Project Management Processes in the Adoption of Smart Building Technologies: A Systematic Review of Constraints

Abstract

Purpose: The necessity for sustainable development and high building performance has emerged the adoption of Smart Building Technologies (SBTs) in the construction community. The SBTs adoption has been hindered in many different parts of the world due to several constraints underpinning the project management processes to help adopt SBTs. This paper presents a systematic review of relevant literature on barriers underpinning the project management processes on the adoption of SBTs.

Methodology: This paper presents a systematic review of relevant literature on barriers to technology adoption published in academic peer reviewed journals and conference papers. The study adopted a systematic review technique on 56 relevant articles and conference papers in relation to barriers to adoption of technology, and barrier frequency was employed to select the most reported barriers.

Findings: The study revealed the most reported barriers underpinning project management process towards SBTs adoption, which include lengthy approval process for new SBTs, structure and organization of the construction industry, higher cost for smart construction practices and materials, unfamiliarity with smart building technology and technical difficulty during construction process.

Originality: This study has contributed to the knowledge of barriers underpinning the project management processes on SBTs adoption by identifying the most reported barriers in literature.

Practical Implication: To both the industry practitioners and policy makers, this review provides a valuable reference during implementation. Also, to the academic scholars on embarking on further empirical studies, the developed checklist of SBTs barriers could be important and useful.

Keyworks: adoption, barriers, construction community, smart building technologies, project management processes, sustainable development

Introduction

The socio-economic development of any nation also depends on the nature of its buildings which translates into its capital stock (Ruparathna et al., 2016; Javanroodi et al., 2019). Buildings are known to consume almost 40%, 25% and 40% of the energy, water, and resources respectively, and emits one-third of the total greenhouse gases (GHG) (United Nations Environment Programme, 2015). Hassan et al. (2014) asserted with empirical evidence and statistics that commercial buildings consume 33% and the residential buildings 21%; an expansion shows that a total of 38,645 GWh was consumed by commercial buildings. On the other hand, residential buildings consume a sum of 24,709 GWh. Dominant emissions from Buildings are known to consist of Carbon (IV) Oxide (CO_2), and 2018 seemed to record the increment of CO_2 emissions by 2.7%, meanwhile 2017 recorded increment of about 1.6% (The Global carbon project, 2018). Buildings are also known to impact the environment in a form of water and air pollution based due to the cement plant (Raffetti et al., 2018). Wang et al. (2019) opined that present actions are not sufficient, thereby suggested the request for resolute and timely effects needed on a global scale to minimize the harmful impact of human or anthropogenic activities on the environment. The approach necessary to help minimize the building negative impact on the environment is sustainable development, which calls for the integration of efficient methods based on multidisciplinary knowledge (Baleta et al., 2019). According to the Energy Performance of Buildings Directive (EPBD), newly constructed buildings in the European Union (EU) need to be NetZero Energy Building (NZEB), which is an integrated part in a smart building (Karlessi et al., 2017) by the end of 2020 (European Union, 2014).

The smart building concept aims to use smart technology to reduce energy consumption, as well as to improve comfort and users' satisfaction (Attoue et al., 2018). Smart buildings can be many things, but simply defined as: Smart buildings use building technology systems to enable services and the operation of a building for the betterment of its occupants and management (Vattano, 2014). Smart Building is generally referred to a building with an integrated services platform for the intelligent management of energy facilities, monitoring of consumption, adoption of security systems and video surveillance (Vattano, 2014). Balta-Ozkan et al. (2014) defined smart building as a residence equipped with a communications network, linking sensors, domestic appliances, and devices, that can be remotely monitored, accessed or controlled and which provides services that respond to the needs of its inhabitants. The Building Performance Institute Europe (BPIE) (2017) also explained smart building as being flexibly connected and interacting with the ecosystem, being able to produce, store and consume energy efficiency.

Smart Buildings contain aspects of automation and similarly intelligence is an important aspect of Smart Buildings (Wang et al., 2012; Shaikh et al., 2014). Automation in buildings requires "a lot of 'intelligent' devices" (Runde and Fay, 2011) and Smart Buildings are increasingly using a number of smart devices, materials and sensors (Arkin and Paciuk, 1997; Wong et al., 2008; Gilder and Clements-Croome, 2010). Possibilities for technological developments through Smart Building Technologies are extensive, but critical approaches also need to be addressed to enable the sustainable and gradual implementation of Internet of Things (IoT) technologies (i.e. to investigate environmental impacts of smart technologies) (Nižetić et al., 2019). Achieving a smart building after incorporating a building with SBTs has never been primarily concerned with environmental impact, therefore, there is cause for concern that, it creates a demand for previously unwanted product and services and, in the process, adds to the inventory of climate and habitat damage caused by modern energy services (Darby, 2007: Louis et al., 2015: Friedl et al., 2016).

Barriers underpinning project management processes on the adoption of the Smart Building Technologies still exist, even though importance has recently been attached to Smart Building. Researchers including Williams and Dair, 2007, in England; Richard and Lynes, 2007, in Canada; Potbhare et al., 2009, in India; Lam et al., 2009, In Hong Kong; Winston, 2010, in Ireland; Zhang et al., 2011, in China; Persson and Gonkvist, 2014, in Sweden; Kasai and Jabbour, 2014, in Brazil; Djokoto et al., 2014, in Ghana, Darko et al., 2017, in Ghana) have conducted research on the challenges hindering adoption of complex technologies such as Smart Building Technologies, Green Building Technologies, etc. there is no hesitation that barriers to Smart Building Technologies (SBTs) will be of an interest to future researchers , as it is important to identify SBTs barriers in specific location so that corresponding measures can be developed to overcome.

Despite the increasing research on barriers to adoption, little research effort has been made to review and analyse existing pertinent literature specifying to SBTs. Li et al. (2000) asserted that it is beneficial to investigate systematically what we do know and how we can proceed to learn more. It is therefore imperative to review literatures on the barriers of the project management processes on SBTs adoption, to widen the understanding of researchers and practitioners on the barriers. This paper aims to conduct a systematic review of relevant literature on barriers of the project management processes on SBTs adoption and offer recommendations for overcoming the barriers. It therefore believed that the result of this systematic review will provide vital information for stakeholders (such as project managers, etc.), industry associations and policy makers on the factors preventing the successful adoption of SBTs, and thus help to identify key areas where initiatives can help achieve successful SBTs adoption. Again, a developed checklist of the barriers may be vital to future researchers who would want to validate the barriers via further empirical studies in different settings.

Conceptualizing Project Management in Smart Building

A project is a unique, transient endeavour, undertaken to achieve planned objectives, which could be defined in terms of outputs, outcomes and benefits (Association for Project Management, 2019). Kivilä et al. (2017) explained that projects are implemented to achieve a certain goal and selected objectives. Silvius and Schipper (2014) added that companies are concerned with a project's broader benefits and value, with respect to the iron triangle objectives of scope, time and cost. Project may succeed and fail in terms of how they reach their goals and are managed (Lehtonen and Martinsuo, 2006; Kivilä et al., 2017). A project is usually deemed to be successful if it achieves the objectives according to their acceptance criteria, within an agreed timescale and budget (Association for Project Management, 2019).

According to Association for Project Management (2019), project management is the application of processes, methods, skills, knowledge and experience to achieve specific project objectives according to the project acceptance criteria within agreed parameters. Project management is often regarded as a set of tools which can help to fulfil the requirement of the system such as waste management, material management and site management (Wu and Low, 2010). Fundamentally, project management provides an organization with powerful tools that improve its ability to plan, implement and control its activities as well as the ways in which it utilizes its people and resources (Meredith et al., 2017). The concept of achieving sustainability has been embraced by an increasing number of project managers, architects, designers and buildings owners (Wu and Low, 2010). In the concept of Smart Building Technology, there are many systems that can help to achieve sustainability including energy efficiency, quality management systems and using environmentally friendly materials, as well as systems to boost the performances of buildings. In the area of project management, the sustainability and the project management has been explored, but only a limited work is observed on finding modern ways for assessment and application of sustainable project management (Chawla et al., 2018), such as smart building project. This study then seeks to identify the barriers underpinning the project management process to help adopt SBTs in the global construction community.

Sustainable Development and Smart Building

The idea of sustainability is most generally known in relation to sustainable development (Manoliadis et al., 2006). The world Commission on Environment and Development (WCED) (1987) defined sustainability as development that is capable of meeting the present needs without compromising the ability of generations to meet their future needs. The construction industry has been identified as an industry that significantly contribute to all aspects of sustainable development, owing to the large environment, economic and social effects of construction activities (United Nations Environment Programme (UNEP), 2009; Sev, 2009; Darko, 2019). Sustainability is increasingly becoming a key consideration of building practitioners with the goal of increasing economic efficiency, protecting, and restoring ecological systems and improving human well-being (Sinha, 2013). Vattanno (2014) asserted that the use of sustainable technologies for buildings, with the goal of creating an environment for living and working that uses fewer resources and generates less waste, also aims to retrofit existing buildings to be more efficient in terms of energy and water. To achieve sustainability, the following objectives should be met: minimize consumption of matter and energy; reusability and recyclability of the material; human satisfaction and minimum environmental impacts and embodied energy (Sinha, 2013). London has launched the Buildings Energy Efficiency Program to retrofit public sector buildings, aiming to a reduction of 440,000 tons of CO2 per year in 2025 (Berthon et al., 2011).

In applying the principles of sustainability, besides technological and economical aspects, environmental and social aspects also need to be considered (Zavadskas et al., 2018). The most general criteria for evaluating building materials are resource management, pollution or indoor Environmental Quality (IEQ), and performance (Milani, 2005; Spiegel and Meadows, 2006). It is important to minimize the energy consumption by buildings, as while a material is consumed, its chances for future use are diminishing; hence, its potential utility to future generation is lost (Sinha, 2013). Another aspect of minimizing the consumption is either reusing the same material or recycling the material to mould into a different or similar building product (Sinha, 2013). This also ties into the third criteria, that is, meeting a certain level of end-user satisfaction (Pearce at al., 1995, Sinha, 2013). Taking advantage of all the modern technologies for energy saving is to reduce the impact on the environment and on the planet that comes from the presence and activities of thousands of people and products that, in various ways, consume energy and produce waste (Vattanno, 2014). By the use of technology, in order to radically improve quality of life, opportunity, prosperity, social and economic development, all life processes and nerve centres of social life are considered in a smart city (Fuggetta, 2012; Vattanno, 2014). Vattano (2014) added that these technologies are integrated with other types of services; indeed, to reduce the negative environmental impacts of the construction and management of buildings. However, the adoption SBTs in different part of the world has not been smooth for various reasons. This study seeks to widen the scope of stakeholder's understanding of what is restraining the successful adoption of SBTs through a literature review, and recommend strategies to overcome.

Research Methodology

The solid base for progressing knowledge of a topic is a review of pertinent literature on the topic (Webster and Watson, 2002). This actually facilitates theory development that is useful in relation to academia and industrial practice. This study is mainly based on a literature review of barriers to SBTs adoption.

The review was scoped to technologies adoption studies that present argument on the issues on barriers to SBTs adoption published in academic (peer-reviewed) journals and conference papers. To retrieve relevant articles for this study, a systematic literature search was conducted with the help of Scopus search engine. Elsevier's Scopus has usually been engaged in similar reviews by (Hong and Chan, 2014; Osei-Kyei and Chan, 2015; Darko et al., 2017) and has a better accuracy and precision in performance than other search engines (Web of Science and Google Scholar) (Falagas et al., 2008). Suitable search keywords used are "barriers", "challenges", "obstacles", "complex technologies in construction", "sustainable technologies in construction", "smart building", "smart building technologies", "barriers to project management processes" and "sustainable building". The initial search identified a total number of 326 articles (searched on 15 October 2019). However, not all the identified presented studies on barriers to technology adoption. Since the aim of the study was to review studies literature on smart building technology adoption, it was necessitated to filter out unrelated articles. After filtering, 56 articles were found to be relevant and valid for further analysis. The study, therefore, adopted a systematic review technique to review the 56 relevant articles, and barrier frequency was adopted to select the most reported barriers. The 56 relevant articles were approved because Darko and Chan (2017) conducted a systematic review on 36 relevant articles on barriers to the green building adoption (published). This study is focused on reviewing and drawing conclusions from relevant articles that were obtained, but not on a review of the complete population of the articles on the topic. The study adopted the flow indicated by **Figure 1.**

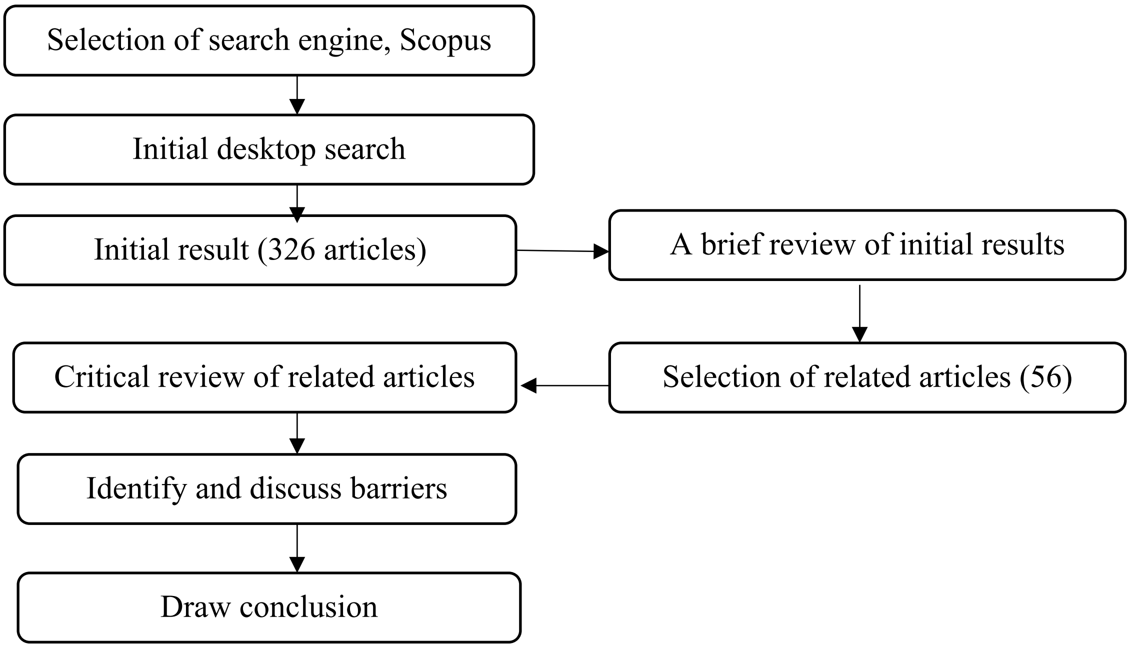

Figure 1: Overall Research Process and Flow, Adapted Source: (Darko et al., 2017)

Results and Discussion

Research Trends in Smart Building Technologies

Smart building technology generally refers to the integration of four systems: A Building Automation System (BAS), a Telecommunications System (TS), an Office Automation System (OAS), and a Computer Aided Facility Management System (CAFMS) (Vattano, 2014). The most modern concept of building automation considers indeed the building structure and technological systems as a single system-building and works out, through integration, conflicts that often arise from the interaction of each individual process (Beccarello et al., 2013). Vattano (2014) asserted that the home automation systems are driving to interesting results related to the increase of efficiency, reduction of waste, accessibility, comfort, safety and making every building active node of an intelligent network, able of sharing data and information with the outside world in an intelligent manner.

Smart Building Technologies were developed at first for luxury home living with a modern flavour and a tang of efficiency (Darby, 2007). Only later did the idea of putting home automation, sensing and remote control at the service of the electricity network come into being (Darby, 2007). According to Yoo et al. (2012), Smart Building Technologies (SBTs) provide huge potential for building new processes, experiences, organizational forms, and relationships in which radio-frequency identification (RFID) tags, digital sensors, networks, and processors create required properties related to smart technologies. Saunila et al. (2019) defined SBT as the bundle of properties embedded into previously nondigital devices and enabling smartness for those devices. Building Performance Institute Europe (BPIE) (2017) reported that dozen Belgian houses, old and new, ‘ are equipped with a range of technologies to provide a maximum of load-shifting potential’ with the aim of balancing the neighbourhood network: solar photovoltaics and thermal capture, heat pumps, and fuel cells or batteries, along with a monitoring and control system. Through literature, the trend of smart building technologies (SBTs) has been defined by numerous researchers as discussed under this section. It is then necessary to discover what will stop stakeholders from adopting SBTs.

Year-Wise Technology Adoption (SBTs) Related-Barrier Papers in Selected Journals

The year wise Technology Adoption (SBTs) related-barrier papers in selected journal **(Figure 2)** provide an insight into the development and research to the topic year wise. The trend is upward from 1989 to 2019. The study considered literature on technology adoption in the construction industry, and further related it to the Smart Building Technologies (SBTs). The maximum number of papers were published in the year 2012 (14 papers), 2015 (14 papers) and 2017 (14 papers), which are regarded as current because they are not more than 10 years old, followed by 2013 (13 papers).

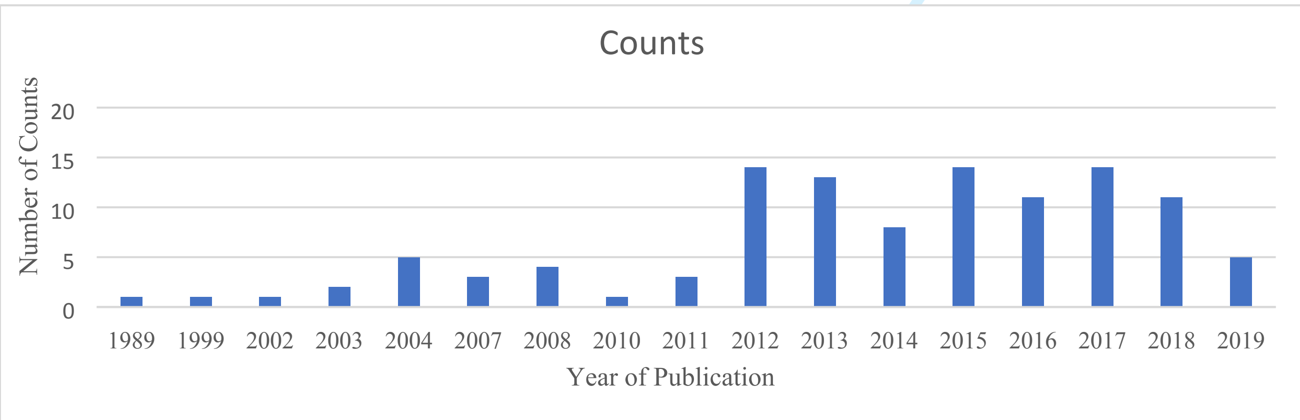

Figure 2: Year-Wise Technology Adoption (SBTs) Related-Barrier Papers in Selected Journals

Understanding the barriers to Smart Building Technology Projects

Smart Building Technology (SBT) Projects, which is a sustainability project, may succeed and fail in terms of how they reach the goals and how they are managed (Lehtonen and Martinsuo, 2006; Kivilä et al., 2016). Organizations and researchers have become increasingly concerned with sustainability as a project goal and as a characteristic of the processes through which the project is managed (Gareis et al., 2013; Silvanus and Schipper, 2014). Kivilä et al., (2016) opined that, to make a sustainable project like smart buildings sustainable, a holistic view to project control is necessary. It is therefore necessary to consider looking at the underpinning push and pull factors of project management processes that can help in the successful adoption of SBTs. To gain better understanding of smart building technologies adoption and its implementation in the construction industry, it is not important to recognize the willingness and readiness of the industry to innovate but also its awareness and appreciation of the barriers to be overcome in relation to the project management processes (Mahbub ,2008). Mahbub (2008) asserted that there is lack of standard design elements which is important in encouraging the use of automated smart technologies as repetition elements are likely to lead to greater utilisation these technologies. Hwang and Tan (2012) also discovered challenges such as increase cost of project cost, lack of communication and interest among project team members, high implementation cost of smart construction practices, lack of credible research on benefits of smart building and lack of interest from the clients

Through a review of the 56 articles, a total of 26 key barriers were identified; however only barriers identified in at least two articles are presented in Table 1 for further discussion. It is observed from **Table 1** that, several barriers hinder the successful adoption of SBTs, and each of them comes with the corresponding reference. With respect to space and word limitation, this paper discusses only the top five (5) barriers. **Figure 3** shows the pictorial analysis of the barriers based on the number of times reported by researchers, as well as the top 5 reported barriers.

Table 1: Bibliometric Analysis of the Barriers to the Adoption of Smart Building Technologies (SBTs)

Code	Barrier Factors	References	Number of times barrier reported	Priority
BF01	Technical Difficulties during construction processes/ Lack of the technical skills regarding smart technologies and techniques	Brown, 1989, Tagaza and Wilson (2004), Williams and Dair (2007), Mahbub (2008), Hwang and Tan (2010), Hwang and Ng (2012), Shi et al. (2013), Gou et al. (2013), Du et al. (2015), Kasai and Jabbour (2014), Hsu (2016), Rizos et al. (2016) Hopkins (2016), Azeem et al. (2017)	14	1
BF02	Unfamiliarity with Smart Building Technology /Worker's unaware of the correct methods and procedures	Pettersen (1999); Ling (2003), Tagaza and Wilson (2004), Williams and Dair (2007), Mahbu, (2008), Love et al. (2011), Hwang and Ng (2012), Ahn et al. (2013), AlSanad (2015), Chan et al. (2016), Darko et al. (2017), Durdyev et al. (2018), Hopkins (2016), Azeem et al. (2017)	14	2
BF03	High cost in smart sustainable materials and equipment	Mahbub (2008), Zhang et al. (2011a, b,c), Hwang and Ng (2012), Hwang and Tang (2013), Shi et al. (2013), Ahn et al. (2013), Chan et al. (2016), Darko et al. (2017), Nguyen et al. (2017), Durdyev et al. (2018), Azeem et al. (2017)	11	3
BF04	Structure and Organization of the Construction Industry	Mahbub (2008), Samari et al. (2013), Hwang and Ng (2013), Chan et al. (2016), Shen et al. (2017a, b), Chan et al. (2017), Durdyev et al. (2018), Azeem et al. (2017)	8	4

BF05	Lengthy approval for new technologies within the organization	Eisenberg et al. (2002), Ling (2003), Tagaza and Wilson (2004), Zhang et al. (2011a), Hwang and Ng (2012), Hwang and Ng (2013), Azeem et al. (2017)	7	5
BF06	Resistance to change from traditional practices	Shi et al. (2013), Gou et al. (2013), Kasai and Jabbour (2014), Du et al. (2015), Chan et al. (2016), Azeem et al. (2017)	6	6
BF07	Adoption of different contract forms of project delivery	Tagaza and Wilson (2004), Rahmani et al. (2013), Hwang and Ng (2012), Olubunmi et al. (2016), Azeem et al. (2017)	5	7
BF08	Smart building consultant delay in provident information	Hwang and Ng (2012), Nowotarski and Paslawski (2015), Harris et al. (2018), Azeem et al. (2017)	5	8
BF09	Availability of smart sustainable material and equipment	Williams and Dair (2007), Hwang and Ng (2013), Ringenson et al. (2017), Drossel et al. (2018), Azeem et al. (2017)	5	9
BF10	The design, orientation and structure of the building	Hwang and Ng (2012), Noe et al. (2017), Das et al. (2017), Azeem et al. (2017)	4	10
BF11	Planning of different construction sequences	Hwang and Ng (2012), Zhang et al. (2015), Nowotarski and Paslawski (2015), Azeem et al. (2017)	4	11

BF12	Planning of different construction techniques	Hwang and Ng (2012), AlSanad (2015), Hwang et al. (2018), Azeem et al. (2017)	4	12
BF13	Longer time required during the pre-construction processes	Hwang and Ng (2012), Grover and Froese (2016), Jabar and Ismail (2018), Azeem et al. (2017)	4	13
BF14	Difficulty in comprehending the sustainable specifications in the contract details	Hwang and Ng (2012), Bachev et al. (2016), Alwan et al. (2017), Azeem et al. (2017)	4	14
BF15	Difficulty in approving payment disbursement to suppliers and subcontractors	Hwang and Ng (2012), Teku (2015), Peters et al. (2019), Azeem et al. (2017)	4	15
BF16	Difficulty in the selection of subcontractors in providing smart sustainable construction services	Hwang and Ng (2012), Polat et al. (2016), Polat, (2016), Azeem et al. (2017)	4	16
BF17	More time is required to implement smart construction practices onsite	Hwang and Ng (2012), Tagaza and Wilson (2004), Azeem et al. (2017)	4	17
BF18	Specific budget specification of the smart sustainable building project	Hwang and Ng (2012), Mohanty et al. (2016), Cease et al. (2019), Azeem et al. (2017)	4	18
BF19	Special request from client pertaining to specific Smart Building Technologies to be used	Hwang and Ng (2012), Long et al. (2016), Minoli et al. (2017), Azeem et al. (2017)	4	19
BF20	Lack of communication and interest among project team members	Tagaza and Wilson (2004), Hwang and Ng (2013), Azeem et al. (2017)	4	20
BF21	Conflict of interest between consultant and project manager	Hwang and Ng (2012), Meng and Boyd (2017), Azeem et al. (2017)	3	21

BF22	More alteration and variation with the design during the construction processes	Hwang and Ng (2012), Eastman (2018), Azeem et al. (2017)	3	22
BF23	Required date of completion	Hwang and Ng (2012), Kerzner (2017), Azeem et al. (2017)	3	23
BF24	Level of risk the client is willing to take in Smart Building Technologies (SBTs)	Hwang and Ng (2012), Jorisch et al. (2018), Azeem et al. (2017)	3	24
BF25	Government policy	Hwang and Ng (2012), Shen et al. (2017ab), Azeem et al. (2017)	3	25
BF26	Unforeseen circumstances in smart building project	Hwang and Ng (2013), Jagarajan et al. (2017), Azeem et al. (2017)	3	26

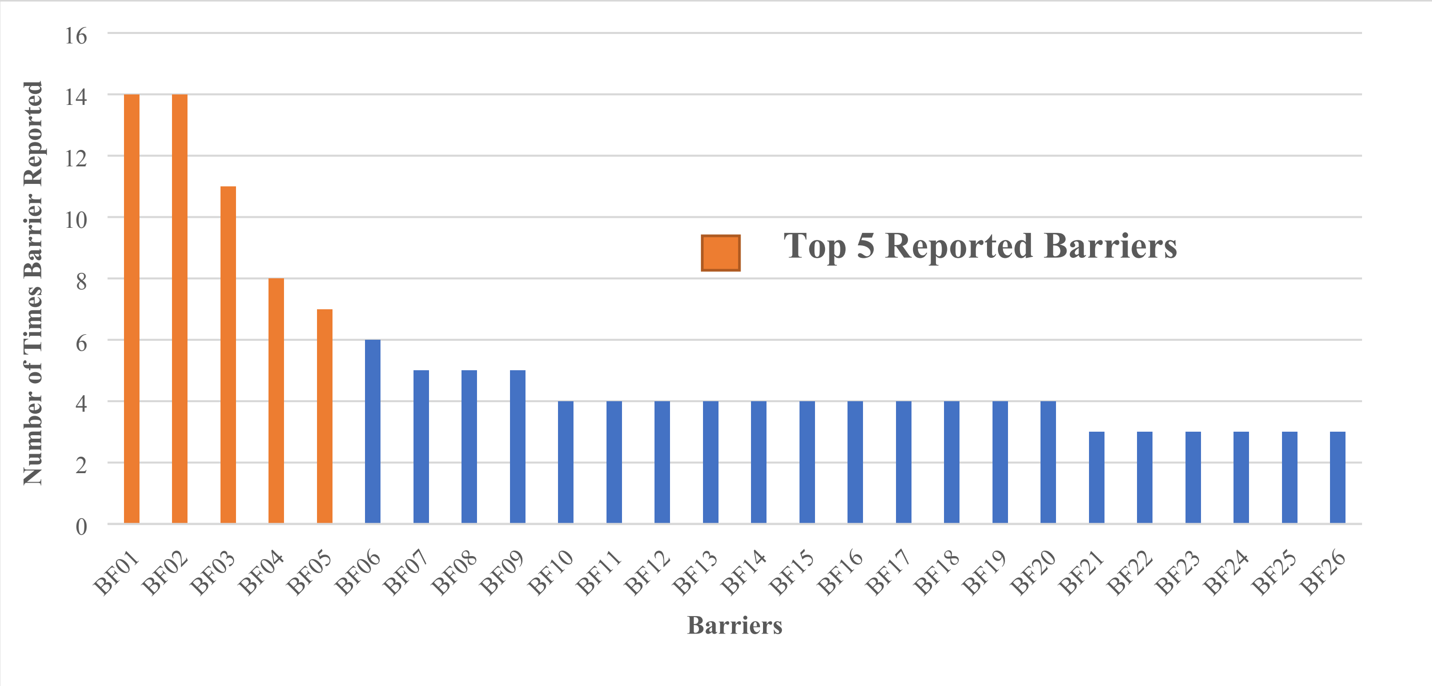

Figure 3: Pictorial Analysis of The Barriers Based on The Number of Times Reported by Researchers.

Technical Difficulty during Construction Process

According to Mahbub (2008), the work process of construction is complex and non-repetitive, generally performed over a large area or site and the work performed is peculiar to that site, that is each project is specific. Tagaza and Wilson (2004) pronounced that one major barrier to the adoption on technology is lengthy planning and approval process for inventive technologies within the firm. Williams and Dair (2007) also found barriers that included the unavailability of sustainable materials and products. For smart automation to work in the construction, it is necessary to adapt the work processes by redesigning and converting ill-structured to well-structured working condition (Brown, 1989; Mahbub, 2008). Du et al. (2015) also unveiled lack of building ratings and labelling programmes which can help to enhance the construction work processes. Other researchers who have considered construction product and processes as a categorized barrier include Shi et al. (2013), Gou et al. (2013) and Kasai and Jabbour (2014). According to Hwang and Tan (2010), design can be more complicated than that of a conventional building due to the evaluation of alternative materials and systems. The study has therefore identified "technical difficulty during construction process" as a major barrier to successful adoption of SBTs.

Unfamiliarity with Smart Building Technology

Development of smart construction are technologically difficult because of the nature of the construction work processes itself (Mahbu, 2008). Tagaza and Wilson (2004) pinpointed that the complexity and unfamiliarity with technologies and lengthy technology time could be a constraint to the project management processes in adopting technology in the construction industry. A project manager has to deliver the project with the required performance specified by the client (Pettersen, 1999; Ling, 2003), and unfamiliarity with the performance of smart building technologies may affect the performance outcome, thereby affecting the adoption. Chan et al. (2016) and Darko et al. (2017) also made a point to the barriers by including unfamiliarity of construction professionals with the technologies to be adopted. Lack of professional knowledge and expertise has a significant constraint factor to the project management processes in adopting new technologies (Chan et al.,2016; Durdyev et al., 2018), as well as lack of awareness on SBTs (Darko et al., 2017). Other researchers who have considered the human and culture factor in adopting technology include Williams and Dair (2007), Love et al. (2011), Ahn et al. (2013) and AlSanad (2015).

Higher Cost for Smart Construction Practices and Materials

A research conducted by Chan et al. (2016) discovered barriers underlying the project management processes to adopt green smart buildings in Ghana by including higher cost of technologies capable of helping to achieve sustainability. Ahn et al. (2013) also asserted to add the following as barriers: first cost premium, long payback period, and higher cost of green smart products and materials. Hwang and Tang (2012) and Hwang and Ng (2013) identified the barriers underpinning the adoption of sustainable technology in Singapore by stressing on the high cost of green smart equipment. Mahbub (2008) concluded that the construction industry is often not willing to put in high risk and costly investment into the technology. Many researchers including (Zhang et al., 2011a, b,c; Hwang and Tang, 2012; Shi et al., 2013; Darko et al. 2017; Nguyen et al., 2017, Durdyev et al., 2018) have considered higher cost to be a major barrier underlying the adoption of complex technologies in the construction industrial to achieve sustainability. Therefore, cost has a major role in hindering the project management processes to help adopt and implement SBTs.

Structure and Organization of the Construction Industry

The fragmentary nature and the size of the construction industry make it unreceptive to revolutionary changes (Mahbub, 2008). The research continued that, for construction smart automation, there is a need for compatibility with the existing design, management capabilities, labour practices and site operations. Hwang and Ng (2013) asserted to this by including the following barriers which are as a result of structure and organization of the construction industry: lack of interest and communication among project team members due to organizational structure, and lack of management to encourage research. Chan et al. (2016) also made a point that the challenges to the technology adoption may include lack of management that create awareness and knowledge. Shen et al. (2017ab) also pronounced the lack of the policies and regulations in the construction industry and then lack of information in the industry. The structure of an organization had been seen as a barrier by many researchers including (Samari et al, 2013; Chan et al., 2017; Durdyev et al., 2018). Structure and organization of the construction industry has the possibility to restrain the successful adoption of SBTs.

Lengthy approval process for new Smart Building Technologies (SBTs)

The market environment suggests that the planning process can be protracted as the process of approving the use of new SBTs can be lengthy (Tagaza and Wilson, 2004). Similarly, surveys conducted by Zhang et al. (2011a) and Eisenberg et al. (2002) show that additional time is expected in order to gain approval. A lengthy approval process presents a challenge to project managers as they develop the schedule and approve progress payment to vendors and suppliers (Ling, 2003; Hwang and Ng, 2013). From the review of literatures, it is therefore necessary to note that "Lengthy approval process for new Smart Building Technologies (SBTs)" has possibility of influencing adoption of SBTs.

Conclusions and Recommendations

This study was conducted as a systematic review of literatures on the barriers of the project management processes on Smart Building Technologies (SBTs) adoption, with the help of the Scopus search engine which was used to collect relevant academic (peered -reviewed) journal and conference papers. From comprehensive literature review, it was revealed that, there are many barriers affecting SBTs adoption, but most reported barriers are lengthy approval process for new smart building technologies, structure and organization of the construction industry, higher cost for smart construction practices and materials, unfamiliarity with smart building technology and technical difficulty during construction process. This then indicates that there are major barriers underpinning the project management processes on SBTs adoption in the construction community globally. The study then presented the top five most reported barriers as the major barriers that cut across globally in affecting the project management processes in adopting SBTs.

With regards to recommendations to overcome the barriers underpinning the project management processes on SBTs adoption, the study recommends that a strong collaborative system between policy makers, industry associations and companies should be established to develop and manage SBTs. According to Chen (2007) cited in Zhang and Wang (2013), Government (Policy maker) involvement is one of most vital and effective ways to promote SBTs in the construction community. Therefore, the government is responsible for formulating an effective mechanism and preferential Smart Building (SB) policy frameworks, while industry associations provide useful guidance to encourage contractors and developers to pursue SBTs. Shi et al. (2013) added that Industry associations are also known to facilitate the sharing of information regarding SBTs between contractors and developer firms.

This study has therefore contributed to the knowledge of barriers underpinning the project management processes on SBTs adoption by identifying the most reported barriers (major barriers) in the literature. From a global perspective, the findings are liable to provide better understanding of what is restraining the rapid adoption of SBTs. Policy makers and industry practitioners would be able to identify gaps in SBTs implementation, and figure out the key areas where policy initiatives can help accelerate SBTs adoption. To contribute to the construction community globally, the study recommends the involvement of the government (policy maker) to help promote SBTs through policy formulation for sustainable development. In future on construction project, stakeholder would be eager to increase the adoption of SBTs when the underlying barriers are identified and overcome. For scholars to further embark on barriers underpinning the project management processes on SBTs adoption, the check list of SBTs barriers and references can be depended on. The study recommends that empirical research could be conducted on the list of the barriers to come out with the significant barriers to the project management processes on the adoption of SBTs in different countries across the world.

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