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Application of Building Information Modelling in Construction Projects

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Abstract:
In recent years, building information modelling (BIM) has been one of the most popularly debated topics in journals on technological progress in construction projects. In the construction project model that is built and applied via a collaboration network, the BIM concept incorporates all tasks related to planning, construction and operation. The paper of focus is applied risk and change management focusing on the building information modelling (BIM) from the perspective of from the point of view of the construction projects management theory and structure. However, negative affects such as setbacks and financial damages to the detriment of participants' public projects, in particular, pose a concern as to whether and how the application of BIM standards will enhance management practices in the context of construction projects correlated with risk. This paper aims to deal with the current situation of building projects, information about risk and change management in the construction project, as regards the application of BIM, and to guide further studies. The arguments highlighted in this paper are using in the analysis of many reference kinds of literature. However, the risk is a subject that should always be established in the concept of BIM. An effective way to combine risk construction projects processes, practises and strategies with other management actions for construction projects within BIM must be created. Moreover, change is considered one of the main factors in risk and the incorporation into this framework of change management processes includes the introduction of guidelines and methodological approaches within BIM. In addition to that studies on this field includes previous expertise in implementing BIM in construction programmes, the involvement in this point of risk-related processes and requirements for successful coordination of management.

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1. Introduction

Over the years, Building information modelling (BIM) on construction projects has been emerging advanced technologies, high processes that have been encouraged towards the object of enhancing productivity and increase the value to the construction projects (Saka and Chan, 2020; Cheng, Qiu and Duan, 2019). What is more, building information modelling (BIM) has been changing the process of architecture, engineering and construction industry (AEC) as well to perfectly operates over many years (Saka and Chan, 2020). From a practical point of view.

Building Information Modeling (BIM) is taking place as a new technique that has been enhanced and used in the engineering domain. This data model incorporates all related knowledge for three-dimensional emerging technology architecture programmes.

In the planning process but even during the building and operating stages, BIM is primarily used. The use of BIM improves design efficiency considerably and decreases the risk in the design and development processes (Wang and Han, 2018). In this regard, based on The National Building Information Model Standard Project Committee, BIM is defined as "a digital representation of physical and functional characteristics of a facility," However, a BIM is "a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition" (Yin *et al.*, 2019; Antwi-Afari *et al.*, 2018; Li *et al.*, 2018).

BIM on a construction project has been presented as an advanced tool and process that can have a solution to figure out the main challenges related to the construction industry. Moreover, It helps to breaks the silo effect among the several participating organizations in efficiently constructing the supply chain and interfaced with the fragmented system (Saka and Chan, 2020). However, BIM on construction project implementation is a complicated process; its regulations and techniques, like any industrial or organisational project, should be followed to be successful. It involves the design and monitoring of indicators, a project management process, and a minimum documentation and collaboration process (Joblot et al., 2019). The elements are required to use support instruments or resources and seek advice. This section examines the suitability of these essential elements and their current scope. Thus, their knowledge and characterization will facilitate them to be transposed or even modified into a framework conducive to BIM's deployment in this band. The purpose of BIM Implementation is summarized in Fig. 1.

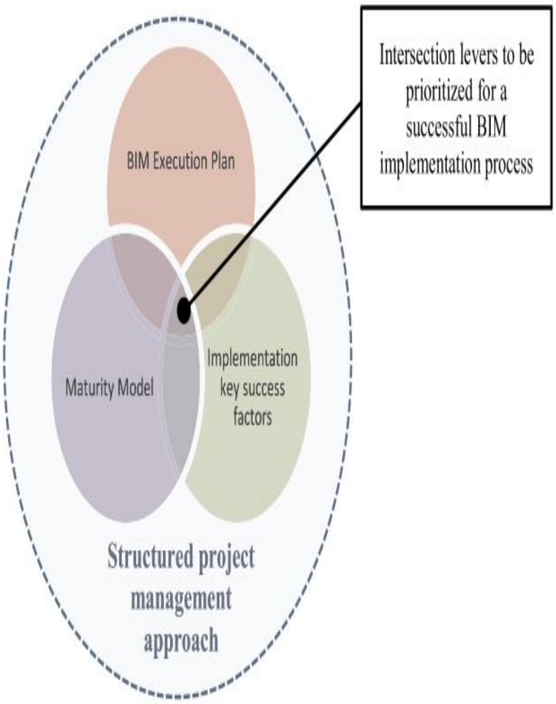

Figure 1 Main BIM implementation levels (Joblot *et al.*, 2019)

Some studies in BIM focus on the factors that influence the choice of digitally based solutions and the determinant of acceptance of new technology. The adoption of technology could be at a national level a decision to mandate or regulate technology use within a construction project but more generally, it is at an organisational level which means that decisions are taken by the top management in organisations according to the strategies of a construction project. This will result in different pressures or calendar constraints and the choice will be imposed or desired. Regardless of what the scenario is the essential factor in the success of a construction project? Fig. 2 presents the requirements for A BIM project lifecycle.

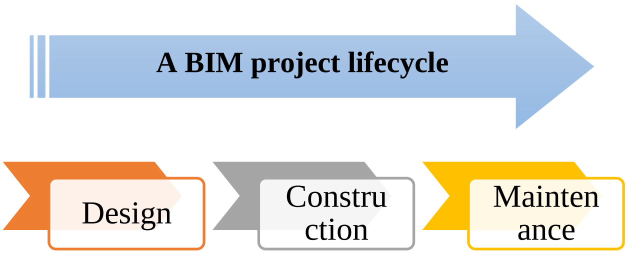

Figure 2 The requirements for A BIM project lifecycle (Hsu *et al.*, 2020).

During the construction Level, as presented in Fig. 2, constructors still frequently required project managers to revise the design in engineering integrated based on meetings the reason behind that the difficulties of construction or even more the lack of feasibility so far. However, dissimilarities between designer and constructors in the approaches for resolving clashes are quite often cognitive since their perspectives are focused on the understanding of the field and previous experience. The reduction in the rate of design changes at the construction site is an alternative to efficiently improve the project completion level. This can be achieved by giving a reference to a BIM model. Plan confrontations may be overcome in this model from the constructor's viewpoint until negotiations in design coordination meetings to identify compromises (Hsu *et al.*, 2020; Rezaei, Bulle and Lesage, 2019; Hsu *et al.*, 2020). Moreover, for construction project purpose, the system architecture uses the BIM programme as a portal for detection of clashes, recovering of geometric and spatial profiles item, and revision of elements. The tests confirmed the efficiency of the proposed method by adding it to the MEP systems in the basement of a student. The experimental findings indicate that the method proposed is feasible and reliable for a construction project (Hsu *et al.*, 2020; Seyis, 2020).

2. Building Information Modelling as Concept of Construction Projects

In this section, the paper gives more details on previous work on Building information modelling as a concept of construction projects. Building Information Modeling (BIM) is an interactive digital framework that transforms the design process from conventional fragmentary practices. Different tools, technology and contracts help the digital representation of the generated project model, generating, analysing and managing.

This paper considers the field of construction projects as the main subject of its study. The authors (Antwi-Afari et al., 2018) discussed building information modelling (BIM) which is comprehensive within the construction projects, the authors have been highlighted the critical success factors that can be measured successful BIM implementation during the period 2005 to 2015. In addition to that, the study has mentioned the elements that can make BIM implementation is not established well. However, each country implements a different set of CSFs such as USA, UK and South Korea, several universal critical success factors are well known between many countries, to mention some: (i) collaboration in design, (ii) engineering, (iii) construction stakeholders; (iv) earlier; coordination and planning of construction works, (v) enhancing. However, these common factors provide a core basis for establishing a standard evaluation model for measuring the success of BIM implementation and serve to identify areas for further improvement. The authors have not discussed a checklist of critical success factors for a different level of BIM implementation.

This is the field of study that deals with the author (Chen et al., 2019). Structures such as buildings and facilities are inspected through vision-based techniques. Due to different contexts in the pictures obtained, traditional vision methods rely on manual processing for the extraction of relevant structures of significance in certain applications for subsequent studies, such as distress detection. This is a difficult, necessary and error-prone exercise. To answer this problem, this thesis proposes a new approach that automatically fits a georeferenced image of actual situations with a simulated image of a building knowledge model, to obtain the related interest structure.

This has been widely adopted in the field of building information modelling (BIM). The author (Gao, Koch and Wu, 2019; Truong *et al.*, 2017) has been discussed the energy modelling of buildings that are designed to research building energy efficiency and to test computer-supported technology for the construction of architectural and structural systems. However, building energy models can deliver more accurate outcomes and better energy-efficient construction in the overall building design phase compared to manual measurements, thumb laws and extrapolation approaches employed by designers. Moreover, conventional building energy modelling is not embedded and known as a fastidious method in digital architecture. Furthermore, building information modelling is considered a software modelling method for the generation and management during the design and construction process, and other decision-making resources may be made available to the captured building training in order to improve building efficiency and to achieve sustainable development.

This research constitutes a relatively new area that has emerged from building energy modelling. The authors (Xu, Mumford and Zou, 2021) has to deal with building information modelling (BIM) using building energy modelling which is a prevalent ramification of the BIM technology. BIM has the potential to reducing the time and price cost of building energy modelling, rapidly assess various architecture alternatives and increase the accuracy of building energy modelling to boost building energy efficiency.

This research (Najjar *et al.*, 2019) concentrated on using buildings for optimal usage of operating energy use because it constitutes the bulk of lifetime energy use and considered the entire building life cycle for the assessment of environmental impacts from building materials, regardless of the building process. In the case analysis, the annual fuel usage rate and the annual energy use intensity of those buildings may be reduced by approximately 45%. Results demonstrate that the energy efficiency of building envelopes depends on all building materials.

The authors (Haruna, Shafiq and Montasir, 2020) have been influential in the Building Information Modelling (BIM) field because of their advantages for different phases of a building life cycle, greater attention was paid to the global Building Information Modelling (BIM) and multi-criteria decision-making (MCDM). This paper aims to enhance the understanding of the BIM and MCDM processes in sustainable energy-efficiency building. For construction professionals and construction industry specialists in Malaysia, a questionnaire study is underway. A multi-criteria decision model using the analytical network method (ANP) was developed using expert survey data to define key factors impacting sustainable building through both incarnate and organisational energy and carbon reduction. Results show that optimization and lower material specifications for sustainably capable construction in the BIM application are significant factors

This paper (Othman *et al.*, 2020) targeted local building association took part in the promotion of the BIM CIDB-led seminars organized. The Melaka, Kedah Sabah and Sarawak questionnaire survey is transmitted. The research also found that it has a major influence on practitioners with management expertise to incorporate and utilise the BIM technology concept in the organisation. If the organisation conducts BIM in its day-to-day work and instruction or promotions of workshops, the amount of BIM adoption and team knowledge is improved. Will and dedication contribute to successful participation in adaptation and promote teamwork to increase awareness of BIM. Furthermore, the most important result of this study is that in Malaysia, the adoption of BIM is still at a rather low level in both private and public building. Any of the organisations analysed do not use BIM and the team does not use the concept. The deployment of BIM is also delayed. Building players have trouble understanding how BIM between parties can be performed. The study reveals that BIM was introduced in a fragmented setting, while BIM implementation is ineffective in the whole BIM project management.

3. Needs for Building Information Modelling (BIM) for Sustainable Construction Projects

In this section, the increasing sustainability focus which includes the following carbon emission and energy dependency on fossil fuels has mandated the construction projects to gain the green building strategy (Haruna, Shafiq and Montasir, 2020). In the private and public sectors, the project that overrides budget and timetable, which is identical in different countries, is also popular. Building operations account for about 40% of world carbon emissions. BIM is a technology that can be used for the modelling of energy consumption, thermal currents, lighting patterns, etc. The structural replacements are compared at the construction level, both in the incarnate as well as the operating energy phases, as part of the whole life cycle study. The exchange of information from designers in construction systems to reduce energy demand and the volume of greenhouse gases can be very useful when making decisions. Therefore, the paper has to be driven by a collective and efficient building information system. The use of BIM in the building industry is strongest in Quality Management. Construction players can routinely check their projects to detect potential construction defects. Security in the construction industry is the least impactful of BIM deployment. While BIM features can be used for security purposes, BIM for safety purposes is still not used by many projects players (Haruna, Shafiq and Montasir, 2020).

4. Building Information Modelling Tools

Building information modelling technologies allow architects, designers and engineers to generate 3D models, analyse the structure and develop effective designs. The architecture of Autodesk Revit architecture allows architects and designers to create an exact and performing 3D model. It is a programme that maintains the same architectural platform, MEP (Mechanical, Electrical and Plumbing) structural analysis (Kavitha and Molykutty, 2021). Revit is a 4D BIM platform that can prepare, use the data available in building materials, or incorporate new materials with their properties. Building Energy model can be built and automatically conduct a Life Cycle Assessment based on emissions of energy, cost and greenhouse gases from hypothetical to modelling phases and ultimately demolition. This thesis uses Revit architecture tools as seen in Fig. 3, to create a 3D model for the energy-cycle analysis of commercial buildings.

Figure 3 Model of the Prestige Polygon building developed in REVIT (Kavitha and Molykutty, 2021).

5. BIM Application for Sustainable Construction Project

5.1 Design optimization

Due to the complicated workloads of designers in the building sector, it is very difficult to achieve an ideal design. Through design optimization, BIM will aid achieve sustainable development (Ding *et al.*, 2020). Optimization seeks suitable solutions for those success parameters (Skandhakumar *et al.*, 2018). Implementation of optimization may enhance the solution and increase awareness about the speed of design.

5.2 Facility management

At the stage of the construction project life cycle, the presence of facilities managers became a rule in the transmission to customers. In architecture and development, BIM has seen improvement and is now beginning to develop into facilities construction project management (Muller *et al.*, 2019). Compared to planning and maintenance costs, the overall lifecycle costs to run and manage a facility are higher. This is why construction workers are increasingly interested in the functional know-how of BIM in the efficiency of its buildings (Li *et al.*, 2018). BIM is a new area of facilities management and no further ideas are yet available in the industry. BIM focuses mostly on new construction in terms of facilities operations (Muller *et al.*, 2019).

5.3 Integrated project delivery

Integrated project management brings all partners, processes, market structures and experience together to collaborate to accomplish optimal objectives by shared information. The adversarial and fragmentation of the building industry has not made BIM entirely competitive (Charef *et al.*, 2019). Integrated project management aims at reducing duplication, reducing costs and improving efficiency for development actors.

5.4 Reduced material needs and waste

Waste has been a significant reversal in the building industry because the climate is unsustainable. The main cause for error and delay in the construction industry is inconsistency and unclear facts. Consequently, explicit storage is required to exchange project information among participants. BIM tackles the issue by including the correct details on time.

5.5 Bioclimatic and integrative design

BIM is an instrument with the sole responsibility of linking sustainable construction with integrated design and with a building life cycle. Bioclimatic design is a sustainability concept that considers climate and human relationships during design. Among the justification of bioclimatic design are achieving maximum comfort and minimizing the energy and cost of building operations.

5.6 Improve schedule

BIM is a tool whose primary duty is to connect sustainable architecture to integrated design and the life cycle of the building (Ding *et al.*, 2020). Bioclimatic architecture is a philosophy that takes the environment and human relationships into consideration during design. Bioclimatic architecture rationale includes optimum convenience and energy reduction and construction service cost minimisation (Ding *et al.*, 2020).

6. Integrated Risk Management in Construction Projects

There are ongoing tasks that include identifying, analysing, evaluating, and preparing and tracking risk management. Different types of risks in the project overlap and involve dynamic monitoring and decision-making practices. Methods of project management understood and studied for many years suppose that good contact is one of the essential elements of the efficient scheme of risk management. The information efficiency and consultation of project partners have a significant influence on risk management effectiveness (Ding *et al.*, 2020).

There has been a broad description of risk control in programmes. While the reference literature provides many conceptions of risk concerns in a construction industry practice and the risk identification and assessment depends mostly on observation, judgement and expertise, there is no formal methodology still in place. Construction projects are at a significantly higher risk than most industries, resulting from the peculiar design of building enterprises. They are distinguished by the uniqueness of any project; Frequent significant intrusion into the natural environment as well as strong influence in the climate, topographical and hydrogeological environments; a long period in investment preparedness and implementation; a longer lifespan and high demands for the capital; complex and dynamic works.

This is linked to an extensive evaluation and reaction preparation through a wide range of risk factors. The risk impact on the key project parameters such as lead-time, expense and efficiency, can be categorised according to these factors. In the following stages of the project life cycle, risks may also be detected. In the three categories: general risk, operational danger and technological risk. Studies have shown that risk should be regarded for construction projects (Charef *et al.*, 2019). The first group covers threats related to the project's economic and legal background. Strict laws and unregulated amendments in the building legislation as well as a host of other laws in connection with the building process are seen in this respect. The specific organisational risk group includes factors linked to a lack of cooperation among investors, lack of experience, and incompetency of an architect, contractors and investment supervision representatives, financial struggles of the contracting partner or sub-contractors, absence or unclear provisions in project specifications of project management procedures. The philosophy of corporate risk management (ERM) combines risk management actions with general corporate goals. In this way, the prism of their experiences, human risk factors, as ties of the value chain, can be viewed. Using this perspective, the enterprise prevents the following important risk management errors: risk identification and evaluation of processes in isolation from the other operations of the business within separate organisational units; fragmented risk management activities that result from this approach that is carried out not in companies but individual departments (counting, auditor, procurement etc.); risk management without the owner of the company.

7. Conclusion:

Reviewing the building information modelling (BIM) on construction projects mainly investigates the current state-of-the-art of paper. In addition to that this study regarding a BIM for construction projects to provide deeper insights into the paper and requires concerning the field. Meanwhile, building information modelling (BIM) as a concept of construction projects has been discussed in the second section. The paper gives more details on the needs for building information modelling (BIM) for sustainable construction projects. Furthermore, building information modelling tools have been clarified. Finally, BIM application for the sustainable construction project is illustrated which is one of the top points of this paper.

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