Essay

Building Information Modeling (BIM) Technologies in the United Kingdom (UK)

Name:
Institution:

BIM, Dimensions, Stages, and UK Processes (2.5)

Building Information Modeling (BIM) refers to a process in which information is created and managed on a construction project, during the project life cycle. As part of improving the understanding of building process, digital tools are used to describe various aspects of the asset to be developed, using relevant technologies (Mayouf, Gerges & Cox, 2019). BIM provides source of information to be used by engineers, architects, contractors, manufacturers, and designers in construction of buildings using 3D models as the source of data. BIM has been described as technological innovation in buildings and construction industry that has improved the level of collaboration, understanding, and performance of construction work according to scope (Woo, 2006). Many contractors in the UK are now implementing BIM in increasing numbers due to the benefits they derive from information-enabled ways of working. The UK is categorized as one of the leading nations in the implementation of BIM technology and processes that use internationally recognized BIM programme.

BIM dimensions have become popular in enabling project management teams have better understanding of the information they are modeling. 4D is used to carry out both modeling a 3-dimension design and adding schedule information for construction sequences, 5D is a model that adds financial costs and budget to the BIM despite lack of consensus about the relevance of costs in BIM (Moses, Heesom & Oloke, 2020). Improvements in BIM technologies have resulted into the development of 5D and 6D models. 6D dimensions are used when designing self-sustainable and energy-efficient building projects. Some of the general benefits of using BIM models is that the construction process is carried out at a fast pace, communication becomes better among the stakeholders, an increase during buildings design since the BIM models are almost closer in similarity to the real construction project, and improved performance and energy efficiency when 6D BIM design is used in the design and operation phases of construction projects.

Digital description may use 3D models and additional information such as product, procedure for implementation, and handover information. The international standards describing the BIM processes are defined in the ISO 19650 and 12006 series standards. The ISO 19650 provides international standards to be observed during the use of information over the life cycle of a project using BIM (Hasan & Rasheed, 2019). The principles and high-level requirements is in close alignment with the current UK standards. For instance, BS EN ISO 19650-1 requires that information about buildings such as civil engineering and building engineering works must be organized and digitized. This is achieved by using building information modeling technologies. ISO 19650-1 requires that building information modeling should be implemented in the whole life cycle of a project such as initial design, strategic planning, development, documentation, daily operations, maintenance, end-of-life management, repair, work scheduling, cost estimates, etc (Yadav & Kanade, 2018). ISO 19650 Part 2 defines the processes to be followed in building information management during planning, managing information and communication with project teams. The objective of the standard is to provide a set of recommendations to all stakeholders participating in the

management of building construction project. The recommended workflow management consists of 8 steps, namely: needs assessment, invitation to tender, response to tender, appointment, mobilization, scheduling appointments, modeling information delivery, and closure of a project (Sulankivi et al., 2010). BIM of the UK define the processes to be followed in management of information within the execution stage for a construction project. The concept of shared information is used in reference to the possibilities of using BIM to develop models for simulation of various stages of project development. The UK BIM principles are beneficial to organizations in the UK in the management of transition from BIM level 2 to the UK BIM Framework as specified on the international standards BS EN 19650. The act of guiding building information management to international standards is useful to clients in adapting their information needs and design information to align with the ISO 19650 (Hasan & Rasheed, 2019). ISO 19650-5 specifies the security related considerations to be observed during building information management (Alzarrad et al., 2021). It requires that sensitive information must be managed by implementing security measures during dissemination or digitization of information pertaining to a civil or building works. It also stipulates the need to implement security measures when creating digital building information in relation to a specific initiative, asset, project, or service (Alzarrad et al., 2021). The significance of compliance to ISO 19650-5 is that there is a risk that a person may inadvertently expose sensitive information about a building or facility to people who may use it for malicious purposes. When security minded approach is used in the management of building and civil engineering works, such risks are reduced (Woo, 2006). It also reduces the risk of misuse of the building or project design information by wrong persons who may use it to carry out tasks where the information is not required. The act of promoting the security of building information according to ISO 19650-5 ensures the building owners are protected against loss, theft of important information, access to personal data, diversion of resources, disclosure of commercial information, reputational damages, among others.

BIM Research Area

Civil Based Authoring / Design Tool

An example of a Civil based BIM design tool commonly used to model building construction projects is Revit. This is a commercial BIM software that is commonly used by structural engineers, electrical engineers, designers, plumbing engineers, and architects to model buildings. Woo (2006) noted that Revit enable designers to create real-life building components such as windows, doors, walls, and floors in place of making precise drawings. It is effective in generating floor plans, building sections, elevations, and construction schedules. The advantages associated with Revit include: the ability to optimize the functioning of architectural design, run an accurate simulation of cost estimates, and monitor the performance of a construction project during various stages of construction. Revit was noted to be usable when creating 3D building visualization since it has a number of rendering tools that can be used to create construction documentation with cutaways and 3D views. Research by Yadav & Kanade (2018) examined the application of Revit for BIM for integrated project delivery of building construction projects

using a literature review research design and found that Revit models improved project quality and enabled sustainable design of buildings. It was also noted that Revit models resulted in time saving by adopting concurrent problem-solving approach in place of sequential problem-solving approach that was used in most projects in the past. It was speculated that the relevance of BIM in construction projects will improve as the software become cheaper, but its effective use will depend on the competence of users such as their knowledge, skills, and experience.

4D BIM

4D BIM is a process where a construction project is modelled by constructing both a 3D model and enlisting the project timeline on the side by adding the time element to the model. When a project is scheduled with time consideration, project managers and contractors can track the progress of construction, have better insight of the timelines for specific activities, and gauge the progress of a project. The addition of scheduling to the 4D model provides an opportunity to plan the time requirements for tasks such as setting components, installation, and creating schedules for approaching tasks. This ensures conflicting activities are identified on-site and the impacts of various processes on a construction site are understood. Research by Alzarrad et al., (2021), examined the use of 4D BIM in design modeling for renovation of a construction project that involved several activities. 4D was used as a modeling tool in place of the traditional critical path method (CPM). An architectural 3D model of a residential bungalow was created using Revit while Microsoft Project 4D was used to integrate schedule to the model. An analysis was conducted to determine whether any clashes occurred using Navisworks. Another 2D model was created for use in comparative analysis using AutoCAD. Cost planning was done by including cost features to the 3D model. It was noted that 4D provided a better insight about the association between the specific activities and better detection of errors than CPM. Another observation made was that 4D BIM enabled optimization of construction schedule and development of an effective process plan, and there was transparency in communication between contractors, project managers, architects, and teams on site Alzarrad et al., (2021). The use of 4D BIM dimension also enabled the project team to prepare adequately to complete the projects within the stipulated timelines, realistic time for completion of the specific tasks was set and the cost escalation was controlled. Furthermore, delays in completion of specific tasks were minimized while the project team encountered few challenges in coordinating the project tasks. Another study by Sulankivi et al., (2010) observed that several 4D BIM based technologies have emerged to optimize building modeling and are available for use by professionals. Examples of such tools are Tekla Structures and Tekla Construction Management software. Tekla structures have been used for structural engineering purposes while Tekla Communication Management has been used on site. Sulankivi et al., (2010) also noted that some forms of 4D BIM have been used to record safety hazards, pilot planning for construction projects, modeling testing, and as tools of collaboration between research partners in building construction.

5D BIM

Research by Mayouf, Gerges & Cox (2019) examined the use of 5D BIM in construction projects modeling by conducting a face-to-face survey among 21 quantity surveyors in the UK. The interview focused on gaining the opinions of the surveyors regarding the strengths and limitations of 5D BIMs. It was found that many respondents agreed that 5D BIM was less effective in achieving project cost standardization and its implementation during project modeling required high skills in workflow management. The implications of these findings is that 5D BIMs are associated with shortfalls that impact the effectiveness of their implementation to model building construction projects. Another research by Moses, Heesom & Oloke (2020) examined the features of 5D BIM by conducting a survey among 21 respondents from the UK constructions industry. After thematic analysis of the views of the respondents, it was found that many contractors faced issues in implementing 5D BIM that were broadly categorized as management issues, process issues, and technology issues. It was recommended that effective leadership, skills, and experience are necessary to successfully use 5D BIM models in construction modeling. On the contrary Hasan & Rasheed (2019) noted that 5D BIM is associated with the strength of enabling the alignment of budget and estimation from the conception stage of a project. However, factors such as gaps in estimating the cost of a project can result in considerable pitfalls in the process of modeling. However, 5D BIM can be used to successfully analyze the costs of a project beforehand. The outcomes of the model can be used to estimate the actual costs to be incurred in the implementation stage of a project, estimation of manpower requirements, and estimation of material requirements. The 5D BIM enabled cost visualization in real-time and provides information about the cost of equipment and systems which enable effective budget analysis. It also enables efficient comparison of predicted and actual spending during the project life cycle.

Software Comparative Analysis: Functionality and Financial Impact

The Number of Analytical Features

Research by Hasan & Rasheed (2019) found that 4D BIM is preferred among building construction projects managers, engineers, and architects because it has the 3D modeling, 2D modeling, and time scheduling features that do not need to be imported from another software. Similarly, Moses, Heesom & Oloke (2020), found that 5D BIM modeling is preferred by project managers who have the desire to model the cost of a project because it provides almost accurate estimate of costs. On the contrary, 5D BIM has the limitation that it cannot be used where time schedule estimates and analysis need to be conducted. Another research by Sulankivi et al., (2010) noted that Revit lacks many BIM features since it focuses majorly on structural components of an architecture. Other design tools can be used to create more fleshed out models but in case of Revit, this is not safely achievable because the software does not have most design tools. This means that Revit cannot be used to render a product to make it stand out. On the contrary, 4D BIM and 5D BIM models provide rendered 3D images and time schedule and cost schedules respectively.

Ease of Use

According to Hasan & Rasheed (2019), Revit is less easy to learn compared with 4D BIM and 5D BIM that do not require considerable skills to know and a person only needs to undergo few days training to acquire skills. However, Revit requires complex skills and complex skills and experience to use an present components compared with Revit and 4D modeling tools. Hasan & Rasheed (2019) noted that 5D BIM estimates of budgets are easy to implement compared with other Revit and 3D BIM models. The ease of use of 4D BIM and 5D BIM may be impacted by lack of skills of users where people who do not have enough skills and training may require longer duration to analyze the models and make a decision.

Accuracy of Estimation

Accuracy concerns have been reported with the use of 5D BIM compared with 4D beam and Revit. 5D BIM model is associated with the limitation of not providing accurate estimates of the cost of building projects (Woo, 2006). This is not the case with respect to Revit and 4D BIM models which provide accurate models of building and construction projects with little requirement to implement make changes to software settings because it can be approved for use.

Analytical Complexity

Research by Moses, Heesom & Oloke (2020) noted that Revit is still not as popular as 4D BIM when selecting a modeling tool because many contractors, architects, and engineers are not familiar with it. Many construction projects managers do not prefer Revit due to its BIM component that is challenging to use. According to Hasan & Rasheed (2019), the analytical complexity of 4D BIM and 5D BIM is low because they are easy to identify for the analysis of the meaning of model such as the building and the components. Lack of analytical accuracy of 5D BIM makes it more likely to be replaced by 3D modelers and Revit modelers in construction projects.

Conclusion and Recommendations

This paper shows that 4D BIM, 5D BIM, and Revit are tools that have transformed the processes of design of civil engineering projects in terms of modeling the actual appearance of a structure in 3D and also the addition of other feature in terms of costs and timelines. All the analyzed building modeling tools have the advantage of enabling better information sharing, collaboration between parties, and reduce risks of making unwarranted decision during project model testing. However, the building and construction industry of the UK is highly regulated with the requirement that designers, contractors, architects, and engineers must comply with the ISO 19650 series of standards during BIM model development. The general findings from the research is that 4D BIM have been effectively used to estimate project schedule but 5D BIM has the limitation of not providing accurate estimates in many cases. Therefore, feature studies should examine the ways of improving collaboration when using 5D BIM to ensure users do not make wrong cost predictions for various stages of projects.

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