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An Investigation of the Adoption of BIM and Value Engineering Barriers in the South African Construction Industry

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Abstract

BIM has proven to be a great tool to facilitate Value Engineering. BIM and Value Engineering are tools that help projects be completed on time and within budget and can increase stakeholder involvement. This paper, therefore, presents findings on the barriers contributing to the level of implementation of BIM and Value Engineering in the South African construction industry.

Primary data was obtained through unstructured interviews. BIM experts and construction professionals who work with BIM were interviewed. Secondary data was obtained through a systematic review of literature from different academic sites, namely, google scholar, Scopus, Taylor Francis and ASCE Library, based on keywords related to the study.

The findings confirm that BIM and VE are practised in the construction industry in South Africa, and the participants found them to be a valuable experience that is efficient and effective. The findings also confirm that although BIM is used, there are barriers to its adoption, which affect Value Engineering processes. These include lack of skills, high cost, lack of government involvement, BIM Infancy, IT Infrastructure and Resistance to change.
The study addresses barriers that construction professionals encounter in implementing BIM and VE. This could lead to efficient problem-solving techniques and strategies based on the identified barriers.

Keywords

BIM, Value Engineering, Stakeholder buy-in

1. Introduction

BIM is a process or system that facilitates management, communication, and information exchange throughout the construction process, from feasibility studies to design, construction, handover, operation, and demolition. Building Information Modeling (BIM) is a collaborative way of working enabled by digital technologies that allow for more efficient designing, creating, and maintaining our assets (Hashemi, 2014).

Value engineering's primary goal is to reduce the facility's life-cycle cost, whereas constructability optimises the entire construction process. It is typically applied during the design phase in most cases of industry implementation. In contrast, practical constructability applications should ideally begin during the conceptual and planning stages and continue through construction (Hassan, 2018). Therefore, applying BIM in value engineering could be efficient and effective. BIM and Value Engineering are both tools that play an essential role in the construction industry, and combining them results in high-quality projects. Previous research on BIM adoption in Value Engineering processes has been published; for example, Li et al. (2021) investigated how BIM can be integrated with Value Engineering and demonstrated the benefits. The study proposed a framework based on the analytic hierarchy process (AHP) and the entropy method to calculate the weight and coefficient.

Further, Nath et al. (2015) proposed a BIM-based workflow for reengineering creating shop drawings. The study applied this method to a building component (a window) to increase productivity. Shin et al. (2016) proposed a value engineering idea validation system based on BIM that includes three modules: life cycle costing, energy savings

costing, and energy performance analysis. Each module estimates the effects of the Value Engineering concept by utilising BIM data that automatically or semi-automatically consolidates the idea.
Therefore, the purpose of this paper was to investigate the barriers that contribute to the level of implementation of BIM and Value Engineering in the South African construction industry

2. Methods

A phenomenological, qualitative design was adopted in this study. Being mainly exploratory, it was carried out using a pre-prepared unstructured interview guide. The first stage was an extensive investigation for literature review that was conducted to clearly understand the key barriers and main influence factors to BIM implementation, whereas the second stage is unstructured interviews. Unstructured interviews were chosen because of their adaptability. According to Jamshed (2014:87), unstructured interviews are controlled conversations that bend towards the researcher's interests. This type of interview should be referred to as a narrative interview (Stuckey, 2013:4).

The tool facilitated conversations with 13 purposively selected construction professionals acquainted with BIM (Palinkas et al., 2015). The selection consisted of BIM Managers, BIM Coordinators, BIM technicians, Construction Projects Managers and Quantity Surveyors who have implemented BIM within their organisations and on multidisciplinary projects. Probing questions were asked about their experiences with adopting BIM in Value Engineering processes and impediments to widespread and optimal implementation of BIM in South Africa.
The interviews were conducted between December 2020 and February 2021. Due to the pandemic, the interviews had to be done via Zoom; each interview lasted between 40 to 60 minutes. The research was carried out in Johannesburg and Cape Town, South Africa. According to the researcher's search, most BIM experts were based in Johannesburg and Cape Town. The participants' rights needed to take precedence over-collecting data to complete this study. The researcher adopted Guba and Lincoln's (1989) proposal on the importance of being morally and legally responsible when conducting a research project involving human participants. As a result, before and during the data collection process, the researcher prioritised the following; Permission to conduct the research was sought and granted by the University of Johannesburg's Faculty Higher Degrees Committee and the Research Ethics Committee. Before conducting interviews, participants were asked to sign a consent form indicating their willingness to participate in the study voluntarily. Participants were informed that they could withdraw from the study if they had any doubts or concerns about researching the items in the interview questions. Before analysing the responses, the researcher ensured that they were anonymised and took special care not to reveal potentially identifying details such as locations, names of construction sites, and names of participants. The researcher put safeguards in place to protect the confidentiality of participants at all stages of the research cycle.

Thematic analysis was used to analyse data gathered from the interviews. The goal of thematic analysis is to identify themes, which are patterns in data that are important or interesting, and then use these themes to say something about an issue or address the themes (Clarke and Braun, 2013). An excellent thematic analysis does much more than summarise the data; it interprets and makes sense (Clarke and Braun,2013). Thematic analysis was performed on the survey data using Braun and Clarke's (2006) six stages of analysis: familiarising oneself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and reporting. The inductive thematic analysis procedure was used to analyse the data.

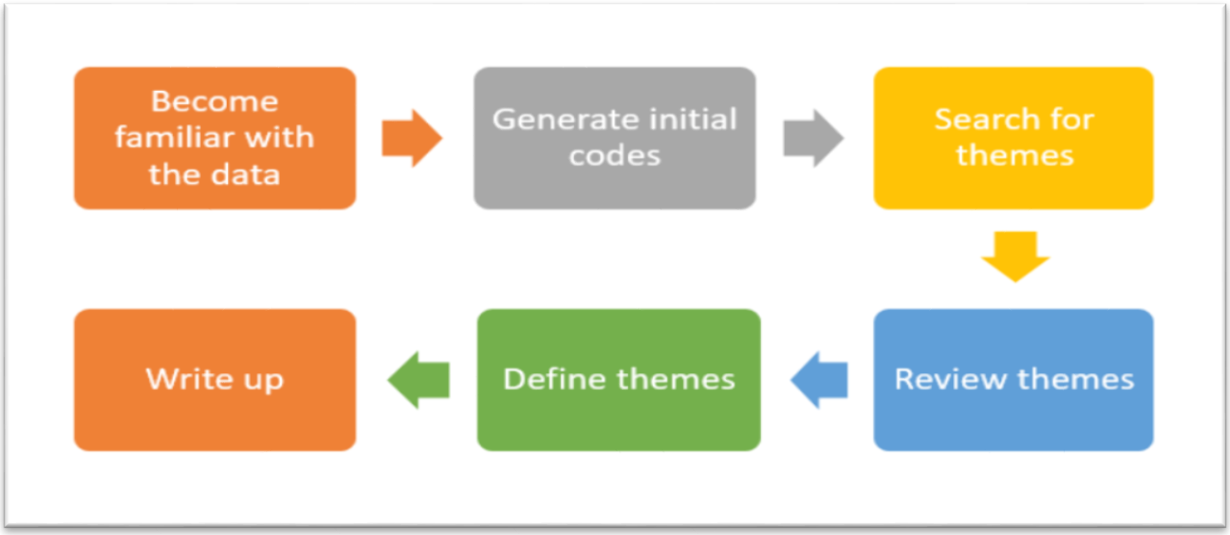

Figure 4: Braun & Clarke's six-phase framework for doing a thematic analysis

3. Results

3. 1 Results/Findings

The study's findings confirm that BIM and Value Engineering are used in the South African construction industry; additionally, participants believe it is an important and valuable experience. These findings show that Value Engineering is necessary, efficient, and beneficial. Furthermore, they demonstrate that Value Engineering produces successful outcomes when combined with BIM. All participants agree that they use BIM and Value Engineering; additionally, they believe that incorporating BIM into Value Engineering is a good idea; however, the participants also stated barriers to BIM adoption. These barriers automatically affect Value Engineering processes.

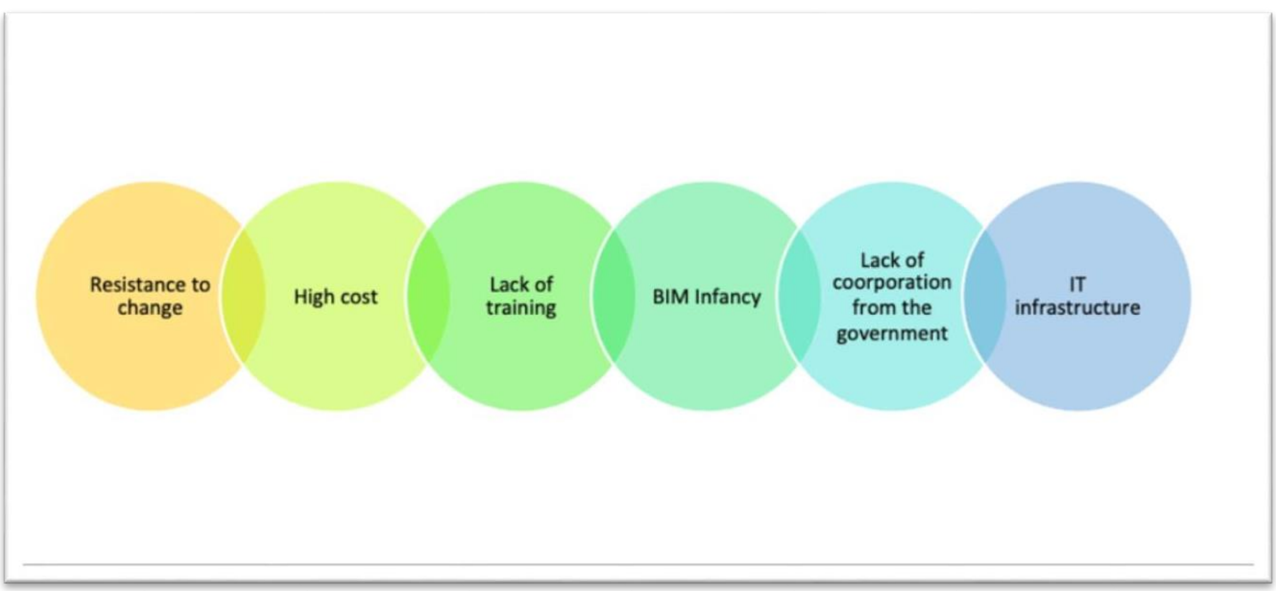

Figure 1: BIM Barriers

4. Discussion

Value Engineering processes are improved by using BIM (Li et al., 2021:3). Value Engineering function analysis is strengthened by BIM fundamental functions such as visualisation, function simulation, clash detection, and information integration. Other benefits of using BIM include faster information extraction and real-time engineering changes, both of which are used to improve the cost analysis of the value study and, as a result, the performance of the Value Engineering analysis (Park et al.,2016). BIM is more than just a new 3D modelling software; it is a comprehensive solution for simulating and combining all Value Engineering and other building performance data. As a result, Value Engineering would be more accurate and timely in providing all relevant information to users at the appropriate location and time (Lee and Na, 2018:309).

The adoption of BIM in Value Engineering is a success in different developed countries where BIM is seamless, where the government provides support, and where the IT infrastructure is impeccable; the two processes are efficient and effective and have made a difference in the construction industry. Various authors have successfully implemented BIM at different stages of Value Engineering processes. For example, Ranjbaran (2013) proposed an automated, integrated model for value analysis used in both the creative and evaluation phases of the Value Engineering job plan. The model provides the user and the Value Engineering team with visualisation capabilities and a comprehensive computational platform that considers various factors. Similarly, Li et al. (2021) investigated and demonstrated the benefits of integrating BIM with VE. The study proposed a framework based on the analytic hierarchy process (AHP) and the entropy method to calculate the weight and coefficient. A case study method of a high-rise building project in China was used to validate the framework and demonstrate how BIM can be integrated with Value Engineering.

Below is what the study has found; These are the barriers to adopting BIM, affecting the adoption of BIM in Value Engineering processes.

Resistance to change

South Africa is still lagging in BIM adoption because most stakeholders are resistant to change. One of the main points raised by participants was the unwillingness of most stakeholders to change. This is what the participants had to say:

"People do not like changing what they use; they would rather stick to AutoCad and drawing on drawing board."
– *Participant 2*

"People are comfortable in their ways of doing things. We consider working in the traditional ways we have always done. Then now you are talking about BIM talking about those within the industry before becoming a thing, Being reluctant to adopt it because it means it is a switchback."
- *Participant 11*

High Cost

BIM incurs several direct costs affecting all design and project team members. According to the findings of this study, these costs are incredibly high, and not everyone can afford them; thus, they impact the implementation of BIM and Value Engineering. This is what the participants had to say:

"Yeah, I have picked it up, so we are very behind in building information models."
- *Participant 9*

"The technology is quite expensive, so the smaller companies do not afford the BIM solutions."
- *Participant 6*

"Public perception says it costs money."
- *Participant 5*

With most participants agreeing that the lack of BIM is due to high costs, Ahmed (2018:107) cites the high cost of BIM purchasing as a significant barrier to BIM implementation. According to Ogwueleka and Ikediashi (2017:309), one of the general challenges encountered when adopting BIM is high cost.

Lack of Training

One of the barriers to BIM adoption is a lack of training. On the contrary, most employers do not train their employees, and some employees do not want to be prepared because they believe they have advanced in their careers. According to Liu et al. (2015:64), the high cost of training and education contributes to a lack of training. This is what the participants had to say:

"But also on the technology side, some guys do not believe in training up their people."

- *Participant 1*

"The biggest problem is human resource development and training. So we also try and get companies to realise that they need to reinvest in their people. It is not the software and computers that make the company. It is the people themselves, So it continues education and training, teaching them how to adopt the new technology."

- *Participant 2*

BIM Infancy

BIM adoption in South Africa is still limited; many companies have not adopted BIM. In South Africa, BIM is still in its infancy. Numerous organisations still do not use it. It is not as popular in developing countries as in developed countries. This is what the participants had to say:

"The construction industry has not adopted BIM only a few companies."

- *Participant 2*

"BIM is still lagging in South Africa."

- *Participant 13*

"Adapting, because BIM is still new in SA."

- *Participant 2*

BIM adoption in South Africa is still limited; many companies have not adopted BIM. Mtya and Windapo (2019:215) agree that BIM adoption by construction organisations in South Africa is still in its early stages. According to the literature, the BIM movement has not benefited the South African built environment.

Lack of corporation from the government

This study confirms that one of the barriers to BIM adoption is a lack of government support. Anything that has the government's support makes things easier. The government plays a significant role in the implementation of any initiative. The government's support makes it easier for other stakeholders to join in. Governments should take the lead in BIM adoption, utilising their administrative functions fully and actively participating in the promotion process.

"Uh, so that one that it is not being driven by clients or by Government Departments. Two, I think once clients and government departments do realise that there are benefits they can make and receive from it. Not only in terms of, you know, clash detection and avoiding rework when executing and building the structure. Using this modelling software, the design team can work out many of those issues upfront. You know, and then asset management and life-cycle management of the building with digital Twins."

– *Participant 12*

"The government has been quite slow with the adoption of BIM. We have been in meetings with them, but unfortunately, nothing materialised; but hopefully, soon that will change."

- *Participant 6*

According to (Ogwueleka and Ikediashi, 2017), one of the significant challenges in adopting BIM technologies is a lack of government direction. According to Farooq et al. (2020), to reap the benefits of BIM technology, the government and all project stakeholders must collaborate to overcome the barrier of priority.

IT Infrastructure

The internet is crucially significant in BIM. Strong internet connections are required to enjoy the benefits of BIM fully. According to Siebelink et al. (2021), internet speed can be a barrier to data exchange. Furthermore, because some projects are in extremely remote areas, the Internet connection quality at project locations affects external collaboration.

This is what participants said;

"In South Africa, there is still a lack of technology infrastructure, i.e. internet and speed of communication."

- *Participant 4*

"For BIM to function effortlessly, basic internet requirements are needed, and South Africa is still battling with that."

- *Participant 2*

The adoption of BIM in Value Engineering is a success in different developed countries where BIM is seamless, where the government provides support, and where the IT infrastructure is impeccable. The two processes are efficient and effective and have made a difference in the construction industry. Various authors have successfully implemented BIM at various stages. For example, Ranjbaran (2013) proposed an automated, integrated model for value analysis used in both the creative and evaluation phases of the VE job plan. The model provides the user and the Value Engineering team with visualisation capabilities and a comprehensive computational platform that considers various factors.

4. Recommendations

It is suggested that the government implement BIM for the successful development and deployment of complex technology systems, strong government support is essential. This could aid in overcoming barriers to BIM adoption. Innovation is widely regarded as a critical driver of national economic growth, particularly in industrial and newly industrialised economies. BIM, as an innovation, will be critical to economic development. Many direct and indirect benefits are provided by BIM technology. It improves the labour market, encourages more collaborative working practices, and improves communication among project stakeholders, among other things.
Furthermore, VE should be made a requirement in projects. Most people do not practice VE because they believe it is time-consuming. While it is time-consuming, it is also efficient and rational. It comes with a plethora of benefits that make a significant difference.

Moreover, the government should put standards that will aid in regulation. The sooner the government does this, the sooner the construction industry will reap BIM benefits in cost, timeliness, and project quality. Interoperability is improved and promoted by standards. The development and implementation of BIM specifications and protocols can result in a consistent and effective data exchange method with significant benefits for construction projects. These Standards promote common understanding and facilitate trade by removing trade barriers.

It is worthwhile to investigate what is being done at the national level to encourage the use and implementation of BIM and legislate and possibly make it a mandatory tool in the South African construction industry. Furthermore, as an organisation tasked with developing the construction industry under the Construction Industry Development Board Act No. 38 of 2000, it is worth considering what organisations like the CIDB are doing in the implementing national and organisational levels. The CIDB's objectives, according to the Act, include promoting the construction industry's contribution to meeting national construction industry demand and advancing industry performance, efficiency, and competitiveness Ndhlela, (2018:22).

While it is not uncommon for the private sector to take the lead in driving BIM adoption and implementation, the evidence highlights the South African case's peculiarity in government agencies' inability to adequately drive BIM adoption and performances and lead in the development of guidelines. Despite this, existing standards from BIM-leading countries are being adapted for South Africa, but these are individual efforts (Akintola et al., 2017:31). Whilethere is a demand for country-specific standards and guidelines for implementing BIM in South Africa, measures fromBIM-leading countries have been adopted and adapted relatively successfully. Nonetheless, because these are individual efforts, the direct implications are project stakeholders' experiences with varying implementation patternsand, as a result, non-interoperability (Beach et al., 2015).

5. Conclusion

This research paper aims at assessing the status quo of factors contributing to the level of implementation of BIM and Value Engineering in the South African Construction Industry. The assessment was done using unstructured interviews with 13 construction professionals acquainted with BIM. The following main topics were considered in the interviews a) The significance of BIM and Value Engineering distinctly b) The efficiency of Value Engineering in BIM, c) The adoption of BIM in the South African Industry and d) factors contributing to the level of implementation of BIM and Value Engineering in the construction Industry. The key findings depict that BIM plays a vital role in Value Engineering processes. Furthermore, the key findings describe that BIM is practised in the South African construction industry; however, some factors impede the complete adoption and practice. Those factors are; 1) resistance to change, 2) High cost, 3) Lack of training, 4) BIM Infancy, 5) Lack of corporation from the government 6) IT Infrastructure.

This study clearly describes the barriers to adopting BIM and Value Engineering. With all the noted walls, solutions will then be generated, which will help enhance efficiency in the construction industry and boost the economy.

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References

Braun, V., & Clarke, V. (2013). Successful qualitative research: A practical guide for beginners. Sage.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi. org/10.1191/14780 88706 qp063oa

Lee, J., & Na, S., (2018). *INVESTIGATION OF PRACTITIONERS' PERCEPTIONS FOR DEVELOPING BUILDING INFORMATION MODELLING (BIM) - BASED VALUE ANALYSIS MODEL*. *9*(1), 301–313.

Li, J., Hou, L., Wang, X., Wang, J., Guo, J., Zhang, S. and Jiao, Y., 2014. A Project-Based Quantification of BIM Benefits. International Journal of Advanced Robotic Systems, 11(8), p.123.

Lincoln, Y.S. & Guba, E.G., 1990. Judging the quality of case study reports, International Journal of Qualitative Studies in Education, 3(1):53-59.

Moselhi, O., & Yalda, R., (2014). *Construction Research Congress 2014 ©ASCE 2014 1606*. *VM*, 1606–1615.

Nath, T., Attarzadeh, M., Tiong, R. L. K., Chidambaram, C., & Yu, Z. (2015). Productivity improvement of precast shop Drawings generation through BIM-based process reengineering. *Automation in Construction*, *54*, 54–68. https://doi.org/10.1016/j.autcon.2015.03.014

Neuman, W.L, (2014). Social research methods: qualitative and quantitative approaches. 7th ed. Harlow, UK: Pearson Education.

Park, C., Kim, H., Park, H., Goh, J., & Pedro, A. (2016). ScienceDirect BIM-based idea bank for managing value engineering ideas. *JPMA*, *October*. https://doi.org/10.1016/j.ijproman.2016.09.015

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and policy in mental health*, *42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Ranjbaran, Y., & Moselhi, O. (2014). 4D-based value engineering. *Construction Research Congress 2014*. https://doi.org/10.1061/9780784413517.164

Shin, J., Kim, I., & Choi, J. (2016). *BIM-based Work Environment of Value Engineering in Sustainable Construction*. *December 2016*, 79–83. https://doi.org/10.14257/astl.2016.141.16

Stuckey, H. L. (2013). Three types of interviews: Qualitative research methods in social health. Journal of Social Health and Diabetes, 1(2), 56-59. https://doi.org/10.4103/2321-0656.115294

Usman, F., Jalaluddin, N. A., & Hamim, S. A., (2018). *Value Engineering in Building Information Modelling for Cost OpOptimizationf Renovation Works : a Case Study Value Engineering in Building Information Modelling for Cost OpOptimizationf Renovation Works : a Case Study*. *January 2019*. https://doi.org/10.14419/ijet.v7i4.35.22856