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Original Research Article

Return on Investment of Building Information Modeling Adoption in the Construction Industry in Developing Countries

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Abstract

The present paper focuses on the business value or more specifically return on investment of adoption of Building Information Modeling (BIM) in the construction industry in developing countries. The research area forms a gap in the knowledge of the research as well as practicing communities. Hence, there is a genuine need to fill the missing knowledge. It is a valid question why such concern about the ROI of adoption has not been raised as far as other tools which represented a paradigm shift in the construction industry such as AutoCAD, by which a complete and rapid switch from manual drawing to digital drawing, still in 2D format but with attributes. Such attributes have been used for material take-off and vendor lists among others. However, BIM was introduced as a revolutionary technology at least thirty years ago, the concern or doubts regarding its overall business value still hanging over, and not a single research paper or report out of the voluminous corpus of literature, has managed to resolve this issue. If we add the element of most studies talk about developed countries, while the situation and numbers are completely different in developing countries which are still struggling with the awareness or adoption of BIM in the construction industry. Among the factors commonly mentioned to adversely affect the diffusion of BIM in developing countries, lack of government support, and more closely related to the present study, concern over the business value of BIM adoption. Research methodology in the present paper has been set after reviewing the voluminous corpus of literature and finding that there exist a large number of questionnaires and/or workshops dealing with the same question in different approaches. Such existent studies processed respondents' answers to reach some conclusions depicted statistically or graphically. Based on this, the author has decided to review such extant studies rather than perform an independent questionnaire which at the end of the day will add to questions rather than to answers. The main finding of the study is no quantitative formulation of ROI can be adopted and the only way to deal with such a question is to rely on qualitative studies asserting there exists a high potential of adopting BIM to generate direct as well as indirect revenues. All attempts found in the literature to quantify the ROI of BIM cannot be generalized due to disputed involved assumptions.

Keywords: ROI; BIM; Developing Countries; Construction.

1. INTRODUCTION

Building Information Modelling (BIM) has been employed in an increasing number of construction projects over the past two decades. Although there is no unified definition, BIM can be defined (NBS, 2019) as a process for creating and managing digital information of a construction project across the project lifecycle. Another definition (Wikipedia, 2021) BIM is a process supported by various tools, technologies and contracts involving the generation and management of digital representations of physical and functional characteristics of places.

One of the key outputs (NBS, 2019) of this process is the Building Information Model, the digital description of every aspect of the built asset. Creating a digital BIM enables interaction with the building to optimize actions, resulting in a greater whole life value for the asset.

The benefits of BIM adoption in construction across the project lifecycle are numerous and have been listed by several publications (Qian, 2012; Stowe *et al.*, 2015). Building Information Modelling (BIM) is perceived (Qian, 2012) as the next-generation solution to enhance the productivity of stakeholders in the construction industry holistically and streamline the delivery process of buildings and structures.

On the other hand, the value and returns of BIM adoption have been questioned (Jupp, 2013) with strong statements such as BIM is luxury rather than a necessity. Another research paper was devoted to clarifying whether you need BIM and how to measure the added value of BIM adoption in construction projects (Won & Lee, 2016).

A research gap has been established due to the conflicting remarks made in the available literature. The focus of the proposed research is on the return on investment (ROI) of BIM adoption in construction projects with an emphasis on how to accurately calculate ROI by comparing available methods (Kouch *et al*., 2018; Kulaksiz, 2019; Salih, 2012). ROI is generally defined (Wikipedia, 2021) as the ratio between net income and investment. A high ROI means the investment's gains compare favourably to its cost. As a performance measure, ROI is used to evaluate the efficiency of an investment.

Geographically, the presented research is limited to BIM adoption in developing countries. Although available data can be scarce, some literature can be directly related (Sahil, 2016). Emphasis shall be placed on data provided by study cases in countries such as Cambodia (Durdyev *et al.*, 2021), Pakistan (Masood *et al*., 2014) and further search shall be made to find similar literature for other developing countries.

2. RESEARCH OBJECTIVES

The present study focuses on the business value or more specifically return on investment of adoption of Building Information Modeling (BIM) in the construction industry in developing countries. The research area forms a gap in the knowledge of the research as well as practicing communities. Hence, there is a genuine need to fill the missing knowledge. It is a valid question why such concern about the ROI of adoption has not been raised as far as other tools which represented a paradigm shift in the construction industry such as AutoCAD, by which complete and rapid switch from manual drawing to digital drawing, still in 2D format but with attributes. Such attributes have been used for material take-off and vendor lists among others. However, BIM was introduced as a revolutionary technology at least thirty years ago, the concern or doubts regarding its overall business value still hanging over, and not a single research paper or report out of the voluminous corpus of literature, has managed to resolve this issue. If we add the element of most studies talk about developed countries, while the situation and numbers are completely different in developing countries which are still struggling with the awareness or adoption of BIM in the construction industry. Among the factors commonly mentioned to adversely affect the diffusion of BIM in developing countries, lack of government support, and more closely related to the present study, concern over the business value of BIM adoption.

The paper is developed to answer the following research questions.

What are the main findings of the voluminous extant literature on related topics?

Can we apply same measurement tools on BIM adoption in different countries?

Can we apply the same measurement tools to different companies and organizations in their quest to adopt BIM?

3. RESEARCH METHODOLOGY

Research methodology in the present study has been set after reviewing the voluminous corpus of literature and finding that there exist a large number of questionnaires and/or workshops dealing with the same question in different approaches. Such existent studies processed respondents' answers to reach some conclusions depicted statistically or graphically. Based on this, the author has decided to review such extant studies rather than perform an independent questionnaire which at the end of the day will add to questions rather than to answers.

4. LITERATURE REVIEW

The present section reviews literature related to the topic of the paper. The author believes that other types of literature review commonly used in case of voluminous corpus of literature, bibliometric or scientometric or latent semantic analysis, although useful, do not serve the purpose of the present study. Hence, detailed content analysis or commonly known as literature review is employed in the following.

4.1. Definition of BIM

The existing definitions of BIM are available in various literature. The definition depends on the understanding of a researcher. In general, BIM is not a software as many people in the construction industry think. The definition of BIM is in the form of using three-dimensional (3D) data in the process of producing and managing building data during its lifecycle, with appropriate building information software to improve productivity in building design and construction. BIM consists of various aspects such as building geometry, spatial relationships, geographic information, quantitates, and properties of building components are also produced from the process.

Apart from that, BIM also serves to share the knowledge through a digital presentation and forms a reliable basis for decision during the entire project life cycle (Building SMART & National BIM Standard - United States, 2007). There is no unified definition of BIM that can be found in the extant literature but rather every researcher defines BIM from his own perspective.

BIM has been defined in various ways due to the area of expertise or to serve the definer's aim (Aranda-Mena *et al*., 2009; Abbasnejad & Moud, 2013).

Succar, B., (2010a), defined a set of technologies, processes, and policies enabling multiple stakeholders to collaboratively design, construct and operate a facility in virtual space as in.

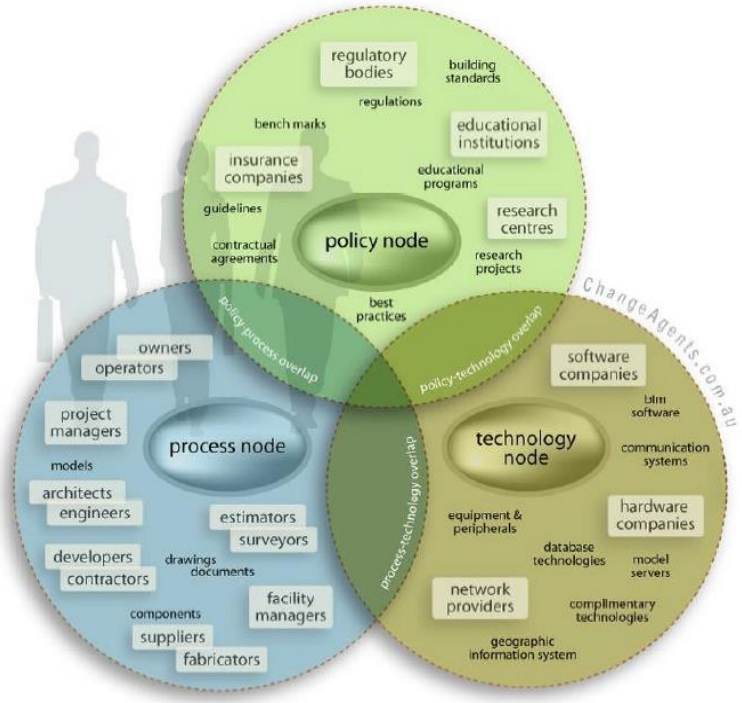

Figure 1: The interlocking fields of BIM activity (Succar, B., 2010)

Autodesk, (2018), stated that BIM is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to efficiently plan, design, construct and manage buildings and infrastructure. Despite that, the different definitions emphasize that BIM helps all AEC projects participants to collaborate in an intelligent environment to improve the projects efficiency, performance, and achieving the stockholder requirements.

5. BIM Measurement Tools

This section is dedicated to responding to the following research question. Should we apply the same measurement tools to different companies and organizations in their quest to adopt BIM?

This section is mainly based on (Succar, B., 2019) published in the 14th issue of BIMARABIA magazine.

5.1. Types of Organizations

Succar, B. (2019) classified organizations in terms of their quest to implement BIM into Yellow and Blue organizations (Table 1).

The Yellow Organisation decided to invest substantial energy and money to acquire object-based software (say Revit®, Tekla® or Vico®). The management, now excited about the commercial possibilities of the new deliverables, instructed its marketing people to inject BIM images and labels into Yellow's corporate website and to start informing potential clients about their new abilities.

The Blue Organisation invested substantial time and energy in investigating, developing and then gradually implementing an overall BIM strategy, tailored training plans, modeling standards and workflow protocols. Internal and external help were sought to communicate, train as well as educate staff about BIM technologies and processes. The management team, after leading this implementation effort from day zero, succeeded in getting all staff enthusiastic and engaged in developing BIM products and processes. They continuously conducted internal assessments to ensure that their BIM productivity is sufficiently stable and that they can predictably and uniformly deliver high-quality models and drawings. Convinced that BIM is the only efficient way to deliver services, they allowed their marketing people to inject BIM images and labels into Blue's corporate website and to start informing potential clients about their new abilities.

Capability is thus a notion quite different from Maturity.

#	Yellow Organisation	Blue Organisation
1	Uses Object-based software tools	Also uses Object-based software tools
2	Can collaborate internally using multi-disciplinary object-based models	Same as left...
3	Can deliver at least one large BIM project of construction value exceeding $200m	Same as left...
4	Has experience in the Health Sector	Same as left...
Quick Conclusion: *the Yellow and Blue organisation have very similar BIM Capability*		
#	Yellow Organisation	Blue Organisation
1	Bottom-Up initial BIM approach	Top-Down initial BIM approach
2	Champion-lead implementation	Management-lead implementation
3	No evidence of overall BIM strategy	Overall Strategy preceded implementation
4	No evidence of internal communication about BIM implementation efforts	There is evidence of internal communication as part of the BIM implementation effort
5	Standards were learned, developed and extended on the go	Standards and workflows where readied prior to wide implementation
6	Evidence of change-resistance (cynicism)	Evidence of wide-spread enthusiasm
7	No evidence of skill/knowledge assessment	Evidence of skill/knowledge assessment

Table 1: Yellow and Blue Organizations (Succar, B., 2019)

5.2. Maturity Models and Tools

A 'maturity model' is simply a set of performance improvement levels that can be achieved by an organization or a project team. There are many maturity models which are relevant to our quest but a few of them below are mentioned in the following.

Table 2: Sample Maturity Models Relevant to BIM

1	COBIT, Control Objects for Information & related Technology – Information Systems Audit & Control Association (ISACA) & the IT Governance Institute (ITGI) .
2	CMMI, Capability Maturity Model Integration - Software Engineering Institute/ Carnegie Melon
3	CSCMM, Construction Supply Chain Maturity Model - Vaidyanathan & Howell (2007)
4	I-CMM, Interactive Capability Maturity Model developed as part of the National BIM Standard (NBIMS) Version 1 Part 1 - a project of the National Institute for Building Sciences (NIBS), buildingSMARTalliance™ - weblink.
5	Indiana University BIM Proficiency Matrix - weblink (MS Excel File)
6	Knowledge Retention Maturity Levels - Arif, Egbu, Alom and Khalfan (2009) [4]
7	LESAT, Lean Enterprise Self-Assessment Tool - Lean Aerospace Initiative (LAI) at the Massachusetts Institute of Technology (MIT) - weblink
8	P3M3, Portfolio, Programme and Project Management Maturity Model – Office of Government Commerce (UK) - weblink
9	P-CMM®, People Capability Maturity Model v2 – Software Engineering Institute / Carnegie Melon - weblink
10	$(PM)^2$, Project Management Process Maturity Model - Kwak & Ibbs (2002) [5]
11	SPICE, Standardised Process Improvement for Construction Enterprises - Research Centre for the Built and Human Environment, University of Salford – Hutchinson & Finnemore (1999) [6]
12	Supply Chain Management Process Maturity Model and Business Process Orientation (BPO) maturity model - Lockamy III & McCormack (2004) [7]

6. Return on Investment

In interpreting the potential costs savings of BIM, return on investment must be explained in brief. Return on investment (ROI) is one of many ways to evaluate proposed investments, as it compares the potential benefit or gain of an investment to how much it costs. Sometimes referenced as the rate of return, ROI is usually calculated by taking a ratio of profits received

as a result of an investment over the price of the investment. That value is then multiplied by 100 in order to establish a percentage that can be used as an indicator of performance. It is important to note that "ROI is a measure of investment profitability, not a measure of investment size (Feibel 2003)." It measures the percent return on an amount of capital expenditure. Some define ROI as a ratio of the net benefits produced by an investment over the cost of the investment times 100 (Feibel 2003).

According to Schachner (1986), Return on Investment (ROI) is a yardstick that enables both the financial executive and the financial analyst to get a quick insight into the profitability of an existing or future investment. It compares the gains anticipated from an investment against the cost of the investment (Autodesk 2007). According to Feibel (2003), ROI is a measure of investment profitability, not a measure of investment size. It gives the ratio of percent return on the amount of capital expenditure. It can be defined as the ratio of the net benefits produced by an investment divided by the cost of the investment and then multiplying the ratio by 100. ROI can be calculated using Equation 1 (Feibel 2003):
ROI = (Gain From Investment-Cost of Investment/Cost of Investment) x 100 ……. Equation 1

Past research has focused on the benefits of BIM. Since this study is related to the ROI of BIM, the studies related to cost analysis of BIM implementation are the main focus of this paper. Azhar, Hein, and Sketo (2008) performed a case study of Hilton Aquarium project in Atlanta and they specified the cost and time savings realized by BIM implementation. They assigned an estimated cost saving for each resolved overhead clash.

Holness (2006) claimed that potential savings from using BIM in the construction industry was expected to be between 15% and 40% of the total construction cost. Further, the author stated that for large industrial projects which have a budget between $75 million and $150 million, BIM implementation cost was found out to be between 0.25% and 0.5% of total construction cost. BIM cost percentage to total construction costs were expected to change as the project type and project size changed.

Barlish and Sullivan (2012) worked on three project case studies, and they claimed that using BIM in the construction of semiconductor manufacturing facilities is beneficial.

In each study, they compared non-BIM projects and BIM projects in terms of:

- The number of requests for information (RFI),
- Project duration,
- The number of change orders.

It can be observed that the past studies have either focused on the financial benefits or investment analysis of BIM for a single construction company and its specific type of projects and these results may not be generalizable to the construction industry.

Because these analyses results hold true for the given company with its specific conditions. The specific conditions are composed of factors such as:

- The kind of project types that the company was working with,
- The company's BIM experience level,
- The project delivery system the company is working with, etc.

7. Assessment business value of BIM adoption

It has been decided to review the exiting voluminous literature and conclude their findings rather than conducting a fresh study repeating the same approach and adding to the overall problem of conflicting remarks and conclusions. Basically, existing research on assessing the business value of adopting BIM in construction industry, can be categorized as two groups. First group, which constitutes the majority of existing literature, has adopted the approach to attempt to evaluate ROI of BIM through sending a well-designed questionnaire with carefully phrased questions to a set of homogeneous practicing AEC firms or organizations. Upon receiving respondents filled questionnaire, analysis is performed including statistical analysis and findings are listed. A sample paper is Enshassi *et al.*, (2018). In spite of the substantial variation of the findings regarding the expected ROI of BIM adoption in construction industry, it would be more realistic to adopt such findings.

The second group, which constitutes far lesser number of papers than the first group, has adopted an analytical approach, in which an analytical model for ROI is developed including direct and indirect costs and benefits of BIM adoption. In order to quantify ROI of BIM adoption a lot of assumptions need to be made. Such assumptions might not be unanimously agreed upon. A sample paper is Giel *et al*., (2010).

8. Developing Countries

If we further focus on developing countries which are invariably still struggling with BIM adoption, another element of complexity arises which is the scarcity of data which in turn lead to unjustified reliance on conditions and findings obtained in developed countries. A sample case is Egypt as detailed in the following.

8.1. Egypt

Amin, K. F. and Abanda, F. H. (2019) investigated the integration of BIM for delivering construction projects in Egypt. The research aim was achieved through literature review and collecting qualitative data from industry practitioners.

Qualitative data were collected through focus group interviews, conducted in Cairo, Egypt. Collected data were then analysed through consecutive stages of audio-recording, transcription, coding, structuring. Analysed data were interpreted using the grounded theory approach, into a theoretical framework, depicting the integration of different BIM activities. The devised plan of work was then put into contrast with traditional project lifecycle stages in Egypt to identify the pros and cons of each methodology.

The opinions of practitioners representing business, design and construction backgrounds. The benefits and challenges of integrating BIM in Egypt have been explored. BIM has been devised based on construction practices in Egypt. Focus groups discussion yielded other necessary themes for successful BIM adoption in Egypt such as teaching design coordination, refining current levels of details LOD definitions and the necessity of governmental BIM mandating policies. However, as a limitation, there has been difficulty reaching personnel with considerable experience in the facilities management domain.

Hence, identified BIM objectives and deliverables are based on the expectations and assumptions of participants representing other domains.

8.1.1. BIM Adoption in Egypt

BIM has been adopted in many countries since the early 2000s (Jung and Lee, 2016). The Middle East and Africa are considered to be in the "beginner phase" in BIM adoption status, despite the rising rate of BIM adopted projects (Jung and Lee, 2016; Mehran, 2016; Gerges *et al*., 2017). The introduction of mandatory policies by governments or public organizations to promote the uptake of BIM is a key factor that have influenced the adoption of BIM in countries like the UK (Abanda and Tah, 2014; Cheng and Lu, 2015). However, the construction sector in Egypt does not have a clear understanding on the application of BIM, urging for the need to provide more knowledge and information to the sector (Elyamany, 2016). In addition, the Egyptian government does not promote the use of BIM and has no published guiding documents or standards related to the BIM field (Elyamany, 2016). Gerges *et al*., (2017) conducted a survey about BIM status in the Middle East, showing that only 20% of AEC companies are using BIM or are involved in the BIM implementation process. However, the same survey indicates more awareness about BIM between individuals, showing that 60% of respondents reported to have between three to nine years of experience and have been involved in at least two BIM projects. It is worth mentioning that the findings from BIM research in the GCC countries can be applied to Egypt and vice versa, due to the similarity in construction trends and practices (Salama *et al*., 2006).

8.1.2. Construction Project Lifecycle in Egypt

Perhaps, partly due to the fact that the Egyptian government does not promote the use of BIM in the construction sector (Elyamany, 2016), there is a lack of publications and guidance on the subject of developing a standard BIM process. Hence, a document has been obtained from a real BIM implementation project in Dar Al-Mimar Group (DMG) Company, illustrating information flow between project stakeholders throughout traditional project lifecycle stages. DMG is a group of companies, specialised in the development, design, construction and operation of luxury real estate apartments and is located in Cairo, Egypt (DMG, 2011). The document obtained, was an assessment of the "as-is" condition of the group, as a first step in their BIM implementation. The BIM implementation was managed by Virtual Projects, a BIM consultant located in Cairo, Egypt (Virtual Projects, 2015).

People's resistance to change is a main challenge

There has been a consensus agreement among all focus groups that the main challenge facing the integration of BIM is the people's resistance to change. The resistance to change is mainly due to a lack of awareness and adhering to old methods. Suggestions have been made to overcome resistance to change through mandating policies and education/training activities. For effective integration of BIM in Egypt, it must be published by an authoritative body, who will take the responsibility of encouraging and enforcing – in some cases – construction companies to adopt the published standards. People will usually try to avoid any additional constraints, even if these constraints were to their benefit. This can be solved by educating people about the benefits of such changes and rewarding those who adopt the change.

9. CONCLUSIONS

Although many secondary conclusions can be stated and they were mentioned in the respective chapters, the salient finding is only mentioned herein.

The main finding of the study is no quantitative formulation of ROI can be adopted and the only way to deal with such a question is to rely on qualitative studies asserting there exists a high potential of adopting BIM to generate direct as well as indirect revenues. All attempts found in the literature to quantify the ROI of BIM cannot be generalized due to disputed involved assumptions.

REFERENCES

- Abanda, F. H., & Tah, J. H. M. (2014). *Free and open source Building Information Modelling for developing countries.* In the International Conference on ICT for Africa 2014, 1-4 October, ICT University, Yaoundé, Cameroon.
- Abbasnejad, B. *Building Information Modelling Adoption and Implementation in Construction*

Firms: A Multi-Stage Model Queensland University of Technology. http://dx.doi.org/10.5204/thesis.eprints.119686

- Amin, K. F., & Abanda, F. H. (2019). *A BIM plan of work for managing construction projects in Egypt.*
- Aranda-Mena, G., Crawford, J., Chevez, A., & Froese, T. (2009). Building information modelling demystified: does it make business sense to adopt BIM? *International Journal of Managing Projects in Business*, *2*(3), 419-434. https://doi.org/10.1108/17538370910971063
- Azhar, S., Brown, J. W., & Sattineni, A. (2010, 2010/06/20). *A Case Study of Building Performance Analyses Using Building Information Modeling* Proceedings -- The 27th International Symposium on Automation and Robotics in Construction, http://dx.doi.org/10.22260/isarc2010/0023
- Azhar, S. (2011). Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry. *Leadership and Management in Engineering*, *11*(3), 241-252. https://doi.org/10.1061/(asce)lm.1943-5630.0000127
- Azhar, S., Hein, M. and Sketo, B. (2008) *Building Information Modeling (BIM): Benefits, Risks and Challenges.* http://ascpro.ascweb.org/chair/paper/CPGT182002008.pdf
- Barlish, K. and Sullivan, K. (2012) How to Measure the Benefits of BIM—A Case Study Approach. Automation in Construction, 24, 149-159. https://doi.org/10.1016/j.autcon.2012.02.008
- Cheng, J. C. P., & Lu, Q. (2015) "*A review of the efforts and roles of the public sector for BIM adoption worldwide*", Journal of Information Technology in Construction, Vol. 20, pp. 442–478.
- Dar Al-Mimar Group, DMG, (2011), President's Report.
- Durdyev, S., Mbachu, J., Thurnell, D., Zhao, L., & Reza Hosseini, M. (2021). BIM adoption in the Cambodian construction industry: Key drivers and barriers. *ISPRS International Journal of Geo-Information*, *10*(4). https://doi.org/10.3390/ijgi10040215
- Elyamany, A. H. (2016). Current practices of building information modelling in Egypt. *International Journal of Engineering Management and Economics*, *6*(1), 59. https://doi.org/10.1504/ijeme.2016.079836
- Enshassi, A.A., Abu Hamra, L.A., Alkilani, S. (2018). Studying the Benefits of BIM in AEC Industry in the Gaza Strip. Jordan Journal of Civil Engineering, Vol. 12, No. 1.
- Feibel (2003). In *Oxford Music Online*. Oxford University Press. https://doi.org/10.1093/gmo/9781561592630.article.j563800
- Gerges, M., Austin, S., Mayouf, M., Ahiakwo, O., Jaeger, M., Saad, A. and Gohary, T.(2017) "*An investigation into the implementation of building information modelling in the Middle East*", Journal of Information Technology in Construction, Vol. 22, pp. 1–15.
- Giel, B., Issa, R.R.A., Olbina, S., (2010) Return on Investment Analysis of BIM in Construction. Proceedings of the International Conference on Computing in Civil and Building Engineering (ICCCBE).
- Holness, G. V. R. (2006). *Building Information Modeling: Future Direction of the Design and Construction Industry*. Journal of Information Technology in Construction, 48, 38-44.
- Jupp, J. (2013). Bim Investment: Understanding Value, Return and Models of Assessment. *Proceedings: 38th AUBEA International Conference Website*, *2013*, 1–10. https://www.library.auckland.ac.nz/external/finalproceeding/Files/Papers/46530Final00075.pdf
- Jung, W., & Lee, G. (2016). Slim BIM Charts for Rapidly Visualizing and Quantifying Levels of BIM Adoption and Implementation. *Journal of Computing in Civil Engineering*, *30*(4), 04015072. https://doi.org/10.1061/(asce)cp.1943-5487.0000554
- Kouch, A. M., Illikainen, K., & Perälä, S. (2018). Key factors of an initial BIM implementation framework for small and medium-sized enterprises (SMEs). *ISARC 2018 - 35th International Symposium on Automation and Robotics in Construction and International AEC/FM Hackathon: The Future of Building Things*, *Isarc*. https://doi.org/10.22260/isarc2018/0126
- Kulaksiz, T. (2019). *Analysis Of Factors Influencing Return On Investment (ROI) For Building Information Modeling (bim) Implementation*. *January*.
- Masood, R., Kharal, M. K. N., & Nasir, A. R. (2014). Is BIM adoption advantageous for the construction industry of Pakistan? *Procedia Engineering*, *77*, 229–238. https://doi.org/10.1016/j.proeng.2014.07.021
- NBS. (2019). *No Title*. National Bureau of Standards.
- Qian, A. Y. (2012). *Benefits and Roi of Bim for Multi-Disciplinary Project Management*. *988*(March), 1–45.
- Sahil, A. (2016). *Adoption of Building Information Modeling in Developing Countries : Degree Of Master Thesis, Colorado State University*.
- Salama, M., Aziz, H. A., Sawah, H.E., Samadony A. E. (2006). *Investigating the Criteria for Contractors' Selection and Bid Evaluation in Egypt, Proceedings, Engineering Business.*
- Salih, S. (2012). The Impact of BIM/VDC on ROI: Developing a Financial Model for Savings and ROI Calculation of Construction Projects. *Department*

of Real Estate and Construction Management, *Master of*(177).

- Stowe, K., Zhang, S., Teizer, J., & Jaselskis, E. J. (2015). Capturing the Return on Investment of All-In Building Information Modeling: Structured Approach. *Practice Periodical on Structural Design and Construction*, *20*(1), 04014027. https://doi.org/10.1061/(asce)sc.1943-5576.0000221
- Wikipedia. (2021). BIM. In *Wikipedia*.
- Won, J., & Lee, G. (2016). How to tell if a BIM project is successful: A goal-driven approach. *Automation in Construction*, *69*, 34–43. https://doi.org/10.1016/j.autcon.2016.05.022
- Succar, B. (2010). Building Information Modelling Maturity Matrix. In *Handbook of Research on Building Information Modeling and Construction Informatics* (pp. 65-103): IGI Global.