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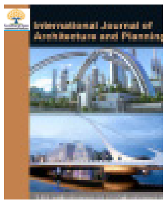

Research Note Open Access

BIM Safety Efficiency and Sustainability in Construction Projects

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Abstract

This study proposal looks at the use of Building Information Modeling (BIM) which has provided a new level of technology and efficiency to the construction industry, making production processes more integrated and proficient. This type of innovation is a complex implementation process with many gaps that must be addressed. This Research Proposal highlights the challenges of implementing BIM, discussing strategies to transform this scenario. The methodology will be developed from synthesizing the literature and analyzing semi structured interviews with architects. The results which will be obtained through content analysis, will be explained by the subdivision of the implementation challenges in the following categories: human factor, management, policy, market, and technology.

Keywords: *BIM, Safety, Efficiency, Sustainability, Challenges, Construction, Implementation*

1. Introduction

According to widely published studies, the construction industry is among the least digitized areas: loss of information and wasting resources is a daily practice, resulting in the enormous ecological footprint of the sector. To reduce this impact, new buildings need to be adequately designed to be (re)used in the future (Nagy Balázs, 2022). Technological developments have occurred in different sectors of activity over the last decades. Nevertheless, in the architecture, engineering and construction (AEC) sector, new technologies in the design, planning and construction phases have not been fully implemented for integrating safety measures in the process (Hire *et al.*, 2022).

The construction industry has been looking for ways to improve your production efficiency and deliver a product with more quality and sustainability to those who use it. In that context, BIM – Building Information Modeling – emerges as a set of policies, processes and technologies of interaction that generate a methodology that integrates professionals in the areas of Architecture, Engineering and Construction (AEC) in the preparation of a virtual model unique, which covers the entire life cycle of a building (Sayali *et al.*, 2022) collaboratively, to professionals who want working with BIM will impose many other challenges that permeate this process (Akram *et al.*, 2021). Discussion in the Architecture, Engineering and Construction (AEC) industry is the digitalization of the built environment through multiple types of technologies and developments. One of the developments that supports digitalization is Building Information Modelling (BIM). BIM provides a platform for visualization, collaboration, automation, integration and

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communication between the different actors in the AEC industry (Petra and Pernilla, 2021). The contributing factors behind these alarming figures are dynamic workplace, worker's behavior, lack of coordination and inadequacy with risk management to name a few (Xua *et al.*, 2020). Another important challenge which commercial buildings face is emission of greenhouse gasses and CO_2 (Szalay *et al.*, 2022). In the recent years there have been a number of studies focusing on the decarbonization of the building sector, which consists of two key parts: renovation of buildings to a carbon neutral level (Galvin, 2022; Amoruso *et al.*, 2022) and setting requirements for new buildings in order to reach carbon neutrality (Zhang *et al.*, 2021; Forde *et al.*, 2021; Szalay *et al.*, 2022). The application of BIM eliminates some fundamental risks such as those related to design and construction drawings. It also assists designers by removing clashes, improving visualization and prefabrication process, and modeling sustainability simulations. BIM also improves communication between project stakeholders, enhances coordination, and reduces the risk of variation and reworks. Further, it reduces safety risks by developing site safety plans and layouts (Xue *et al.*, 2021).

2. Related Work

2.1. Wearable Tech, IoT, and BIM—A Safety Trifecta

The convergence of wearable technology, IoT, and BIM presents a formidable alliance for ensuring safety on construction sites. This proposal explores the seamless integration of these technologies and their collective impact on identifying, preventing, and addressing safety issues in real-time.

2.2. Wearable Tech in Construction

A Safety Revolution Wearable technology has witnessed widespread adoption across various sectors, with its application in construction signaling a new era of safety and efficiency. This section outlines the key wearable technologies and their revolutionary impact on construction safety.

2.3. IoT in Construction

Paving the Way for Smarter, Safer Sites. The Internet of Things (IoT) has the potential to transform the construction industry by providing real-time data and solutions to age-old challenges. This section delineates the applications and benefits of IoT in construction, including equipment monitoring, environmental sensing, asset tracking, and its integration with wearable technology.

3. Problem Statement

The problem statement is strengthened by the unexplored integration of BIM technologies with safety analytics, predictive modelling, and real-time danger monitoring in construction safety. Focused research is also required because there is untapped potential for using BIM to improve employee awareness, the effectiveness of training, and induce behavioural change. The existing building stock in Central Europe and the rest of the World, comprising structures from the 19^{th} and 20^{th} centuries, presents a unique challenge for renovation and reconstruction due to the diverse range of traditional technologies used. Many of these structures, with masonry as their primary vertical load-bearing material, have undergone historical modifications and renovations (Nagy Balázs, 2022).

4. Contribution

4.1. Research Objectives

1. The goal of this study is to help in the thoughtful and best possible rebuilding of old structures. Important material details are identified for moisture and temperature testing. Building layouts are studied, both in person and in the lab. Plus, we'll be creating fresh, scientific knowledge.
2. To look into the effective fusion of real-time hazard monitoring, predictive modelling, and advanced safety analytics with BIM technology, and to outline strategies for doing so to improve safety measures in the context of environmental construction projects.
3. To analyze the real-world effects of safety improvements made by BIM in environmental initiatives. Determine how BIM's impact on budgets, timeframes, and resources for safety improvements has changed over time.

4.2. Research Question

These questions will help to collect data from the BIM Engineers, Project Managers, Civil Engineers, Company Employees BIM Actors.

1. How can real-time hazard monitoring, predictive modelling, and sophisticated safety analytics be seamlessly linked with BIM technology to improve safety measures in environmental construction projects?
2. How can these components be effectively tapped into and what potential do BIM-enhanced safety measures have for increasing worker awareness, training, and decision-making dynamics?
3. Why and how does the use of BIM technology result in quantifiable effects on project schedules, budgetary allotments, and resource management in the context of safety enhancements?

5. Methodology

This article is characterized as qualitative research, and as for the nature of its objective, we understand the existing challenges in implementing BIM. Therefore, Semi-structured interviews will be conducted with a large number of representatives from almost five case companies. The interviews will focus on gaining insight into the developments of BIM, its consequences for the industry, the development of new professional roles, as well as the particular BIM actor in their firm. This facilitated reflection and deepened understanding of the practice performed by BIM actors. Interviews will be held either individually or in small groups of two to four persons and included project managers, BIM coordinators, ICT managers or BIM strategists/specialists working with the technology. The BIM strategist/specialist is comparable to a BIM manager as used in other countries. While in some other countries the BIM modeler, coordinator and manager are clearly distinguished roles, Interviews will be carried out with architects who went through the design process BIM implementation. Responses will be recorded and transcribed into your entirety to prepare the data for analysis. From that, codes will be assigned to words, phrases and segments within the data relevant to the research question (Bardin, 2022). These codes will be then categorized on relevant topics and tabulated using the software excel.

Table 1: Overview of Data that will be Conducted During Our Research (for the Experience in Industry as well as Knowledge in BIM we will Use a Scale of 1-3 of which 1 = Little Experience/Junior and 3 is much Experience/Senior)

Case	Size firm	Observation in hours (h)	Interviews	Interviewee experience in industry/BIM (scale 1–3)
A: Construction	Number of Employees	3 × 5 h = 15	6 Managers	1-Mar
			2 ICT managers	
			7 BIM strategists	
			2 BIM coordinators	
B: Construction	Number of Employees	h2 × 8 h = 16 h	2 BIM strategists	3-Mar
			1 BIM coordinator	
C: Construction	Number of Employees	1 × 6 h = 6 h	3 Managers	1-Mar
			1 ICT manager	
			1 BIM strategist	
			2 BIM coordinators	
			1 BIM coordinator	
D: Architecture	Number of Employees	3 × 5 h = 15 h	2 Managers	2-Mar
			2 BIM strategists	
			2 BIM coordinators	
E: Architecture	Number of Employees		1 ICT manager	3-Feb
			1 BIM strategist	

6. Conclusion

The construction industry, often perceived as resistant to change, is currently undergoing a technological renaissance with BIM as its nucleus. Despite existing challenges, the potential for creating safer, more efficient, and sustainable construction sites is immense. This proposal asserts that industry stakeholders bear the responsibility of championing and adapting to these technological changes for a safer future.

The AEC industry has long sought techniques to reduce accidents, project cost, increase productivity and quality and reduce project delivery time. Building information modelling offers the potential to achieve these goals. Replacing a 2D or 3D CAD methodology by BIM, however, involves aspects that go beyond the acquisition of software, hardware and training and necessary to change the general aspects of the company. The search for the implementation of this new technology is justified, among other reasons, by the need to increase productivity within the entire value chain. In this sense, companies and professionals in the sector are exploring new ways of developing and managing projects, seeking greater efficiency and effectiveness. Thus, the aspect most addressed by interviews when justifying migration to BIM was based on the need to increase productivity (60%).

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