mazzara (2017).

4.5 Effective Performance of Office Building Accessories in Intelligent and Non intelligent buildings

Table 4 Factors that influence the performance of intelligent buildings and Non intelligent buildings

S/N		Mea [Non	Ran	Mea	Ran

i.	Cost of upgrading failed parts	3.5	1st	3.6	1st
ii.	Lack of knowledge of operation	3.5	2nd	3.5	2nd
iii.	Delay in responding to faulty areas in the building	3.4	-	3.4	3rd
iv.	Lack of information on operational requirements	-	-	3.4	3rd
v.	Limited expertise in handling Intelligent buildings	-		3.3	5th
vi.	Lack of sufficient human personnel	3.3	4th		

Source: Author’s Field Survey (2019) Conclusion

V. FUTURE VULNERABILITIES OF INTELLIGENT BUILDING SYSTEM

There is no system that are not vulnerable to change elements, some of the change element are necessary to be taken into consideration, they are summarized in this section, some are human induced while some are force majeure i.e. the act of God’’ some of them includes; device mobility (especially wireless technology), network architecture, increased connectivity, increased connectivity and flexibility and common device design approach (Amusan, Omuh, Mosaku (2019)

There is a need to inculcate development of Network Architecture. Network designers and programmers usually adopt different methods in the design of network structure. Network architecture can take the following forms: open architecture, closed architecture, Semi open architecture and semi closed architecture. Open architecture allows for a wider range of connectivity and interoperability along with the ability to replace parts of the system without completely overhauling the system (Amusan, Kehinde,,Ignatius.,Awotinde, 2019;Brooks, 2012). However, this open system is susceptible to hackers, parasite programmes and virus attacks. Also, a closed architecture do not fully accept network interoperability and not susceptible to hackers and other security threats. Also, increased connectivity is necessary e.g. through the use of IB System Communications

IBS systems offer the user the ability to have access to the system “on-the go”, wherever they may be at any point in time. The user can be connected to the system at all times. Due to increased connectivity, buildings within the same business district will be expected to talk to each other in the nearest future. (Brooks, 2012). Similarly, Increasing Connectivity and Flexibility in system is essential. The system will be able to allow connections of external or foreign devices through straight forward installations and increasing flexibility and connectivity. Although plug and play devices offer some sort of security, they require awareness, activation, monitoring and response to detected threats.

Finally, creating Common Device Design Approach through Security Informatics. In security informatics, hidden functions may be embedded in the device which hackers may be aware of and use for exploitation purposes. In present times, manufacturers are producing single devices with numerous functions depending on the services required in the building. This allows for a wider international market with local installers activating their functionality depending on the needs of the client (Brooks, 2012 and GSA 2005; Amusan, Samuel, Faith, Ladi,, Adegbenjo, Peter 2019).

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