Benefits of Adopting Intelligent Building System

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Keywords; Affordable housing; Building management; Sustainable building; Intelligent building systems; Benefits.

SUMMARY

Intelligent building systems have seen a lot of reviews in recent times; Construction professionals in the diaspora are now more interested in how automated and smart, buildings are. This research therefore aimed at identifying the benefits attached to the adoption of Intelligent Building Systems in the Construction industry. The demand for a better quality of life has led to the continuous search for more Comfortability within homes, hence, Intelligent Buildings. Quantitative approach was employed for the purpose of this research, with questionnaires administered to construction professionals that are relevant to the study. A total of 176 professionals (Engineers, Architects, Quantity Surveyors and Builders) were reached. However, 135 returned Questionnaires were passed fit and certified for further analysis. Analysis was carried out using the Mean Item score and standard deviation. The findings from this study reveals that the biggest incentives for adopting Intelligent Building Systems are; Better environment and intelligent city respectively. Reduced energy cost and optimised cleaning are further down the list. Over the long run, the benefits should outweigh the barriers because Intelligent Building Systems aids Sustainability of not only our buildings and cities, but also our lives.

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1.0 INTRODUCTION

An intelligent building as a building that gives a productive, cost efficient environment through the optimization of structure, systems, services and management including the interrelationship that exist between them (Warrington & Harris, 2013). This system seeks to find a balance between various elements such as data communication, voice automation, lighting, heating, air-conditioning etc.; so as to successfully manage resources in a synchronised manner to achieve maximum occupant performance and operating cost flexibility and savings. A building cannot be intelligent on its own (Iwuagwu & Iwuagwu, 2014); it is what it is by functional artificial intelligence which can only be automated through humans. A clever structure OR intelligent building is where the mix of advances and interconnected systems reinforces the usage of the convenience by the structures clients, engages the capable action of the structure and enables reconfiguration of the space as a result of changing use plans. Insightful structures may likewise be alluded to as shrewd structures. The word insightful structure has been in presence since the mid-1980s and you would believe that a general acknowledged significance of the properties of a savvy building would have been built up now; everything considered, rethink. In spite of the fact that a couple of scientists have attempted to set up a general significance, there are a colossal number of definitions with various degrees of detail and different degrees of accentuation on various pieces of structure insight. The principle definition, begat by the Intelligent Buildings Institute, describes a canny structure as one which gives a profitable and savvy condition through enhancement of four fundamental segments: structure, frameworks, administrations and the board, and the interrelationship between them. Another definition says that a canny structure is one that in a perfect world organizes its four parts to the customer's needs with an accentuation on the innovation that makes the interrelationship between the segments conceivable (Warrington & Harris, 2013). As astute structures grabbed hold the world over in the late 1980s and 1990s, many contending definitions were advanced.

2.0 LITERATURE REVIEW

2.1 Building Automation System (BAS)

The electronic equipment that automatically carries out facility specific function is what comprises a Building Automation System. Commonest definitions of BAS attempts the automatic control of one more building system functions such as; HVAC system, the safety and security system, the lighting system and the vertical transportation system. In simpler terms, the integration of temperature control functions, lighting, fire prevention and security into one common operation is what is referred to as Building Automation System (BAS) (Saidur, Rahim, Islam & Solangi, 2011). According to Cempel & Mikulik building operations personnel can make use of BAS as a tool to achieve more effective and efficient control over all building systems (Cempel & Mikulik, 2014). In short, BAS makes use of computing and automation programs for monitoring, organising, optimising and coordinating all building control sub-systems (HVAC, security, lighting etc.). The following are the most used applications of the BAS; Operator adjustment (gaining access to the operation set-points capable of tuning systems to changing conditions); Alarm reporting (involves notifying personnel of maintenance needs or out of temperature/pressure limit or failed equipment); Monitoring (energy use, equipment sop and start times, logging off and on of room temperature and pressure); Scheduling (optimising set times for starting and stopping the heating and ventilation equipment or the Lighting system). Lloyd (1995) stated that savings in energy cost which is established by BAS is a building application. Information derived from the production equipment allows the BAS to shut down different services equipment. Therefore, only the equipment needed for the building to function properly by the system is suitable to the individual building and also to satisfy the needs of its occupants. The lay out routine of the BAS that are important in the design of an intelligent building includes the following: Finely zoned air-conditioning control, Furnish relevant building performance data, Protect the occupants, Occupant Comfort, Reliability. The BAS is of high relevance in the successful completion and performance of any major building project. BAS plays a vital role in order to gain or retain occupants both old and new structures, First and foremost, the building services is controlled by BAS which have the highest impact on tenants feeling of how the building performs such as comfort, security and safety. Secondly, BAS determines the level of intelligence built in the building design which in turns differentiates it from an ordinary building. Finally, although it might be a less contributor or capital cost it has a substantial effect on operation and maintenance costs for the building, which covers about 80% of the buildings life cycle costs.

2.2 Vertical Transportation

Cempel & Mikulik defines vertical transportation as any transportation method such as escalators, hydraulics, hoists, lifts or elevators, passenger conveyors (Cempel & Mikulik, 2013), which influence or cause upward or vertical movements within the building. However, the vertical transportation system then involves, bringing all these different methods of vertical transport under one control unit. A very useful application of Vertical Transportation systems is in high rise buildings. Buckman opined that a higher level of tenant satisfaction can be reached with an improved elevator service (Buckman, Mayfield & Beck, 2014). The designs of these systems are highly technical, it is advisable that only skilled personnel be allowed anywhere near the elevator controls, as they could be a little complicating. Over time the Personnel and design team has agreed over important characteristics an effective vertical transportation system should possess and they include; stopping or slowing down the motion of escalators when it detects no traffic, this saves much energy; Integration with the building automation system to enable the usage of access control cards; shutting down elevators for some time once its past traffic hours; permitting dynamic changes to user privileges etc. Another very important characteristic of elevator systems that should be taken cognisance of are monitoring and control aspects of the vertical transportation system, as well as the safety devices. Advantages of monitoring elevator systems as identified by earlier studies are; assistance for trapped passengers at any time of the day (24hours); Increased safety, availability and reliability; swift response system in the event of breakdowns; providing a program for condition maintenance. In addition, general attributes of remote monitoring system as postulated are as follows; automated alarms once passengers are trapped; collecting lift performance data automatically; Indicating lift-in-service status; Indicating lift maintenance status; Alarms trigger when lifts or elevators are inoperable; open ended (two-way) conversation with trapped passengers; controlling online investigation and analysing lift activity (Cempel & Mikulik, 2013).

2.3 BENEFITS

Environment: One of the advantages of expanded advancement of data innovation has been the improvement of framework which is equipped for estimating, assessing and reacting to change. This has thus produce results on the advancement of our physical condition, for example, its structure and especially the structure (Kua & Lee, 2002). The insightful structure should give the earth and intends to an ideal usage of the structure, as per its assignment. This all-encompassing capacity of a structure can be accomplished uniquely by methods for a broad utilization of structure administration frameworks, for example, HVAC; electric power; correspondence; wellbeing and security; transportation; sanitation, etc. (Kua & Lee, 2002)

Cost Saving: The expense of a structure must incorporate the working and upkeep cost over the structures life expectancy and not simply its development cost. Green development yields various advantages to the proprietor, both unmistakable and impalpable (Arkin & Paciuk, 1997). Shrewd planned structures profit by life-cycle cost reserve funds (counting conceded substitution cost), upgrades in human execution (counting efficiency increase, better well-being), and an expansion in notoriety (Nalewaik & Venters, 2009). Insightful structures permit decrease in expense (through sharing of hardware by numerous clients) in each angle by upgrading mechanized control, correspondence and the board frameworks. They likewise prepare for fix costs, representative time/efficiency misfortune and income misfortune. For instance, whenever an entryway and window screen closes and opens when a person draws near, difference in climate and wind development individually, they are free from dealing with and slamming that may bring about fix and upkeep cost (Doukas, Patlitzianas, Iatropoulos & Psarras, 2007).

Energy saving and Sustainability: After the establishment of a computerized structure framework there is a significant decrease in a structure's vitality spend and the carbon impression of the structure truly recoils with each gear information sensor. Vitality effectiveness is quick winding up some portion of land the executives, activities technique and offices the board because of the expansion and familiarity with vitality use concerns and the advances in financially savvy innovations. As the expense of vitality and water increment, there is progressively monetary inspiration by the proprietor to decrease utilities costs over the lifetime of the structure. A decrease in vitality use (the two gas and power) and both inner and outside water utilization (counting sewerage) may diminish operational (Siew, Balatbat & Carmichael, 2013). For lighting framework, vitality sparing can be up to 75% of the first circuit load, which speaks to 5% of the absolute utilization of the private and business divisions. Vitality sparing potential from water warming, cooling or boiling water creation can be up to 10% which speak to up to 7% of the vitality utilization of private and business area (Derek, 2014).

Green House Gas Benefits: Ozone depleting substance emanation decreases correspond to decrease in vitality use. Savvy structures add to the decrease in vitality use, in business, modern, institutional and private areas (GhaffarianHoseini, 2012).

Intelligent City: Shaping African urban areas with savvy structures is connected to more extensive dream of shrewd urban communities. At the point when each structure in a city is smart, at that point the city is canny. An astute city is the place the city framework is overseen all the more keenly through a successful and fitting innovation. In this respects, insightful structures are remain solitary substances, yet interconnected centre points inside the city wide foundation. The common outcome of this is the advancement of urban communities inside urban areas with littler environments including a firmly incorporated system of structures that

better empower the administration and improvement of frameworks and assets (Tauheed, Aniya & Lawal, 2007). This will offer ascent to an altogether unique arrangement of drivers that make savvy structures a monetary and business need. Maybe the most significant business driver is the capacity to decrease cost, streamline labour usage and improve administration level through total, administration incorporation and procedure mechanization. Clever structure advances will enable issues to be unravelled well ahead of time of the present limit. The world is becoming overwhelmingly urban with over portion of the total populace living in urban communities (Yang, 2012). The use of keen structure will improve the personal satisfaction and profitability of the nation.

Caring Homes: One of the prospects in savvy building is the minding homes. Minding homes execute a great deal of physical activities which could be programmed or under remote control (Sharples, Callaghan & Clarke, 1999). A delicate old or debilitated individual who needs to stay free in their homes is great clients of minding homes. The structure will assemble data on approaching risks, utilizing voice or different modalities of arranging and will bring help if need be (Wood, 1999).

Efficiency equals Savings: Operational proficiency is one of the real points of interest driving brilliant structure selection. By furnishing building administrators with noteworthy information that can improve vitality use and maintainability, upgrade occupant comfort, bring more noteworthy robotization, and so forth., they can decrease working expenses (Dounis, Tiropanis, Argiriou, Diamantis, 2011). Up to 30 percent of structure upkeep expenses can be decreased with shrewd structure arrangements. As postulated by Ning, Sandborn, and Pecht (2013), an appropriately structured and worked framework will be productive and spare expenses.

Reducing Energy and lowering operational costs: Expanding vitality utilization and rising power costs are pushing building proprietors to receive shrewd structures arrangements that can robotize control frameworks and empower them to evade vitality wastage. Private apparatuses devour about 30% of the all out power utilization and produce 12% of all vitality related CO_2 emanations (Perez-Lombard, Ortiz & Pout, 2008); for example, about 54% of the vitality utilization in US private structures is expected to HVAC frameworks, and about 6% to fake lighting, while in business structures HVAC and counterfeit lighting frameworks represent 40% and 15% of vitality utilization, individually. Upgradeable programming replaces resolute, cabled and tedious undertakings. There will be less requirement for costly staff that investigates nonstop (Siano, 2014)

Increased property value: An improvement in technology and sustainability leads to a higher property value as the building now can be certified on a higher level growing rental rates by up to 24.9% compared to a conventional building. Saidur et al. (2011) uncovered that introducing innovation to meter and screen vitality utilization has a normal recompense time of under a half year.

Building and asset performance (easier maintenance and repairs): An automated asset management system will pay for itself quickly by measuring different property life-cycles, which in turn will lessen expensive repairs down the road. British Standards (BS 4778-3.1: 1991) characterizes upkeep as the way toward keeping up a thing in an operational state by either anticipating a change to a bombed state or by re-establishing it to an operational state following disappointment. The reasons for structure support are to: secure the well-being and security of inhabitants and the general population everywhere; hold estimation of venture; keep up the structure in a condition. Bohm and Peat expressed that 'the safe framework is the main methodology that can clear up falsehood in a characteristic manner' in which it keeps on satisfying its capacities; and present a decent appearance (Bohm & Peat, 2010).

Improved occupant comfort, productivity and health: This is a pretty obvious one: when a building can keep its tenants comfortable, healthy, productive and happy, the more likely it is that they will thrive and stay (Klein, Kwak, Kavulya, Jazizadeh, Becerik-Gerber, Varakantham, Tambe, 2012) Tenant well-being and solace might be improved in intelligent structure and obligation decreased through the decrease or end of lethal or destructive substances, which may bring about diminished non-appearance and turnover (Koga, Lehman & CxA, 2008).

3.0 RESEARCH METHODOLOGY

Research design is a mapping strategy. It is essentially a statement of the object of the inquiry and the strategies for collecting the evidences, analysing the evidences and reporting the findings (Josh, Kale, Chandel & Pal, 2015). Research design helps in achieving the plan for getting to conclusion from the questions raised in the research. The aim of the research was to identify the benefits of adopting intelligent building systems in the construction industry. The study was fundamentally a descriptive quantitative research in which the population for the research were the major professionals in the construction industry, which comprises of the Quantity Surveyors, Architects, Builders and Engineers. Sample size was obtained from a sample frame consisting of only the registered member of the professionals. The primary data for the study was carried out through field work which covered the use of questionnaires. It also allows for statistical analysis of large data base using statistical tools available in Statistical Package for Social Science (SPSS). The adequacy of a sample is assessed by how well such sample represents the population of participants from which the sample is drawn (Kothari, 2004). Due to the lack of usage of intelligent building despite its numerous benefits which could curb the challenges associated with the use of ordinary building, this study was conducted with the aim of assessing the level of adoption and awareness of intelligent among construction professionals in the Nigerian construction industry and, in achieving this, a survey design was carried out among construction professionals in Ondo State. A sample is a representative of the entire population and sampling procedure is a definite plan for obtaining a sample from a given

population. The sampling frame from this study will form the basis for the determination of sample sizes. Yamane postulated the formula stated below which will be used to calculate the sample size for this study (Yamane, 1967).

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

Where n = the sample size

N = the total population

e = the level of precision which will be 10%

Information gotten from the professional governing bodies were; Nigerian Society of Engineers (NSE), Ondo state chapter, 180 Engineers; Nigerian Institute of Architects (NIA), 27 Architects; Nigerian Institute of Quantity Surveyors, 161 Quantity Surveyors; Nigerian institute of Builders (NIOB), 40 Builders. Applying the Yamane formula to these figures, we had, 64 Engineers, 21 Architects, 62 Quantity Surveyors and 29 Builders, arriving at a total of 176 respondents in all, after applying the sampling formula. Data collected from these respondents were analysed using Mean ranking and Standard Deviation. 135 questionnaires were returned and analysed; this connotes 76.70% response rate.

4.0 FINDINGS AND DISCUSSIONS

Table 1.0 as well as Figure 1 shows the benefits of adoption of an intelligent building system in the construction industry. Environmental benefit is the most important with mean value of 4.51 and standard deviation value of 0.76, Intelligent City is ranked 2nd with mean value 4.48 and standard deviation value of 0.70.

Table 1.0 Benefits of adopting intelligent building system in the construction industry

Factor	Mean	Std. Deviation	Rank
Environment	4.51	0.76	1
Intelligent City	4.48	0.70	2
Individualized temperature and light control for individualized comfort	4.43	0.64	3
Efficiency equals Saving	4.41	0.62	4
Green House Gas Benefit	4.37	0.65	5
Improved worker productivity and tenant satisfaction	4.33	0.81	6
Improved Occupant Comfort, Productivity and Health	4.23	0.73	7
Increased Property Value	4.22	0.83	8

Reduce Energy Cost	4.21	0.91	9
High Speed connection	4.19	0.80	10
Increased safety and security	4.19	0.91	11
Optimized site cleaning	4.17	0.84	12
Energy Saving and Sustainability	4.15	0.71	13
Self – monitoring	4.15	0.78	14
Building and Asset Performance (Easier maintenance and repairs)	4.08	0.91	15
Cost Saving	3.99	0.85	16
Lower Operational Cost	3.97	0.89	17
Redesigned space	3.89	0.92	18

Individualized temperature and light control for individualized comfort is the third most important benefit with mean value of 4.43 and standard deviation value of 0.64, Efficiency equals Saving is ranked 4th with a mean value of 4.41 and standard deviation value of 0.62, Green House Gas Benefit is ranked 5th with mean value of 4.37 and standard deviation value of 0.65, Improved worker productivity and tenant satisfaction is ranked 6th with mean value of 4.33 and standard deviation value of 0.81 while Improved Occupant Comfort, Productivity and Health is the seventh most important benefit with mean value of 4.23 and standard deviation value of 0.73. Increased Property Value is ranked 8th with mean value of 4.22 and standard deviation value of 0.83, Reduce Energy Cost is ranked 9th with mean value of 4.21 and standard deviation value of 0.91, High Speed connection is ranked 10th with mean value of 4.19 and standard deviation value of 0.80, Increased safety and security is ranked 11th with mean value of 4.19 and standard deviation value of 0.91, Optimized site cleaning is ranked 12th with mean value of 4.17 and standard deviation value of 0.84. Energy Saving and Sustainability is ranked 13th with mean value of 4.15 and standard deviation value of 0.71, Self – monitoring is ranked 14th with mean value of 4.15 and standard deviation value of 0.78 ,Building and Asset Performance (Easier maintenance and repairs) is ranked 15th with mean value of 4.08 and standard deviation value of 0.91, Cost Saving is ranked 16th with mean value of 3.99 and standard deviation value of 0.85, Lower Operational Cost is ranked 17th with mean value of 3.97 and standard deviation value of 0.89. Lastly, Redesigned space is the least benefit of IoTs with mean value of 3.89 and standard deviation value of 0.92.

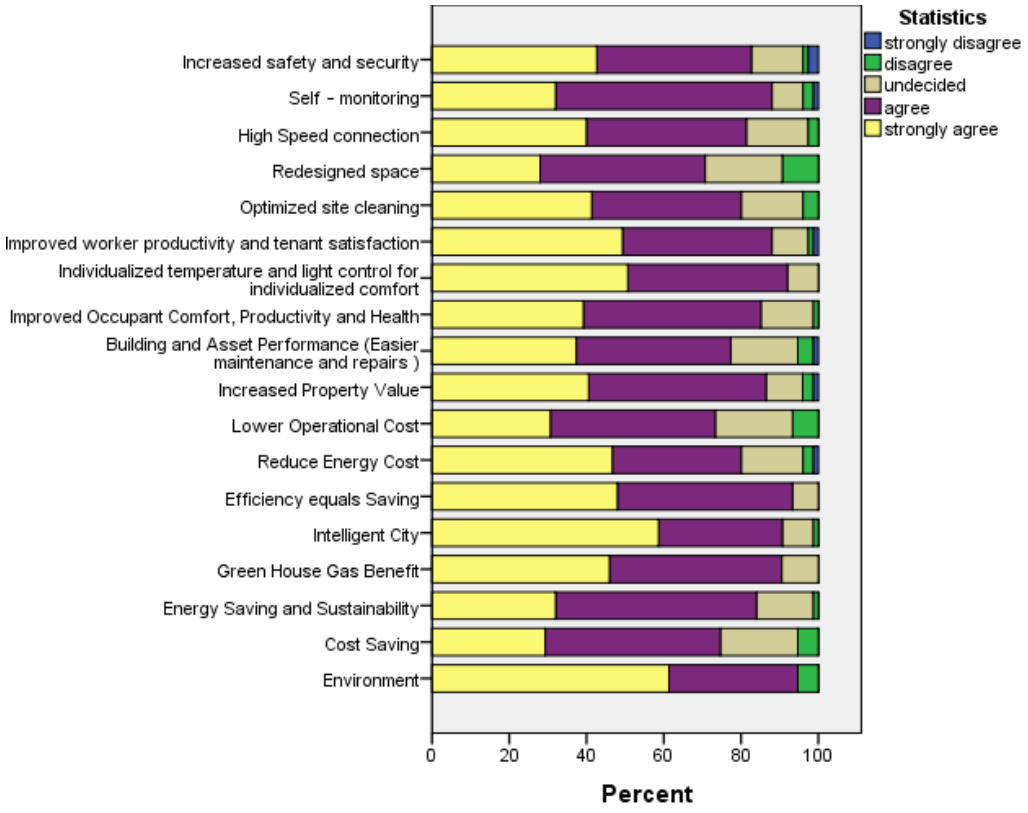

Figure 1.0 A Cluster bar chart for benefits of adopting of intelligent building

According to the analysis carried out, it shows that there are lots of benefits in the adoption of intelligent building in the construction industry. The bar chart above represents the responses of the respondent towards the benefits. It is found that most of the benefits, are above 75% i.e. combining the strongly agree responses and agree responses which makes the majority of the whole response. Therefore, with the above stated benefits the intelligent building should be adopted. Energy saving and sustainability is one of the identified benefits of adopting IBs among other benefits and this corroborates Derek's contribution to benefits of IBs adoption (Derek, 2014). In addition, efficiency equals to savings was identified to be one of the benefits of adopting intelligent building system which aligned with Ning, Sandborn & Pecht findings (Ning et al., 2013) Also increased property value is also on the benefits of adopting IBs which corroborates with Energy Savings Trust contribution to benefits of intelligent building (Energy Savings Trust, 2015). Lastly, easier maintenance and repairs was identified as one of the benefits which corroborate with Bohm & Peat contribution on the benefits of adoption of intelligent building (Bohm & Peat, 2010).

5.0 CONCLUSION AND RECOMMENDATIONS

The benefits of adopting Intelligent Building systems surely outweigh whatever barriers currently facing its pending adoption. Despite the many distinct benefits of IBs, such as reduced operating costs and a more reactive building, providing owners, operators and users a better experience, it has really not been adopted fully in the industry which is as a result of the barriers inhibiting it. Therefore, for intelligent building system to be fully adopted in the construction industry, all barriers mitigating its adoption must be overcome and dealt with accordingly. As identified in the research findings, "Environment" is the perceived most important benefit of IBS; meaning that impacts IBS can have on the Environment is very massive. This can be further linked to Environmental Sustainability. In conclusion, the benefits of such buildings cannot be over emphasized environmentally, socially and economically. It has been proven through various researches, that intelligent buildings might be the solution to some of the sustainability issues currently facing the 21st century. It is highly recommended that more awareness programmes like seminars and workshops are set up in order to increase the awareness levels of construction professionals to these benefits.

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