Study on Business Value of Building Information Modelling – Applied in Developing Countries

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Abstract

This research investigates the business value of implementing building information modelling (BIM) in developing countries. The study of BIM in this research is conducted with a focus on its return on investment (ROI) in the construction sector. There is an imperative need for such new systematic studies to contribute to the growing knowledge of the practicing communities. After studying the extensive body of literature, it was determined that there were numerous surveys and/or workshops that addressed the same topic from various angles. This led to the research methodology used in the current paper. Such existing research analysed respondents' responses to arrive at some conclusions. Based on this, the author chose to analyse these prior studies and not necessarily create an independent questionnaire that would ultimately add more questions than it would solve. The study's key conclusion is that no quantitative formula for ROI can be used, and the only option to address this issue is to rely on qualitative research that claim adopting BIM has a high potential to provide both direct and indirect income. Due to disputed underlying assumptions, every attempt to estimate the ROI of BIM discovered in the literature cannot be generalised.

Keywords: Business Value; Building Information Modelling; Construction

1 Introduction

Over the past two decades, a growing number of construction projects have used building information modelling (BIM). Although there is not a single definition for BIM, it can be described as a process used to develop and handle digital information about a construction project throughout the project lifetime (NBS, 2019). Another description of BIM is a method that involves the development and administration of illustrations of the physical and functional attributes of places and is supported by a variety of tools, technologies, and contracts (Wikipedia, 2021).

It is reasonable to wonder why concerns regarding the adoption's return on investment (ROI) have not been raised to the same extent as with other tools, such as AutoCAD, which completely and quickly transitioned the building industry from conventional to computerized drawing, in 2D but with attributes. Among other things, vendor lists and material take-off have both utilised these properties. However, despite the fact that BIM was launched as a breakthrough technology that goes back to the 1990s, there are still concerns or scepticism about its total commercial worth, and out of the vast body of literature, not a single research paper or report has been able to address this problem.

If we take into account the fact that the majority of research focus on industrialised nations, the scenario and statistics in developing nations, where BIM adoption or awareness are still issues, look very different. Lack of support from the government and, more directly connected to this current study, risk regarding the business value of BIM adoption are among the elements that are frequently

deemed to be having a negative impact on the proliferation of BIM in developing nations.

The BIM by providing a description of individual features of the building is considered as one of the major outcomes (NBS, 2019). Building a BIM in the digital space allows for interaction with the structure to optimise actions, increasing the asset's whole life value.

There have been plenty of listed benefits of using BIM in construction throughout the project's end-to-end cycle (Qian 2012, Stowe et al., 2015). It represents the future solution that can be capable of comprehensively enhancing the productivity of different players in the construction industry in addition to enabling a more effective delivery process of buildings and structures (Qian, 2012). Whereas the value proposition and economical gains of BIM adoption are still under scrutiny (Jupp, 2013), especially by the classical stakeholders, there is perception of it as luxury, hype and not necessarily an enabling technology. The research by (Won & Lee, 2016) looked into this very question in an attempt to provide some criteria of when BIM is needed and suggested some indicators of the added value of implementing BIM.

A gap in the open literature has been identified to stem from the aforementioned concluding remarks from different reports. The proposed research puts more emphasis on how to evaluate ROI of BIM adoption in construction projects by associating available methods (Kouch, Illikainen, & Perälä, 2018; Kulaksiz, 2019; Salih, 2012). The standard definition of ROI used in this research is that provided in (Wikipedia. 2021); it is defined to be the quantitative relation between the net income and the amount of invested resources. It is worth highlighting that the ROI can be used to evaluate the potential profitability of a certain investment, but at the same time it may not provide a means of quantitative measurement of such investment (Feibel, 2003). As mentioned in (Schachner, 1973), return on investment (ROI) allows both financial managers and financial analysts to have a quick look at the ability of an investment to generate profit now or in the future. It compares the expected benefit obtained via the investment with the cost of the investment (Autodesk, 2007).

This research focuses on BIM adoption in developing countries in order to shed some light on the consequence of a country's economic status on implementing BIM. Despite the available data's scarcity, some prior research can still be relevant (Sahil, 2016; Durdyev et al., 2021); Masood, Kharal, & Nasir, 2014).

2 Research Objectives

This research aims at studying the ROI aspect of the business value associated with adopting BIM in the developing countries. The prior research summarized in the introduction section highlights the imperative need to investigate and comprehend the factors of ROI of BIM adoption, which represents the most significant advancement in the digital transformation of the construction industry since the breakthrough done by AutoCAD, which took place in the form of comprehensive and swift switch from manual conventional drawing to digital 2D drawing with attributes to enable material identification and vendor lists. Three decades ago, BIM was introduced as an innovative technology, however, there's no systematic study in the vast literature that addresses the concerns or doubts regarding its overall business value. This is further compounded by the fact that most studies focus on case studies in the big economies only, while the indicators are significantly different in developing countries that are facing challenges with the paradigm shift to digital systems in construction, not to mention the adoption of digital transformation enablers (e.g. BIM in the construction industry). The research addresses the main findings of the literature. It also investigates the possible adoption of unified measurement tools in different countries as well as companies or

organizations that implement BIM.

3 Methodology

The research methodology for the current study was established after examining the extensive body of literature (Sadek, 2022) and discovering that there are many questionnaires and/or workshops that address the same subject in various ways. Such existing research investigated respondents' responses to arrive at some conclusions that were then shown either visually or statistically. Based on this, the author chose to analyse these prior studies rather than create a separate questionnaire that would ultimately add more questions than it would solve.

4 Literature Review

This section reviews the prior literature relevant to this current research. The author believes that although important, other methods of literature reviews, such as bibliometric, scientometric, or latent semantic analysis, which are frequently utilised in cases of large volumes of literature, are ineffective for the current study's objectives. Therefore, in the following, an analysis of the critical literature content is conducted.

4.1 The BIM Definition

The current definitions of BIM in the open literature stem from the understanding of the author that are influenced by their range and scope of experience. There is a general misconception across the construction industry community that BIM is nothing but a software package or an add-on tool. However, the definition of BIM is portrayed as using 3D data in handling building data during its end-to-end lifecycle, with the right BIM tools to enhance building design and construction productivity. The BIM comprises different aspects and outputs that are produced from the process. This includes, but is not limited to, geographic information, spatial relationships, building geometry, quantities, and properties of building systems and components.

Aside from that, BIM also facilitates information transfer through digital presentations and provides a solid foundation for decision-making throughout the course of a project (Abanda & Joseph, 2014). Every researcher defines BIM from his or her own point of view; there isn't a single definition of BIM as can be found in the body of existing literature. Due to the definer's experience or purpose, the definition of BIM has been developed from different perspectives (Amin & Abanda, 2019; Mena et al., 2009).

5 BIM Measurement Tools

In this section, the research question on unified measurement tools to be applied is addressed based on (Succar, 2010). The research in (Succar, 2010) classified organizations with respect to their strategy of BIM implementation. The Yellow Organisation adopted an approach to invest heavily to adopt software packages that are object based in their nature. The management gave its marketing team the go-ahead to insert BIM labels onto the website of the Yellow corporate and begin acquainting potential customers with their new potential capabilities as well as the commercial potential of the new technologies and tools. The Blue Organization put a lot of time and effort into researching, creating, and then progressively putting into place a comprehensive BIM strategy, customised training programmes, modelling standards, and workflow processes. In order to communicate with, educate, and teach workers about BIM technologies and processes, both internal and external assistance was sought. After taking the helm in this implementation effort from the beginning, the management team was able to inspire and involve every employee in the creation of

BIM products and procedures. They did ongoing internal evaluations to make sure that BIM productivity was steady enough and that they could consistently and predictably generate high-quality models and drawings.

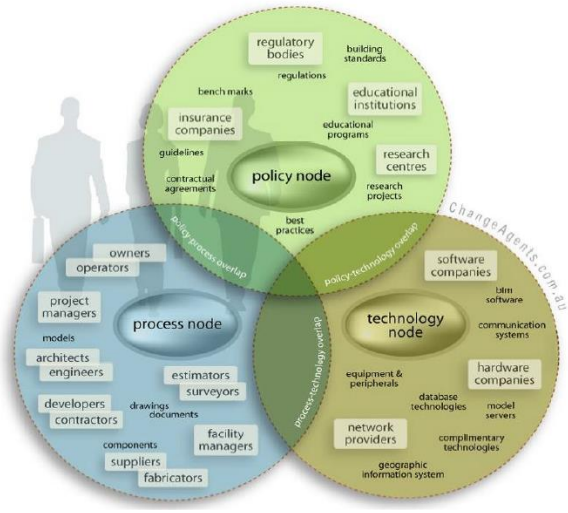

Fig. 1: The Interacting Elements of BIM Activity (Succar, 2010)

They enabled the marketing team to insert BIM visuals onto the website of the Blue Corporate website and begin alerting potential customers about their new capabilities since they were certain that BIM is the most effective approach to deliver services. Thus, the idea of capability differs greatly from that of maturity. A 'maturity model' puts together the main performance improvement levels, which need to be achieved by a certain entity (organization or a project team). The maturity models reported by COBIT, ISACA and CMMI, are some examples of several maturity models reported in the literature that respond to the first quest.

Previous research studied the BIM benefits. As this study relates to the return on investment of BIM, the research related to BIM implementation cost analysis is the focus of this article. The authors of (Azhar, 2008) conducted a study on the Atlanta Hilton Aquarium project and detailed the time and cost savings of BIM implementation. An estimated cost saving has been assigned for each resolved cost conflict.

Research in Holness (2006) has stated that the potential savings resulting from the use of BIM in the sector of construction are expected to range from 15% to 40% of total construction costs. In addition, the author states that for industrial projects that are deemed large scale projects with budgets of $75 to $150 million, the cost of BIM implementation ranges between 0.25% and 0.5% with respect to the total construction costs. The percentage of BIM costs to the total cost of construction is anticipated to change as the type and size of the project changes.

The available studies reported in the literature have concentrated on either the budgetary benefits or the speculation investigation of BIM in a single development company and its particular applications and project deliverables, which may not be scalable to other applications in the construction industry. This is expected since these investigations are limited to the company in question within its particular conditions and circumstances.

6 Adopting Bim: The Business Value

It was decided to review the extensive existing literature and finalize its findings, rather than conduct a new study that would repeat the same approach and compound the general problem of conflicting

conclusions and comments. Basically, the existing research evaluating the business value of BIM adoption in the construction industry can be divided into two groups. The first group of the existing literature, attempted to assess the ROI of implementing BIM by conducting a relevant questionnaire with carefully worded questions targeting a set of homogenous companies or organizations practicing AEC. After receiving the questionnaire completed by the respondents, an analysis including statistical evaluation is carried out and the results are listed. A sample article is (Enshassi, A., & AlKilani, 2018). Although there is wide variation in outcomes related to the foreseen ROI of implementation of BIM in the construction sector, it is more realistic to adopt such outcomes.

The second group, with a much smaller count of contributors than the first, followed an analytical methodology and developed an analytical model of his ROI, including the direct and/or indirect benefits and costs of adopting BIM. A number of assumptions have to be made to quantify his ROI of BIM implementation. The aforementioned assumptions may not be unanimously accepted. The sample release is (Giel & Issa, 2013).

7 Developing Countries

Developing countries that still struggle with BIM adoption presents another complication. The lack of data leads to undesirable interdependence on conditions and conclusions drawn from cases of implementation in the developed countries. Data were collected through the conducted focus group interviews. The analysed data were interpreted into a theoretical context representing the synthesis of various BIM activities using a grounded theory approach. The resulting work plan was then compared to the traditional phases of the Egyptian project life cycle to identify the strengths and weaknesses of each method.

7.1 BIM Awareness and Implementation in Africa

A fast growth of the Architecture, Engineering and Construction (AEC) industry in Africa is foreseen in the next few years. This will position the African continent as a major player worldwide in such industry. To highlight the size of major AEC projects conducted in the regions of Eastern, Southern, Central, Western and Northern Africa, the Deloitte report (Deloitte, 2022) listed the values of such key projects with a total of around $187bn, $125bn, $26bn, $82bn and $148bn, respectively. Such a challenge is compounded by the slow rate of digital solutions adoption in the AEC industry.

The adoption rate of BIM in Africa is lower compared to the developed countries. According to the research in (Abubakar et al., 2014) the level of BIM awareness in the above-mentioned five African regions ranged between 30% (Zambia) and 100% (Cameroon). The level of BIM awareness in Egypt (as indicated by the contributions to literature) exceeds 90% which is relatively high. Nigeria has contributed a high number of publications and awareness. However, the subjective sampling approach adopted in these surveys makes such results less indicative of the real situation. Nevertheless, they effectively depict their relative level of awareness. In the case of some leading countries (Egypt, South Africa and Nigeria), the high number of BIM publications indicates an advanced level of awareness but does not necessarily indicate an associated high level of implementation in AEC projects.

The BIM research is still at an early stage in the African continent. In general, the studies across Africa have shown that the implementation of BIM in Africa is facing the challenges of the barriers related to people/process interactions (e.g. lack of awareness, training, demand, and government support) followed by those related to economic and technological factors.

Therefore, increasing the awareness is mandatory as well as changing the mindset of the stakeholders in the AEC industry to start appreciating the benefits of BIM. The governments in Africa seem to have no clear mandates or policies towards such a paradigm shift, which necessitates adopting a bottom-up approach.

The cost of software and personnel training has been repeatedly reported especially by small and medium enterprises (SMEs) in different parts of Africa as a major challenge that hinders the spread of use of BIM in the AEC industry. This is merely attributed to the limited resources available for such SMEs to invest in such a risky transition to BIM. Finally, challenges related to lack of BIM standards, and inadequate infrastructure have adversely affected the development of BIM implementation in the AEC sector in Africa. Developing detailed action plans in the African context are necessary to target the resolution of the aforementioned challenges in order to support diffusing the BIM technology.

7.2 BIM Adoption in the Egyptian context

The feedback from practitioners in sales, design and construction in Egypt have been used to explore the benefits and challenges of BIM integration. In this case, BIM was developed based on Egyptian architectural practices. Focus group discussions revealed topics necessary for a successful implementation of BIM that included training on design coordination, as well as redefining the current detail levels, in addition to the necessity of governmental BIM mandating policies. A limitation, however, was the difficulty in reaching out to staff with extensive facility management experience.

Despite BIM's wide adoption in the industrial and developed countries since the onset of this century (Jung & Lee, 2016), the regions of Africa and the Middle East have been lagging and still struggling to actively catch up with other regions in such aspects. Although the number of BIM adopted projects has been going on (Gerges 2017, Jung & Lee 2016), more systematic and systemic efforts are still needed in order to perform such paradigm shift in the region. The creation of obligatory regulations with the aid of using governments' groups to sell the endorsement of BIM is an essential aspect that have motivated the adoption of BIM in international locations just like the UK (Abanda & Tah, 2014 and Cheng, 2015). However, Egypt's construction sector does not have enough expertise on the implementation of BIM, urging for the need to offer additional information and data to the industry (Elyamany, 2016). This is compounded by the circumstance in Egypt where the government is not promoting the use of BIM in addition to the lack of BIM published documents and standards (Elyamany, 2016). Elyamany (2016) and Gerges (2017) reported results of a survey on the BIM status in the Middle East. The survey showed that only 20% of AEC companies are either currently or have been using BIM or in the course of the BIM implementation process. On the other hand, the same survey depicted indicators of increased BIM awareness among the individuals of the workforce and end-users. This was evident from the high percentage (60%) of respondents who indicated that they possess between three and nine years of experience through which they have conducted a minimum number of projects adopting BIM. It is important to highlight that the findings from BIM research in the GCC countries and Egypt can be interchangeably applied. This is attributed to the resemblance of such regions' construction practices (Salama et al., 2006).

8 Conclusions

A quantitative formula for ROI of BIM implementation cannot be applied, and the only way to address that aspect is relying on qualitative studies. Such studies indicate a well-established potential

for BIM adoption to generate different forms of revenue. All the attempts reported so far throughout the open literature to quantify BIM ROI could not be generalized due to the controversial assumptions involved. A full list of literature is available in (Sadek, 2022) and reader is referred to such reference for extended bibliography to support all statements made herein. This reference is salient as it is a doctoral dissertation by the author. It contains around 400 references, only a fraction is cited in the present paper for simplicity and clarity.

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