OVERCOMING BARRIERS THAT HINDERS THE ADOPTION AND IMPLEMENTATION OF BUILDING INFORMATION MODELLING IN THE SOUTH AFRICAN CONSTRUCTION INDUSTRY

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Building Information Modelling (BIM) is a concept that has been defined as a technology that digitally constructs an accurate virtual model of a building. BIM can be defined as an IT enabled approach that involves the application and maintenance of a fundamental digital representation of a building and all its information throughout the different stages of the project. This study assesses the ways to overcome the barriers hindering the adoption and implementation of BIM in the South African construction industry. The data used in this paper were derived from primary and secondary sources. The primary data tool (questionnaires), was designed based on the related literature that were reviewed. The questionnaire was distributed to construction professionals in the South Africa construction industry, facility managers, and academics who have are scholars on BIM in the South African construction industry. The questionnaires were analysed using descriptive statistical procedures. The findings revealed that a lack of skills, education, and knowledge of BIM are the biggest barriers to the adaptation and implementation of BIM in South Africa. Furthermore, the results also show that educational and skill development initiatives are widely considered to being the answer to the existing barriers to BIM adoption. Lastly, the study makes some recommendation on feasible ways of moving away from the common practice of construction process and to the adoption of BIM on construction projects in South Africa.

Keywords: building information modelling, construction industry, South Africa

INTRODUCTION

BIM produces a model known as the building information model, which according to Ahazar (2011) and Bryde et al., (2012), can be used throughout all the project stages to, and including the operation and maintenance of the facility. According to Riddel (n.d.), BIM represents the design of the building as objects that carry their geometry and full attributes. This is achieved because the model will depict how the building will look once all the components have been inserted or built into the data. According to Ashraf and Esquire (2008), some of the other possible uses for BIM in construction industry include it being used solely for design purposes, for coordination and clash detection, estimating material prices, construction simulation, and the creation of shop drawing and for review of submittals, amongst others. Although BIM is perceived to being able to eradicate almost all the inadequacies that arise in the process of construction, it is not the solution to all the problems in construction (Davidson, 2009). Eastman et al., (2008) further states that BIM is a modeling technology, which has an associated set of process that produce, communicate and analyze building

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models. The authors further identify the characteristics of these models by the building components that are digitally represented, the different components of the data, and the data, which produces the different views of the model. The communicated views are 3D representations which is something that cannot be achieved without the usage of BIM. However; even with the documented benefits of using BIM, it has certain barriers that make potential users reluctant to its full adoption and implementation in the construction industry. Daivdson (2009) attributes some of these barriers to issues such as workflow disruption, staff and training, legal and contractual issues and interoperability. Some of these attributions are echoed by Ku and Taiebat (2011) and Takim et al., (2013). These barriers are universal because of the professionals' reluctance to move away from their usual methods of managing and carrying out projects. Furthermore, Cidik et al., (2014), with aid from Bank et al., (2010) identify other abilities of the BIM technology, including those before mentioned, to help professionals in carrying such performance assessments at earlier design stages of the projects as a benefit of using BIM. Although BIM is proving to be the answer to a lot of construction related problems, it has also been widely noted by authors such as Brewer et al., (2012) and Ashcraft and Esquire (2008) that BIM doesn't come without its challenges. From the literature that was reviewed, the researcher found that there were two major issues which were turning out to being barriers to the adoption and implementation of BIM in construction industries across the world. These barriers could be divided into two groups namely contractual issues as explained by Ashcraft and Esquire (2008), and personnel issues as explained by Ku and Taiebat (2011).

Ashraf and Esquire (2008) have identified certain legal issues that that stand in the way of the full adoption and implementation of BIM. These issues provide headaches with regards to who should be taking responsibility for which parts of the model, as well as the distribution of risk amongst all the professionals within the project team. Therefore, in this research study, the researcher has looked at what BIM is, the critical barriers to its adoptions, and how these barriers can be successfully overcome in the South African construction industry.

BARRIERS TO THE IMPLEMENTATION OF BIM

Ashraf and Esquire (2008) have done a lot of research on the barriers to the full adoption and implementation of BIM in construction. And they have listed the following as the some of the existing barriers:

Standard of care of using BIM

This looks at the inability of the professionals to identify and rectify any physical conflicts (clash detection) that may occur during the project life using BIM. The resulting consequences of such 'negligence' may include delays and cost overruns due to reworks that will be required once clashes are detected.

Design delegation and professional responsibility

This clause looks to define and identify the roles and responsibilities of the parties involved in the project. The process between design, construct and ownership of the building puts normally puts the architect and/or engineer as the person with the most responsibility for the model. Alternatively, a new position such as a BIM-modeller can be created (Brewer et al., 2012) to carry out the same responsibilities.

Intellectual property
This refers to the challenges that will arise in terms of what is the design and who owns it amongst others. Such problems are only resolved by contractual agreements at the commencement of the design process. Failure to do so may lead to violations because the model holds the parts of the design.

Insurability
This relates to who has rights in the model of the project at hand. Hence the rights to the models have to be insured. Insurance brokers involved in the construction industries are yet to allow stable and assured policies with regards to these issues.

Data translation
This relates to the sharing/feeding and/or transferring of information into the model. The appropriate interoperability of the information is a fundamental aspect of BIM. The ability for different tools in the model to adequately send and receive information is of utmost importance. The ethics of the professionals plays a role in ensuring the smooth-running of this part of the model.

METHODOLOGY

The data used for this paper was derived from both primary, and secondary sources. The primary data was obtained through a structured close-ended questionnaire, and the secondary data was obtained from the relevant literature that was reviewed by the researcher. A total number of 65 structured questionnaires were sent to individuals in the municipalities of Tshwane, City of Johannesburg, and Ekhuruleni (all in Gauteng, South Africa) who are practicing as Quantity Surveyors, Construction Managers, Architects, Facility Managers, Project Managers, or Academics. The questionnaire was designed based on the information that was gathered during the literature review. A 5-point likert type scale was used for the questionnaires. This scale measured the extent to which the respondents agreed or disagreed with the factors presented to them. A random sampling method was adopted for the purposes of this research. This method was preferred due to the fact that it gave all the targeted respondents an equal chance and opportunity of being selected.

From all the questionnaires that were sent out; 50 usable questionnaires were returned. This meant that the response rate was at 77%. The data were then analyzed using the Statistical Package for the Social Sciences (SPSS); with the frequencies and mean item scores (MIS), and the standard deviations (SD) of the rated factors being considered. This research was conducted between the months of May and September 2014; with the data collection being carried out between June and August 2014.
The Likert scales were transformed to an MIS for each of the research objectives as applicable. The indices were then further used to determine the rank of each item according the results obtained from the respondents. These rankings made it possible to cross compare the importance of each item to the respondents. The MIS was based on previous studies as conducted by Mukuka et al., (2013) where the ‘MIS’ rating was used. This method was also used for this study to analyze the data collected through the distributed questionnaire. The MIS was calculated from the total of all weighted responses and then it was related to the total responses on a particular option/item on the questionnaire. This was based on the principle that respondents’ scores on all the selected options, considered together, are indices of the relative importance of each of

the options. The index of MIS of a particular factor is the sum of the scores that were received from the respondents (on the particular Likert scale of that question) as just a proportion the overall score that all respondents could give to that factor (one to five), which, for the two main questions for this study, mean "Not a barrier (NB)-Extreme barrier (EB)" and "Strongly Disagree (SD)-Strongly Agree (SA)". The relative index for each item was calculated for each item as follows, after Aigbavboa et al (2013). Following the mathematical computations, the criteria are then ranked in descending order of their relative importance index (from the highest to the lowest). The next section of the article presents the findings of the survey and some discussions.

FINDINGS AND DISCUSSIONS

Biographical data results

Findings from the respondents revealed that 64% of the 50 respondents were male; while 36% were female. Furthermore, 36% were between 20 and 25 years of age, 28% were between 26 and 30 years of age, 18% were between 31 and 35 years of age, 10% were between 36 and 40 years of age, 4% were between 41 and 45 years of age, and 4% were between 46 and 50 years old. Results also showed that none of the respondents above the age of 55 years old. The results further showed that 42% of the respondents had obtained a Bachelor's Degree, 38% had a Diploma, 14% had a Master's Degree, and only 6% had a Matric certificate as their highest educational qualification, 32% were working as Quantity Surveyors, 32% were Architects, 18% were Construction Managers, 12% were Project Managers, 4% were Construction Project Managers, and only 2% were working as Facility Managers. When asked about their years of experience in their field of work, 52% had between 1 and 5 years, 30% had between 6 and 7 years, 12% had between 11 and 15 years, 4% had between 16 and 20 years, and only 2% had above 20 years of experience; while 32.7% worked for contractors, 28.6% worked for/as consultants, 20.4% represented a client in the private sector, 12.2% represented the government as a client, 2% worked for higher learning institutes, and 4.1% worked for organisations that weren't listed as one of the available options. All these biographical information were obtained within the three main municipalities of Gauteng known as Ekurhuleni, Tshwane, and the City of Johannesburg.

Critical barriers to the adoption of Building Information Modelling

When the respondents were asked what they thought were the barriers to the adoption of BIM in the South African construction industry, they identified and ranked a lack of BIM skills development as the main barrier (MIS=3.56, SD=0.675). The results, shown in Table 4.3., also show that lack of training on BIM (MIS=3.53, SD=0.892, Rank (R) =2), lack of education on BIM (MIS=3.52, SD=0.909, R=3), the unavailability of qualified personnel (MIS=3.42, SD=0.785, R=4), and the lack of expertise on BIM (MIS=3.32, SD=0.768, R=5) are amongst the major barriers to the full adoption and implementation of BIM in the South African construction industry. This is in full agreement with what Ku and Taiebat (2011), Aouad et al (2006), and Arayici et al (2009) said about personnel problems being the biggest hindrances and barriers to the full adoption of BIM in organisations. The results show that problems arising from contractual issues (MIS=2.74, SD=0.922, R=16), licensing procedures (MIS=2.68, SD=0.935, R=17), and insurance issues (MIS=2.65, SD=0.830, R=18) are the lowest ranked in relation to them being factors in the full adoption and implementation of BIM in the South African construction industry. The lower ranked factors are also in agreement with Eadie et al (2014) and Ashcraft and Esquire (2008) who said contractual issues were also barriers in the adoption of BIM globally. However, the results contradict Ashcraft and Esquire's (2008) conclusion that the contractual issues are among the main barriers.

Ways of overcoming the barriers to BIM adoption

In addition, when the respondents were asked to rate their agreement with the researcher as to which ways would work best in eradicating these barriers, education on BIM came out on top. The results, also shown in Table 2, show that the respondents believe that BIM should be integrated into education courses across all built environment disciplines (MIS=4.52), that BIM skills development programmes should be conducted in the construction industry (MIS=4.32), and that the availability of BIM technology be increased (MIS=4.28).

Table 2: Shows the identified ways of overcoming barriers to BIM adoption in the South African construction industry

Ways of overcoming barriers to BIM adoption in South Africa	MIS	SD	RANK
Integrate BIM into education courses across all built environment disciplines	4.52	0.707	1
Conduct BIM skills development programmes in the construction industry	4.32	0.844	2
Establish feasible ways of moving from common practice into BIM	4.28	0.784	3
Increase the availability of BIM technology	4.28	0.927	3
Conduct workshops on BIM benefits to create awareness among all the stakeholders	4.24	0.797	4
Undertake pilot projects to validate and demonstrate the BIM outcomes.	4.10	0.839	5
Improve interoperability of the BIM software with existing applications	4.08	0.922	6
Communicate lessons learned from the pilot projects to all stakeholders	4.08	0.944	6
Develop forms of contracts for stakeholders for the use of BIM technology	4.04	0.947	7
Develop forms of contracts for stakeholders for intellectual property of BIM	4.02	0.958	8
Improve on BIM software standardization.	3.94	0.843	9
Develop forms of contracts for stakeholders for warranty requirements of BIM	3.94	0.956	9
Educate government departments on 'model-based' deliverables and its benefits	3.94	1.038	9
Develop forms of contracts for the insurance of BIM	3.84	0.934	10
Have government enforce the usage of BIM as a primary requirement in the built environment sector	3.72	1.230	11

The results have also shown that the respondents consider the improving of BIM software standardization (MIS=3.94), the developing of forms of contracts for the insurance of BIM (MIS=3.84), and having the government enforce the usage of BIM as a primary requirement in the built environment sector (MIS=3.72) as the lowest ranked. However, it must be noted that although these three are at the bottom of the list, the MIS's are not too far from those at the top. This explains that any, if not all, these suggested ways to overcoming the identified barriers could have a major impact if they were taken forward and enforced.

CONCLUSIONS

The study has assessed the critical barriers to the adoption and implementation strategies of BIM in the South African construction industry. The findings of the study suggest that the barriers to the adoption in South Africa are similar to those of the first world countries. The findings reveal that BIM and its tools are used in South Africa, however it has not been exposed to enough people for it to be considered on construction projects in the local industry, with only 38% of the organisations using BIM on often and/or all their projects. The findings further reveal that a lack of skills, education, and knowledge on BIM are the biggest barriers to the full implementation of BIM in the South African construction industry, in addition to that, the results also show that educational and skill development initiatives are widely considered to be the answer to the existing barriers to BIM adoption. Also, increasing the availability of BIM technology to all organisations, and establishing feasible ways of moving away from the common practice (way of doing business) into using BIM on all construction projects have been ranked highly as possible ways of overcoming the identified barriers to the full implementation and adoption of BIM in the local South African construction industry. Therefore, the study's objectives of assessing the critical barriers to the adoption of BIM in the South African construction industry, and to suggest feasible ways of overcoming the berries have been met.

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