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BIM as a tool to optimize and manage project risk management

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Abstract

Project management ensures that all risks pertaining to a particular project are eliminated, if not minimized. The risks can originate from artificial activities or natural causes. Although some of the risks are potential to the project, others are not and are usually unforeseen to the project managers. Projects risks have adverse effects to the project if they are not eliminated or mitigated. It is the duty of the project team to collaborate in mitigating risks using appropriate tools. Although varying project teams and managers use different approaches to mitigate against project risks, Business Information Management (BIM) has emerged as a vital approach to mitigate project risks. BIM technology is crucial to the project life, beginning from planning, design, and construction management. Using BIM ensures that collaboration of the project team through information management enables adequate monitoring of the project, thereby enabling effective execution and achievement of set milestones. Despite the effective use of BIM in various projects, its use in the construction industry is unclear. This research investigates and analyzes significance of BIM as the most appropriate method in mitigating project risks.

Keywords: Building information Modeling, BIM, Project risk management, Project risks

1- INTRODUCTION

Every project has a risk and one of the most important roles of a project management is to ensure that these risks are minimized, if not eliminated (Zou, Kiviniemi, & Jones, 2017). Risks can be manmade or natural and the effects of these can be very devastating, hence the need to have in place measures to overcome these risks, however, most of these have been found to be ineffective in different ways. Over the years, there have been many tools that have been given to enable project managers to overcome risks. Building Information Modeling is a methodology that enables the digitalization plans and designs of mega building infrastructure (Zhang, Skibniewski, Wu, Chen, & Deng, 2014). Most of the large construction projects have realized the importance of BIM in their operations and hence the growth of the use of BIM in the last couple of years (Tomek & Matějka, 2014). BIM methodology is crucial in the project life cycle where key data from all stakeholders, including information about geography, about components, about costs, about geometry, etc., in such a manner that supports planning, designing, and construction management in a sustainable manner.

Since large projects require a lot of resources and planning, the use of a modelling tool for this provides a way of simulating events that will take place through the life of the project, from the start to the end, with the outputs being realistic and where corrective measures can be employed to deal with any challenges that might arise.

Risks are unforeseen situations and understanding the effects of risks can be beneficial for any organization. Unforeseen circumstances must be defined, understood and evaluated, with the view to ensure that they are either prevented, transferred or taken up, as an organization deems fit (Azhar, 2011). The risks managers should, therefore, be able to identify the elements of risks, be able to gauge these and manage risks as they become due.

The use of BIM is, however, effective when the risks associated with a project are clearly identified and defined Zou, Kiviniemi and Jones (2017), and a project risk log is crucial for this to be achieved. The use of BIM is gaining a lot of popularity and to this extent, it is worth examining its important.

Carrying any project will definitely face many risks that is required to manage, some are potential and others are not expected at all, and being as efficient project managers, such risk should be taken care of. On sake of a successful project flow a strong risk plan should be in place to respond to any risk, either by avoiding its effects or at least mitigating those effects.

The studies and practices of risk management are the key aspect of project management success. The purpose of risk management is to increase the probability and impact of positive events, and decrease the probability of negative events on the project. Risks are major topics at every team meeting as risk can lean to two options either win or lose.

Projects that are created weather in construction or other fields have risks that must be managed as the project manager role is to be capable to have an overview of project risk management and deep understandings that risk management is about maximizing the probability and impact of positive events (opportunities) and minimizing the probability and impact of negative impacts (threats) to the project.

Research questions

i. Can BIM optimize project risks management
ii. Can BIM manage project risk management
iii. How does BIM model projects?

The questions that that have been given above are vital as guiding questions on the topic of risk management using a methodology tool for this project has indicate that there is need to be clear with the questions and be able to examine these carefully (Porwal & Hewage, 2013; Zhang, Wu, Ding, Skibniewski, & Lu, 2016). By answering the questions given above, this project's aim was achieved.

Research organization

the project is organized in a number of chapters. This above chapter provided the background to the study and developed the aim and hypothesis for this project. The next chapter explores existing literature in this field by examines the views of different author on this topic with the view to identify the knowledge gap. The third chapter is the methodology that guided the conduct of this project. The fourth chapter is the analysis and lastly the conclusion and recommendations.

2- LITERATURE REVIEW

Existing literature reviews on BIM have primarily focused on this as a tool of large construction projects (Zou et al., 2017; Bing, Akintoye, Edwards, & Hardcastle, 2005), and which aids in ensuring that the management of a project is efficient (Azhar, 2011). It is worth examining the key reasons why the growth of BIM has continued in recent times. Large construction projects have become common feature in many countries, especially where governments and big organizations are seeking to invest in infrastructure (Zou, Kiviniemi, & Jones, 2017; Ameyaw, Hu, Shan, Chan, & Le, 2016; 18]. With such magnitude of projects, the existence of risks is also often a factor.

Whereas studies that have looked at risks have mainly focused on the common risks of fire, theft, and some natural risks (Tomek & Matějka, 2014; Zhang et al., 2014), there are new realities facing large constructions projects. In their review on the types of risks facing engineering construction projects, Iovino and Tsitsianis (2020) noted that the reliance of projects on modern technologies has meant that there are new challenges that cannot be addressed using old methods. The assumption that risk can be categorized and addressed in relatively same way is no longer tenable. In another study on the kind of risks that are increasingly being seen in construction projects, Zou et al. (2017) identified the human resources errors as a major risk whose anticipation can exist but whose calculation will often never be ascertained. To this extent, Aibinu and Venkatesh (2014) has stated that there appears that such risks are often mitigated by allocation of funds and time, but the accuracy with which such allocations are made is often never guaranteed. With this being the situation, chances of allocating a few resources as contingency is often very high. There are, however, other studies that have stated that in modern times, project management tools and methods have improved drastically and the erstwhile elements that are considered risks have somehow been rendered less risks (Zou et al., 2017; Chapman, 2006; Zhang, Wu, Ding, Skibniewski, & Lu, 2016). This means that there is more to examine within this realm than just the fact that risks exist. To this extent, it can be said that project risks should be examined in the light of the methods used to tackle them.

To this extent, Chien, Wu, & Huang, (2014) stated that it is worth examining the benefits of BIM as a tool for managing project risks, and allowing organizations engaged in construction projects to decide which of the elements of the benefits can be used to counter impending risks. The following are the benefits that exist in the use of BIM for project risks management at different stages of a project life cycle.

2.1 Design and planning stage

BIM is crucial in supporting prototyping and analysis, because at this stage, it supports data storge which consequently can be used to analyze performance. Zou, Kiviniemi, and Jones (2015) indicated that at this stage, incompatibilities can occur, when, for instance a pipe meets other elements, but the use of BIM helps in ensuring that there is adequate planning Aibinu and Venkatesh (2014) and identifying potential problems that might arise, thus allow for early intervention to take place.

2.2 The construction stage

The BIM is very important in ensuring that information collaboration takes place, thus providing an adequate monitoring tool, which can be used by the project management team to coordinate suppliers and other stakeholders (Zhang et al., 2014). BIM provides a visual display of the issue that might take place during the construction and thus provides a way of seeing reality from expected (Ahmad, Thaheem, & Maqsoom, 2018; Aibinu & Venkatesh, 2014). When this happen, it means that elements of a project that interferes with its progress tends to be identified and remedial measures can be put in place.

BIM has also been found to improve decision making and help maintain safety of staff members and hence reduce cases of litigations, and these benefits can be seen during the construction stage. This thus meets the important need of keeping costs down and improving on time management during a project's construction stage (Zou et al., 2017).

2.3 Maintenance stage

BIM has been found to provide maintenance predictability, by anticipating changes and problems and hence preparing the project management team in being able to tackle the problems as and when they arise (Zou et al., 2017). Zou, Kiviniemi, and Jones (2015) stated that the task of maintaining projects is crucial as it enables and contractor to be able to provide guarantees to the client and to do so with some level of certainty Zou et al. (2017) has examined the benefits of BIM for three categories of project management stakeholders: Contractors, Owners and Designers and enumerated a number of benefits. The benefits range from competitive advantage to the owners of projects, to efficiency for the contractors and designers. Underlying these benefits is the fact that BIM can be used across the board, and at all stages of a project. However, despite the benefits that have been enumerated, there are a number of challenges that have been associated with the BIM methodology. First, studies by Aibinu and Venkatesh (2014) and Tomek and Matějka (2014) state that the interoperability of the BIM and the levels of training needed has made this a difficult technology to adopt (Zou et al., 2017; Zhang et al. 2014). Azhar (2011) has gone ahead and stated that there is a need for cultural change that has made it difficult to employ BIM in a lot of construction projects, because large construction companies that engage in such large projects tend to find it hard to adapt to change. Other studies have found that fragmented legal mechanisms that surround the adoption quest for BIM has made organizations to be slow to adopt it. Studies by Ahmad, Thaheem, and Maqsoom (2018), Aibinu and Venkatesh (2014), and Zou et al. (2017) opined that there are no standards that have been set that can guarantee BIM's sustainability. All these are factor that make the adopt and usage of BIM for examining risks and other project management tasks, very difficult.

2.4 Construction project risks and risk management

As indicated in the initial parts of this report, every project has a risk and risks must be managed (Aibinu & Venkatesh, 2014). Studies that have examined the nature and types of risks that organizations are facing when engaging in construction have all opined that there are three categories of risks in terms of their intensity: High, Medium and Low (Zou et al., 2017; Chien, Wu, & Huang, 2014). Construction risks can be financial Zou, Kiviniemi, and Jones (2017), human error Tomek and Matějka (2014) and others sZhang, Wu, Ding, & Skibniewski (2013). In a study by Zhang et al. (2014) and Aibinu and Venkatesh (2014), these risks have to be examined carefully by project managers because, failure to make this analysis can be a catastrophic mistake.

One of the problems of managing risks is that these tend to be changing from time to time (Azhar (2011). For instance, the risks of mega construction projects like the Heathrow Terminal 5 were identified later after the completion of the project (Bing, Akintoye, Edwards, & Hardcastle, 2005), whereas those of Dubai International Airport were identified all through the period of project execution (Azhar (2011). This is an important aspect of the evolution of risks (Zou, Kiviniemi, & Jones, 2017). Ameyaw et al. (2016) stated that a good risk management policy should be reviewable gradually, especially when the projects are enormous in terms of costs and tasks (Tomek & Matějka, 2014). A research by Ameyaw et al. (2016) has stated that it is vital to identify the risks in terms of the three tenets of project scope: Time, Cost and Quality. This is shown in figure (1) below.

Figure 1

The project scope given above has been coined as the starting point of using BIM for managing risks that might arise (Zou et al., 2017). Zhang et al. (2014) have indicated that when the focus of a project is low cost and done quickly, there will be low quality, whereas if the project is low cost and high quality, there will be low priority for doing it, and lastly, if the project is done quickly and of high quality, it must be of high cost. All these elements of the scope can lead to risks that might impact the success of a project. This calls for all the project's stakeholders to be involved in examining the scope and ensuring that the project is successful. Ahmad, Thaheem, and Maqsoom (2018) went ahead and started that the use of this scope allows managers to identify the key areas where attention must be afforded if a project is to succeed. BIM thus, Sahay (2016), Tomek and Matějka (2014), and Azhar (2011) noted, fits within the broader task of managing all aspects of projects, including risks, in a way that allows for the project to be carried out but at the same time allow for other methodologies to be employed during the planning, execution and closure of projects.

On the basis of information presented in this section, it can be seen that management of risks is an important aspect of managing projects, and BIM is a tool that is increasingly being employed for this purpose. Available literature attempt to place BIM within the greater scope of project management, not necessarily risk management. There is, however, little evidence in existing studies that examines the role of BIM in considering risk management within the three project scope pillars of Cost, Time and Quality. The next section provides the methodological aspects that were considered in the conduct of this study.

2.5 Facility Management

The role of facility management starts once the project is completed, the project department hands over all the project details such as, drawings, warranties, guaranties, operation manuals and a snag list that must be prepared by both parties to ensure a smooth hand over, once the project is completed the facility management role starts by operating the project such as a building, road or airport and they are responsible of maintaining all the operations of the project such as MEP, landscapes, cleaning, security and safety. Facility management must be involved in the project from the design stage as they have to add their comments and suggestion in every single point that will affect their operation management at later stage as they will be responsible for the project till the demolition date.

2.6 Risks of Traditional Method

Risk of facility management are many, the major risks that affect the cost and time of operation will be identified. The facility management often suffer to get a smooth handover from the projects department which leads to many discrepancies between the two departments, the typical handover goes with hard copy of drawings warranties and operation manual that is being transferred from the projects archive to the facility management archive which sometimes are being copied which costs environmental and cost impact.

Risks in the construction industry are influenced by two types of factors either internal or external. The internal factors can be controlled by the team leader or the project manager. While the external factors such as bad weather cannot be controlled by the project manager (Hammad, D.B., et. Al, 2012).

Another major risk is the time wasted between the facility management and projects employees during the handing over period and the data loss to be found in the archiving of both departments.

2.7 BIM as a Solution

2.7.1 About BIM

Building Information Module is a program that constructs a bridge between a valley one is the project department and the other is facility management department that simply shows a 3D perspective of the proposed project which includes every single detail of the project. It can be used in construction which plays an essential role that supports the project from the date of birth (planning stage) up to the demolition day. BIM is being a trend now days because the world is moving into smart cities and BIM can be compatible with much software such as the Auto CAD; it is an easy tool to amend with and a friendly program that can support your innovative ideas. It has been noticed as a forward step towards sustainability and is considered to develop the employee time and raise their happiness level for achieving a faster better-quality service. The program will assess the project and give its feedback towards the design as it is designed to identify problems and provide some solutions for them. To accommodate the huge growth of construction, develop in a sustainable approach.

The BIM will work like a bridge that connects the projects department and the Facility Management department it will be initiated in the planning of the project by showing a perspective and to meet the age of speed the BIM enables us to catch up with the future and support us to 3D of how the building will look like with its details this will allow the consultant to create a 3D bill of quantity for the building integrated with the perspective layout which will make the tendering process smooth and fair. The next stage will be in construction where it will show the engineers how the building will look like and identify the structural details via coordinates which will reduce or even eliminate mistakes, one of its great advantages is that the engineer may update and amend the specification of the building and give the as built drawings. Once the project completed a soft copy of the BIM will be handed over to the FM department which includes every single detail of the building such as the type of lights, date of manufacturing and fixing and many more details such as the total sprinklers in a specific area which will make the fit out work easy and smooth with minimum errors. Later on, the sales department can use it in order to lease the shops and restaurants which look smart and elegant as the tenant will have a realistic image of what he will get and can plan his finishing smoothly as he will have it in soft copy and will amend his changes by braking partitions on the software rather than reality which will reduce the cost and time drastically.

BIM provides a solution that it has a central software that integrates all the handover needs from warranties, guarantees, operation manual and vendor contacts with the estimated cost, they can even tender the damaged parts such as glasses via BIM and get an instant approval from the vendor to supply the material as the vendor offer will be added in the BIM as the estimated time of delivery and cost which will make the choice easy and immediate. Such saving and risk mitigation for having a customer satisfied environment can only be implemented by using the BIM software as it will please the internal and external stakeholders and will support them for taking innovative decisions by using such a smart technology.

2.7.2 Risk Management with BIM

BIM and its benefit is a highly discussed topic these days. In some parts of the world BIM become common and this usually by the means of some degree of standardization and government support. BIM is involved in all project life cycle starting from design phase going through construction phase and operation phase and ending with demolition or renovation. During this cycle BIM will be covering modeling, budgeting and quantity takeoff, time planning and site analysis. In each of the phases there is risk involved and this risk has to be managed.

When the owner is used to change the design that results risk of overtime or poor communication between design staff and the owner a risk is created. However, Building Information Modeling (BIM) refers to the coordination and creation for the use of a collection of digital information about a building project. Such information can include cost, schedule, fabrication, maintenance, energy, and 3Dmodels which are used for design decision-making, production of high-quality construction documents, predicting performance, cost estimating, and construction planning, and eventually, for managing and operating the facility based on those functionalities of BIM, it can therefore be used in mitigating construction risk.

2.7.3 BIM Solutions for risk management

Yes BIM is part of the solution, it can help in avoiding and mitigating risks associated with Facility management field. BIM risks are mostly internal Thompson dividing the risks of BIM in to two categories legal and technical.

2.7.3.1 BIM solution to Time Risks

Another issue is who can benefit from the savings and profits of BIM, and which party is responsible for the costs of implementing BIM. Which party is going to take the risks of implementing BIM. What most stakeholders focus when the issue of implementing BIM is raised is if implementing BIM offers so many benefits, then why it is consuming so much time for it to be implemented. BIM has been known for many years now but the adoption of it is slow considering its benefits. Therefore, they will start considering the probability that there must be something wrong with BIM. There are many issues which are causing the slow adoption of BIM. One of these issues is how the involved parties are responding to the idea of collaboration between them. For example, the architect has all the rights to control the design of the project. And the engineer has the same right in controlling the structures and services of the project. Which raise the question is there a real possibility for those parties to share their information and collaborate without any problems? Sharing data and collaboration is not very common in the construction industry (Cicmil & Marshall, 2005) cited in (James Harty & Richard Laing, 2010). An example to that is the two-stage tendering procurement it was inadequate because of the solidity of the QS in their previous role of advisor to client. There is no clear technique which makes it possible for the QS to start collaborating with the main contractor. At the same time the main contractor does not have the desire to implement that kind of collaboration (James Harty and Richard Laing, 2010).

It is proved that BIM consumes lots of time and effort initially that theoretically can recover faster in the complex projects rather than the typical repetitive projects, The Risks are mainly related with the disadvantages of implementing BIM in construction projects as they need to be identified, identifying the root cause by using "Ishikawa or fish bone" method to visualize the effect and more control in managing and monitoring the time baseline of the project.

Although BIM has a lot of benefits related with implementing it, but there are some risks which should be considered. These risks can vary from one project to another subject on many variables, but in general those risks can be legal concerns, financial risks and people denial to change. On the traditional procurements the contract focuses on the rights and responsibilities of the individuals, while implementing BIM requires teamwork between the involved parties as well as sharing information. Therefore, contracts which are being used in the traditional procurements are not appropriate when it comes to BIM. Because this will result in tension between the need to identify responsibilities and reduce dependence on other parties, and at the same time enhance collaboration (Ashcraft, 2006 Cited in Foster, 2008). Susan McGreevy supported Foster by stating that although BIM being collaborative is an advantage because it allows everyone to see the information of the project under the control of the party which is using them. But collaboration is not effective all the time, due to the generated risks from the collaboration to the parties involved. McGreevy stated that when most of the contractors were asked to collaborate and share information, they showed concern regarding the use of this shared data (McGreevy, 2010).

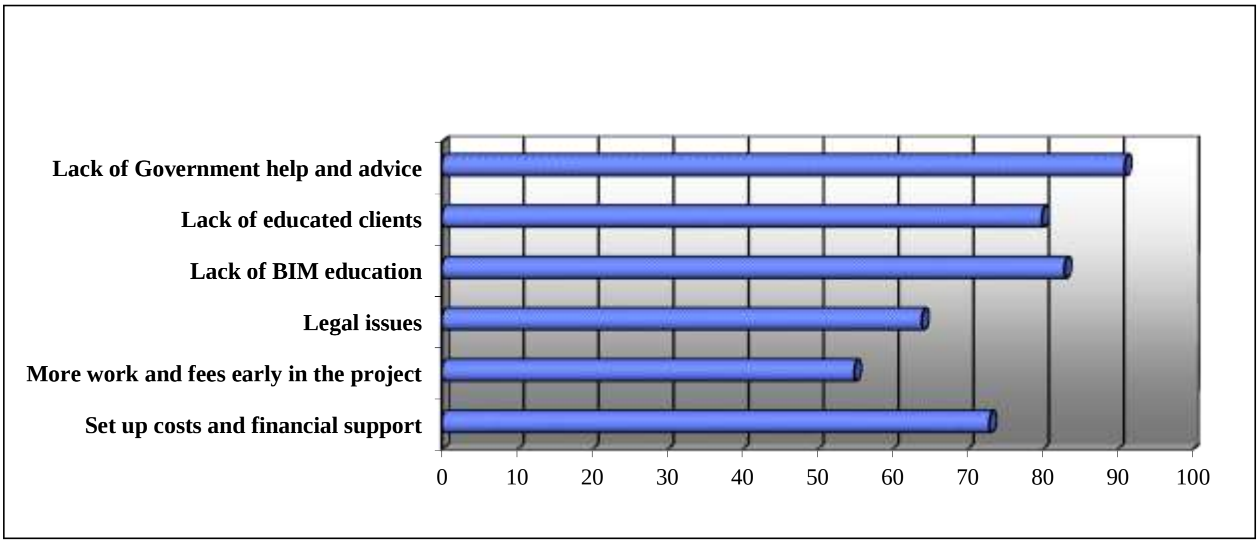
2.7.3.2 BIM solution to Cost Risks

Both stated that one of the major obstacles for users who are not familiar with BIM is the available capital for investment. Users who are not familiar with BIM agreed that there is no problem financially with BIM software, and they did not consider that as a barrier. On the other hand, they stated that the major barrier was the other related investments which are related to BIM. What was considered as a major barrier beside the financial issue is the phase when the contract is being awarded because the involved parties are unable to improve their added value (Both and Kindsvater, 2012).

Morrissey supported both statement by stating that when contractor and consultants are required to implement BIM, the first thing to do is checking the software and the training. For them implementing BIM will require higher fees which will be bad for their business. Most of them are not enthusiastic to spend money on the initial investment of BIM. For the contractor sometimes they have to double the efforts, because small sub-contractor requests 2D drawings. Small sub-contractors need 2D drawings on hardcopy paper, because they are not experienced with the 3D model. Therefore, BIM implementation requires a change in the current culture for all the involved parties who are planning to use it. Selecting the team which is going to implement BIM should be done wisely. Because BIM depends on collaboration between all the users therefore any weak link might have bad impact especially on time wise on the whole team which is using BIM. One of the major disadvantages of BIM, if the consultants use different type of BIM software. The software might not be compatible with the product that is being used by the contractors. This will raise the question which software is more reliable and more time saving? For this reasons BIM software should be more standardized and interoperability should not be a major problem. This can take place when BIM is more popular and widely used (Morrissey and Mansfield, 2012).

Bataw made questionnaires which involved many professional in the UK, supported by interviews with Academics. With total amount of participants was 84, Figure 2 shows that most of the participants companies are concerned about implementing BIM. Large number of participants replied yes when they were asked if their companies are concerned about implementing BIM. Figure 1 shows that most of the participants companies are unaware with the challenges of BIM 65%, while only 20% of them were aware of it. One of the reasons for these results is that implementing BIM will require a significant amount of investment from the stakeholders. Implementing BIM requires extra costs for the software and hardware, and in addition to the costs of training. Such costs are preventing small companies within the industry from implementing BIM. Figure 1 shows that when it comes to implementing BIM there are 6 concerns, two are financial concerns. As 72% of the participants are concerned about the initial setup costs and financial support. And 55% are concerned about implementing BIM because it might bring extra fees and more work early in the project (AnasBataw, 2013) Figure 3.

Figure 2: Professional concerns for BIM implementation (Anas Bataw, 2013).



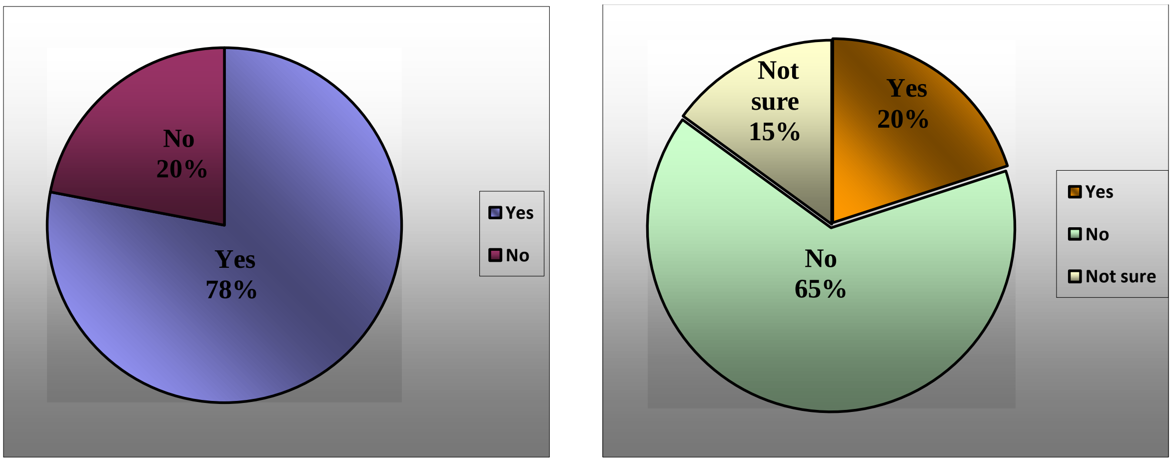


Figure 3: Professionals reaction to the implementation of BIM (Anas Bataw, 2013).

Hozler stated that people who are trying to promote BIM claim that all the involved parties who are implementing BIM will profit from it. The list of those involved parties includes the clients, quantity surveyors, engineers, contractors and subcontractors. The only problem raised is who get to control the BIM model. Usually, the architect is responsible for the role of the project coordinator. This will raise the question if the architects are not the only party who is going to gain profit and benefit from implementing BIM. Then why would they bother and do the additional job of information management rather than just modeling. The ultimate value which BIM adds to the project is still unclear. A more transactional compensation models for allocating the financial benefits for those who are actually doing the work is needed (Dominik Hozler, 2007)

Ashcraft supported Hozler by stating that with the current practice of BIM the designers could be the only party who will bear the extra costs of BIM. Without extra benefits than the other involved parties (Ashcraft, 2009) cited in (Macadam, 2012).

Norbert disagreed by stating that the involvement of the contractors and construction manages in implementing BIM is more than the work of the architects and engineers. Norbert's survey showed that most of the respondents think that implementing BIM had absolutely no impact on the requirements of the staff and office space. About 59% of the respondents believed that the space needed for the office was unchanged by using BIM. While 11% thought that they needed less space for implementing BIM, and 9% needed more space. When the respondents were asked about the staff and there training 41% said that the staff was not changed for implementing BIM. While 29% stated they needed less staff for implementing BIM. And 13% reported they needed more staff. However the majority stated that the costs for implementing BIM includes new software, hardware and training was not more than 0.5% of the total net revenue of the project. The respondents also stated that training did not affect the cost of implementing BIM a lot. While the costs of hardware were the most effective factor. Around 39% of the respondents stated hardware costs added between 0.5% - 1.49% followed by software costs. The majority of the respondents stated that they paid for such costs. And only 1 in 10 passes these costs to the owner through fees. While a few respondents 3% - 4% stated that the owner shall provide the hardware, software and services needed to implement BIM which covered those costs directly (Norbert W. Young Jr, et. al, 2009).

2.7.4 Legal Risks In BIM

One of the reasons for increasing legal risks in BIM is that when the information is shared in a collaboration network, ownership of this information is not determined. Therefore, this information must be protected through copyright laws. For example. the owner might feel that they own the design because they paid for it. If the design members provide proprietary information to be used in the project. This proprietary information must be protected. For those reasons the ownership of the data is not very clear, and the answer to the question of who owns the ownership cannot be determined at the moment. It requires response from every project where BIM is implemented to address the participants' needs (Thompson, 2001) cited in (Salman Azhar, 2011). McGreevy also stated that BIM holds legal risks, which requires risk management.

McGreevy divided the legal risks of BIM in to three categories which are:

- Intellectual property: this includes the copyrights of the model, and the responsibilities of the users of BIM and their contributions to the model.
- Liability of content: this includes corruption, variations, misinterpretation.
- Model identification: this includes identifying the model if it's a contract document or not. Also, to clearly whether it can be used in even of conflict or not (McGreevy, 2010).

Another risk associated with the implementation of BIM is the accountabilities of each of the involved party are not clear. This will increase the level of liability and risk in the project. For example, if an owner files a letter regarding an error in the design. All the involved parties will be confused trying to conclude who was responsible for that error. This will cause legal problems, because it will be default to determine who is responsible for that error cited in (Salman Azhar, 2011).

Thompson and Milner stated that the programs which are being used by the involved parties might create a problem. For instance, most contracting companies want their subcontractors to submit a schedule using the critical path method. Only if both the contractor and the subcontractor are using the same program this will not be a problem. But if not even if that program is a BIM module or another program that is integrated with BIM. When the schedule is updated in different program problems will occur and it will reduce the accuracy and efficiency of the schedule. If this happens then instead of reducing the rework this has just created an extra work cited in (Salman Azhar, 2011). Hozler stated that one of the things which are creating this problem is that BIM is technology-centric. Which make most stakeholders think that BIM is just implementing a new software. This will lead to a fundamental problem in implementing BIM, and in understanding BIM as a method of construction (Dominik Holzer, 2011).

2.7.5 Lack of Experience Risks in BIM

Multiple stakeholders is one of the main constrains in any construction project. When this happens, the main barrier will be a smooth flow of information between those stakeholders. If the information is not flowing to all the stakeholders this will lead to poor relationships and mistrust between the involved parties (D.B. Hammad, et. al, 2012). The collaboration platform of BIM can solve this issue because it allows the information to be shared. However, this will lead to another problem which is lack of experience of the BIM users which is preventing information from flowing accurately. Lack of experience is one of the main barriers when it comes to BIM because it does not allow the users to fully implement BIM. And it prevents them to implement it correctly either.

Dobelis stated that if the hardware and software can provide such benefits to the construction industry. Then why no one is introducing and initiating these potentials in everyday practice. The main factors for not implementing them would be the cost and training. This also apply to BIM, because the learning curve of BIM is the major barriers for implementing it. Another two important factors are the change factor and the people factor. Because implementing BIM requires an organizational change, which is a difficult process. People must accept this change; some people will adopt faster than the others. The organization might have to release some of its employee because they refuse to change. To avoid this problem, it was suggested that BIM should be taught at universities so people can process the idea of implementing it. However, a recent study on 119 building construction schools has shown that only 9% of those schools are teaching BIM. (ModrisDobelis, 2013) The McGraw Hill Smart market report shows that when it comes to initial cost, and training. Lack of experience was the major barrier for implementing BIM. Nonetheless, the report shows that 50% of the respondents do not think that lack of experiences and training had a huge impact on the decision for adopting BIM or not. The report addressed lack of experience barrier as one of the four major barriers which are preventing BIM from being implemented. Which is conflicting information because the report shows that lack of experience was not one of the main reasons for not implementing BIM but still addressed it as a major barrier for not implementing it. (Jones, et. al, 2012).

The reason of such conflicting information.

McGraw is resolved in a survey which was made by NFB. The survey main purpose was to measure if the contractors are ready for BIM implementation or not. But the survey showed that there is a technical gap between larger contractors and the rest of the industry which can be the reason for the conflict information in McGraw report. NFB survey also showed that this gap is also created due to lack of experience in using BIM features and other 3D drawings. The majority of respondents reported that they have no experience in using BIM tools. When it comes to large contractor only 21% of the respondents replied that they have no experience in using BIM. Using BIM is limited with the small contractor for many reasons mainly because the lack experience and technical skill as well as the ability to finance the BIM implementation. Figure 2 shows that about 43% of the large contractors have done more than 10 projects by implementing BIM. The percentage becomes much less between (1-9) projects which indicates that the BIM is only being implemented by large and experienced companies (Julia Evans, 2012).

Leeuwis research on small architectural organizations supported NFB survey. The research shows that BIM implementation by small architectural organizations is still in its first stages. Most of those firms identify BIM as a 3D modeling approach rather than a collaborative platform. The rest of the small firms were seeking data exchange methods there for they were looking to upgrade their level in using BIM in the future (Leeuwis, 2012).

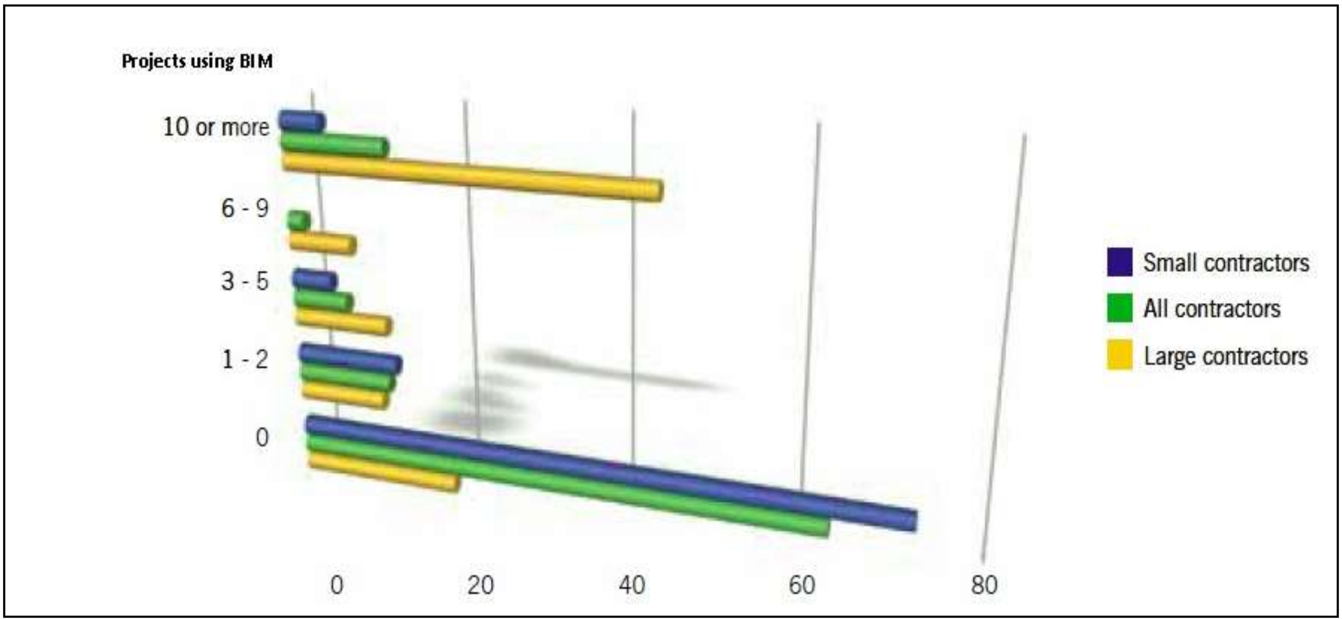


Figure 2: Relationship between company size and BIM implementation (Anas Bataw, 2013).

2.7.6 IT Related Risks

BIM is software, it can reside physically on dedicated server or virtually as part of cloud. And in the most of cases it is exposed to external networks which will cause high probability of information leakage or data loss due to security issues. Such risk could be mitigated by using security prevention systems like firewalls to isolate any un-authorizes access to the systems. Internally there is another risk might result from abusing BIM or ambiguity of using it. And this risk could be avoided by applying authorization matrix which will allow right permission for the right user.

Beside the security risks there is risk of lack of training to work with BIM taking in consideration that BIM training is costly and require a continuous extensive training to reach to the appropriate of knowledge level to use it in daily basis. Stability of BIM is another issue, any software is subject to stability issues which will result with interruption or stop for the users who relies on BIM to do different tasks.

The BIM Specifications at Tender stage

Project tender requirements specified that the General Contractor must develop, communicate and share a complete BIM for all disciplines, including all Sub-contractors' and manufacturers' scope. The BIM Implementation therefore, had to cover Design and Engineering (clash mitigation, coordination of design, RFI systems, shop drawings), Planning and Project Controls (Scheduling, Cost Estimation, Progress, and 4D studies), Quantity Surveying and Contractual (Quantity take-off and measurements) as well as Manufacturing (Digital Fabrication). Site logistics, temporary installation, scaffolding, and formwork must be BIM driven.

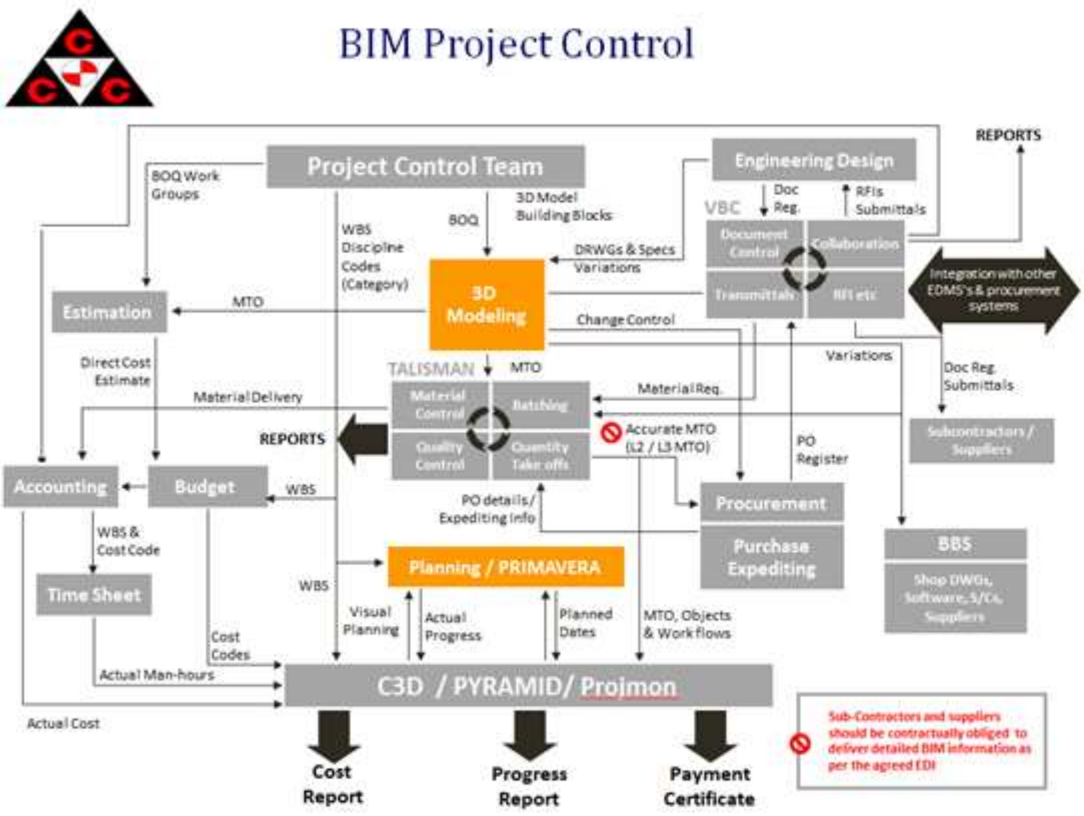


Figure 5: Abu Dhabi International Airport BIM Project Control (thebimhub:2014)

Pre-Award stage Preparations

Abu Dhabi Airports invited five major international Joint Venture (JV) Consortia to bid for the construction contract of the Mid Terminal Concourse project. The JV of CCC, Arabtec and TAV developed an approach based mainly on the experience and expertise developed in-house by CCC over the past decades. CCC's accomplishments in this field are well recognized by its peers and reputed manufacturers of BIM Software. Their BIM processes were developed completely in-house, building on the demands of its core business and the control systems that had been established within the company.

A Bold Approach

The complexity of the Midfield Terminal Building project modeled many challenges to the General Contractor before and during construction. Mitigating such challenges, ensuring the quality of the completed product and meeting the stringent demands of "BIM-driven" project delivery, demanded a gigantic commitment from the JV in terms of pre-planning, technical understanding of the project and available resources. Certainly, it was felt that the only way to meet these demands and be prepared for project award was to commence the BIM process prior to the project commencement.

A brave initiative was taken by CCC and its IT/BIM department to start developing the 3D BIM platform for the project eight months prior the project was even awarded. This approach qualified the JV to get a head-start on the project (in the event that they were effective in their tender), however, it also ran at great risk and cost in the event that the tender bid was unsuccessful. A preliminary BIM was developed from the tender documents at CCC's BIM centers. A decision was also taken to commit to the training and preparation of forty additional BIM engineers in the event of a successful award.

Resourcing BIM

The position of 'BIM Engineer' involves professionals with multiple skills. Accordingly, CCC assembled top quality engineers at a range of levels - senior, skilled and young engineers - through a rigorous selection procedure. Serious and ambitious intensive training was provided to the new recruits to orient them on the BIM workflows, authoring, project controls, design coordination processes and many other concepts that are needed for an effective and productive BIM implementation.

The training which continued for more than a year, included the extensive use of the software for creating and adapting geometry in 3D, introductions to all design and project control concepts and participation in actual, medium to large scale projects. This supported the team to develop essential skills and knowledge base in real project conditions.

BIM Tender

Throughout the last eight months of the training the new recruits were deployed under the supervision of more experienced BIM staff to develop the initial model (LOD 300). This model was then used to integrate with the preliminary WBS (Work Breakdown

Structures), clarify the project scope, extract material take-off reports and merge them to the project Bill of Materials and finally compare it to the tender BOQ.

The BIM tender would enable the JV to start the project – if their tender was successful - with a proper wealth of information, RFI's (Request for Information) prepared, design discrepancies, good environment and a scope management for initial logistics and constructability studies. BIM advisory team developed the BIM Specification for Abu Dhabi International Airport (MTB-ADIA) for Building SMART ME,

3. Research Method:

This section examines the methodological approach that governed the conduct of this project. The examination of this section has been done through the use of a Research Onion framework by Saunders et al, (Sahay, 2016). This framework has been shown below in figure (4);

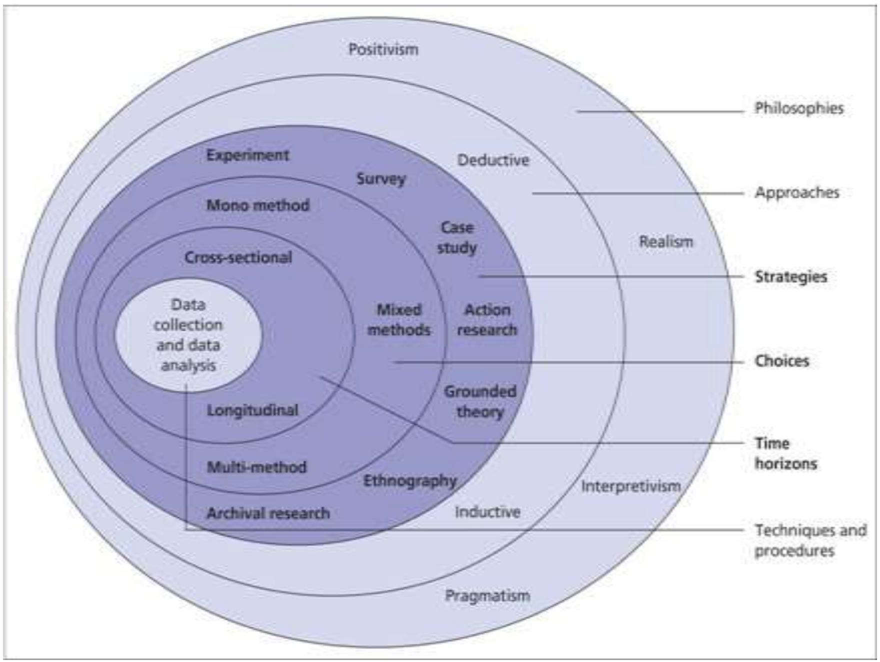


Figure 4: Research method used

The following provides the stages of the 'Research Onion' as applicable to this project;

Research Philosophy

The assumptions that govern the conduct of this project, are based on certain worldviews [18]. Philosophies are often examined with relations to the ontological [existence of reality], and epistemological [our knowledge of reality] (Ngozwana, 2018). Key philosophies that are used in academic researchers are positivism and interpretivism (Mohajan, 2018). In this study, a positivist approach was taken, with the assumption that the knowledge that is gained in the quest to examine the phenomenon of BIM and construction risks, are independent of the social subjects (Sahay, 2016), meaning that positivist studies are more scientific.

Research approaches

Saunders et al [2009, 2013] have given two key approaches; Inductive and Deductive. In this study, inductive approach was used, where the researcher starts with observation then goes to theory (Sahay, A., 2016; Mohajan, 2018). This study thus examined what is taking place in the sector and links these to the existing theoretical viewpoints.

Research strategy

Sahay (2016) indicated that the choice of a right strategy is vital for a successful execution of a research. A number of strategies can be employed, including case study, surveys, interviews, experiments and systematic reviews (Sahay, 2016). The strategy that has been employed in this study is the case study has been used, where three companies were examined, and their use of BIM was evaluated with the view to identify how the use of BIM has helped these organizations.

Choices and time horizon

The choice that has been consider for this research is mixed method where the study included an examination of case study and literature review. The use of case study provided the researchers with a real-life example of how the BMI has been employed in organizations and the results thereof. In terms of Time horizon, a cross section study has been conducted where the three organizations have been examined once, and on the basis of how they have used this methodology to manage their risks.

Data collection techniques

This involves the method that was used to collect relevant data for this study. Primary or secondary data collection methods can be employed (Mohajan, 2018). In this study, secondary data collection technique through the use of case study and literature examination was conducted. The cases came from the internet and other sources and the outcomes of these have been analyzed.

4. Case Studies

4.1. Primary data:

Case study 1: Van Wijnen

Image courtesy of Van Wijnen

The case study shows how BIM can minimize the risks of time and cost to the minimum as it clearly indicates that time has been reduced to 50% and cost by 15% by only implementing BIM that manages the supply chain required for the design of the project and manage the long lead item and ensure the delivery just in time as well as the cost can be reduced by having a clear image about the required materials and compete more competitively on tenders that will forward their tender offer in cost and time wise in addition they can order in advance and have the time to negotiate prices with the vendors. Having 1400 employees and 23 offices in Netherland shows clearly that BIM benefits large organizations drastically and privilege them with an opportunity in the market as BIM offers a green sustainable environment the consumes paperless drawings all can be updated on site by an iPad and progress photos can be updated and attached just where the 3D drawing shows. For a company who seeks for a high quality delivery with a reasonable cost BIM supports their commitment in many aspects specially in the growth of construction demand and the evolution of the technological competencies and as the general manager at Van Wigjnin who admits that BIM have had helped the company to increase the pace of construction and enhance the quality delivered to the stakeholders he simply clarify that BIM has solved many problems and reduces the issues in construction and most importantly drive the construction process faster and increase the revenue of the company.

Case study 2: Midfield Terminal Building - Abu Dhabi International Airport (MTB-ADIA)

Abu Dhabi International Airport (MTB-ADIA)

A case study about BIM-integrated processes in Abu Dhabi International Airport Midfield terminal Building is considered the largest project implementing BIM, as BIM have participated in mitigating and transferring risks of the project such as the accuracy input of thousands of piles that are critical and must ensure the bedrock assurance as all the details in the design has been inputted to the BIM and the actual figures have feed back to the system to ensure that stability of each pile and its coordinates. Such quality assurance has helped to mitigate the time delay risk and contributed in a drastic cost saving to the project. BIM manages the Site Logistics - Tower Crane Coordination and the Construction Sequence – 4D Studies along with the Drawing Traceability and File Management in addition to the Clash Detection and Issue Reporting for the Midfield Terminal Building of the Abu Dhabi Airport (MTB-ADIA) is a $3billion, 700,000-sqm development, providing a terminal building with passenger and a cargo facilities, duty-free shops and restaurants for a total capacity of 27 to 40 million people annually. The unique X-shaped building will be located between the existing two runways, giving it the name 'Midfield'.

The project is designed to render an open and spacious environment the MTB features large column-free zones with inclined steel arches supporting the rising roof. A large hall leads passengers to the center of the building, which embraces a hotel, lounges, cultural outlets, stores and a park-shaped garden. Guided by environmental objectives the Midfield Terminal Building is designed to meet the UAE's Two Pearl Rating for Sustainable Design. (TheBimHub, 2014)

4.2 The secondary data:

Case study 3: Kathleen Kilgour center

Case Study No. 3 | Building Information Modelling [BIM] | Kathleen Kilgour Centre [squarespace.com]

Case study 4: **Dubai Museum of the future**

AEC Excellence Awards 2017 [autodesk.com]

Case study 5: **Imperial Avenue – Residential and commercial**

Case Study - Imperial Avenue Tower | Residential & Commercial Tower [architecturalbimservices.com]

5. Analysis

5.1 Analysis method

It is important to choose the right method of analysis that will enable a researcher to understand the data that has been gathered in a study (Mohajan, 2018). In this study, advanced qualitative analysis method has been used, where the tabulation of the thematic viewpoints that arise from this study have been examine. These themes are explained in the light of the aim and research questions that were given in the introductory section this study, and to identify if the hypothesis can be accepted or rejected.

5.2 Analysis and Findings

The following section provides the findings of three secondary case studies that were examined of projects that have employed BIM. The findings have been presented on the table below and discussion thereof ensues.

Pointer	**Kathleen Kigour Centre**	**Dubai Museum of the future**	**Imperial Avenue – Residential and commercial**
Project description	Construction of a healthcare facility in New Zealand. A 3000 msqr facility with three treatment space and a clinic. |Cost of the project was $ 35 million.	The Dubai Museum of the future is a state-of-the-art museum that embodies new ideas. It is a $136 million, 30000 square meters building showcasing glazed Arabic calligraphy, with exhibition space spanning 7 floors.	A residential and commercial complex, spanning 13,40,000 sq feet, and whose design was done by using BIM. A 40-storey tower with a health club, a jogging club and visitor parking area.
Extent of use of BIM	Collaborating of planning activity, while ensuring that there is a high level of communication and sharing of information between stakeholders.	BIM was used by the designers to design and showcase a 3D model of the museum, while allowing for collaboration of resolutions, and in helping stakeholders to make decision about the components of the museum.	BIM modelling used for designing the project and supporting all 3D, 4D and 5D activities.
BIM and risk management issues	-Provided high level visualization that traditional design methods could not achieve. -Digital prototyping helped to 'build before you build', hence	Through BIM -Communication between stakeholders greatly increased through the construction projects.	The use of BIM helped in identifying flaws that were hidden during the transition from the design stage and helped the management to solve conflicts as

	allowed for risks to be identified and mitigated. Through BIM savings were made to the project.	- There was a visual representation and simulation of the projects and hence identification of areas of 'fault'. Tobias Bauly, the director of BuroHappold said, 'BIM is the medium, without which, this project would have been impossible,'	and when they arose, between the designers and the owners.
Link	Case Study No. 3 | Building Information Modelling [BIM] | Kathleen Kilgour Centre [squarespace.com]	AEC Excellence Awards 2017 [autodesk.com]	Case Study - Imperial Avenue Tower | Residential & Commercial Tower [architecturalbimservices.com]
Primary Data Case 1: Van Wijnen	BIM can minimize the risks of time and cost to the minimum.	It clearly indicates that time has been reduced to 50% and cost by 15%. BIM manages the supply chain required for the design of the project and manage the long lead item and ensure the delivery just in time and cost minimization.	Having 1400 employees and 23 offices in Netherland shows clearly that BIM benefits large organizations drastically and privilege them with an opportunity in the market.
Primary Data Case 2: Midfield Terminal	A case study about BIM-integrated processes in Abu Dhabi International Airport Midfield Terminal Building.	BIM has enabled mitigation and transfer of risks via accuracy input of thousands of piles that are critical and must ensure the bedrock to guarantee stability of each pile and its coordinates	The outcome is mitigation of the time delay risk and contribution toward a drastic cost saving to the project.

5.3 Discussion

From the table above, it can be seen that the use of BIM has proven to be generally very important in the construction sector. BIM has been seen to promote coordination of activities at administrative levels and at the same time, helping in performing the construction tasks (Zou, Kiviniemi, & Jones, 2015). The findings are consistent with the study by [15, 16] who stated that BIM is the tool for both the activities of construction and management levels in a construction project. The three cases given above have been drawn from two different parts of the world, all showing mega construction tasks adopting and realizing the benefits of BIM. Tomek and Matějka (2014) have indicated that the important thing about BIM is that it cuts across regions and remains with the profession. It should be noted that the administrative and construction level benefits, are helping to address risks and hence make these projects to be safer.

The nature of BIM's benefits that are associate with risks showcase a level of risk management at both the low, medium and high. A study by Aibinu and Venkatesh (2014) indicated that a good project modelling tool is such that can examine risks, not as a risk element but as a mechanism for supporting project execution. It is the view here that such a tool should manage large and small risks and not just part of the risk.

5.4 Optimization of BIM

At the center` of operationalization of BIM is the quest to make it effective, useful and anticipatory of the future needs. This study identifies the use of BIM as crucial for construction as a sector. The ability of BIM to work across other technologies and support improved building and construction projects is crucial. Optimization of BIM can be achieved through stepwise review of the processes and updates to the software, in such a way that it can link with other activities and operations of other sectors (Zou et al., 2017; Ameyaw et al., 2016). This calls for the design and development of a robust system that has been crafted by those who are drawn from different sectors.

In the design stage, the developers should be able to explore the limits that a BIM project and process might have to encounter, then work backwards towards the objectives of a project. This is like testing a project, and ensuring that the tests that a project is subjective to are extreme, thus allowing for the development of robust mechanisms for shielding the system from breakdown.

1. Conclusion & Recommendation

In conclusion the risks associated in the project has a direct impact on the facility management and the role of facility management starts from the planning of designing the project till the last day of the project. Involvement of the facility management in the early stages of the project will allow them to manage the risks and ease the decision towards mitigating, transferring, and/or avoiding the upcoming risks. BIM provides solution to reduce the risks by saving time and cost to the project and provide an integrated platform of communication between stakeholders that create an environment of direct updated engagement between the projects and facility management.

We recommend to start implementing BIM in all of the projects and take risk for learning and upgrading our systems as we challenge such change will result with a positive outcomes that will reduce time in communications, processes and arguments which leads to a faster project completion that will benefit all parties and clients who gives bonus to the contractor who accomplish the project ahead of time will consider BIM as a vital tool to support such demands, the cost savings are considered as well without compromising the quality of work as BIM eliminates discrepancies and reduce double works and provide a paperless environment that is more sustainable and green. All of the above are what BIM was really invented for back on 2006 to create innovative ideas to architects and enhance the communications with the contractor and plant a provisional risk relation among all project stakeholders.

Conclusion

This project has examined the benefits of BIM as a modelling tool in identifying the problems that affect an organization in the construction sector. There are a number of methodologies that can be employed in managing projects, and it has been found that risks are a major problem for any project. Risks are a problem and gauging the risks is crucial. The project employed secondary data collection method and managed to explore five case studies of organizations and it was found that BIM supports administrative and construction projects. It is, however, evident that BIM's usage has increased but not at a higher level. There is need to ensure that there is a higher adoption of BIM by all nature of organizations.

On the basis of the findings and the discussion that have been presented, it can be said that the project's aims have been met. The BIM is an important modelling tool for managing project risks.

Recommendations

On the basis of the information that has been presented in this study, the following are some of the recommendations that have been given

a. There is need for BIM to be expanded in the construction industry. BIM's adoption needs to be expanded through education in such a way that construction companies can fully use this technology. To this extent, governments must encourage companies to use this modelling tool, especially in projects where governments are the client.

b. One of the problems that has been found about BIM is that there are no standards that help BIM expand. There is need to ensure that standards of operating BIM in the construction sector are well set and defined, so that the stakeholders are able to adopt it. Setting of standards should involve a number of stakeholders in the construction sector, because in so doing, there will be a high level of adoption, which will be beneficial in risk reduction.

c. BIM as a risk management tool has been found to be helpful for the owners, contractors and designers. To this extent, there should be a clear definition of the usage of BIM by the different stakeholders in the industry. This will make it effective in identifying and managing all elements of risks. [14] has indicated that although as a modelling tool, BIM is used by a number of stakeholders, a clear definition of how these stakeholders can use BIM is the first step in countering risky projects.

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