EXPERIENCES OF COUNTRIES WITH THE ADOPTION OF THE BIM-BASED PERMIT PROCESS

Mirjana Terzić¹, Igor Peško¹, Milena Senjak Pejić¹, Vladimir Mučenski¹, Dragana Stanojević¹

¹ University of Novi Sad, Faculty of Technical Sciences, Department of Civil Engineering and Geodesy, Novi Sad, Serbia

Abstract

Construction projects are revolutionized by the introduction of Building Information Modelling (BIM) in the construction industry. It changed the way projects are managed and executed as a collaborative approach to building design, construction, and management. A relatively new concept that has been adopted in several countries around the world is the BIM-based permit process. This process involves the use of BIM technology to optimize the permit process for construction projects. The traditional process of obtaining a building permit involves multiple stakeholders and numerous steps and is often handled using paper documents or digital file submissions. Inefficient building permit procedures are considered time-consuming and prone to errors. Additionally, the demand for building permits has increased due to rapid urbanization, placing more significant pressure on regulatory authorities. This paper presents an analysis of the experiences of countries where the BIM-based permit process has been implemented: Singapore, Norway, Estonia, Finland and Netherland. Reviewing the existing literature and case studies, the advantages and challenges of this method are presented. The benefits identified include increased efficiency, improved accuracy, and reduced costs and delays in the permit process. However, there are many challenges, such as resistance to change and legal support. The paper also highlights the importance of government policies, stakeholder collaboration, and adequate training and education in successfully implementing the BIM-based permit process. The study concludes that the BIM-based permit process has the potential to improve the permit process for construction projects significantly, but its success depends on various factors.

Keywords: Building Information Modelling, building permit, compliance checking, case study.

1. Introduction

Construction projects are revolutionised by introducing BIM (Building Information Modelling) in the construction industry. It changed how projects are managed and executed as a collaborative approach to building design, construction, and management [1], [2]. Construction is currently the least digitised and industrialised of all industries. However, at the same time, it has the most opportunities and a comprehensive range of directions in which it can progress. What started digitisation is the emergence of all modern technologies. They are applied to some extent in construction projects, and BIM technologies are the most prominent [3].

According to the definition from the “National Building Information Modelling Standard” [4], the adequate description of the BIM is: “A BIM is a digital representation of physical and functional characteristics of a facility. As such, it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward”. Although BIM technologies are emerging fast in the AEC (Architecture, Engineering & Construction) industry, a common problem is its implementation in public institutions and the processes of obtaining specific permits and legal documents. These processes are responsible for delays at the very beginning of the project, along with frequent errors and a large amount of human work. The issuance of building permits is considered one of the leading indicators for measuring a country’s business [5].
Obtaining a building permit is a complex process involving the cooperation of many stakeholders through multiple steps [6]. In many countries, this process needs to be updated - where the paper format of documents is still used, with a low share of digitisation and process optimisation. Many governments are handling digital documents on different e-platforms, but still with a high range of manual work prone to errors and delays in the construction process. Rapid urbanisation has also led to an increased need for digitalisation, setting pressure on local authorities by increasing the number of requests for building permits [7]. A large number of researches in the past few years aimed to define the factors affecting the implementation of BIM technologies. The most commonly identified factors are grouped into categories, including top management and leadership, a workflow of the processes, technology and software availability, people and skills, standards and legal requirements, collaboration and communication [8]. Analysing the processes in the cities of Finland and Estonia resulted in four key categories: technology, people, process and policies, with the highlighted following factors: compatibility with the building regulations and codes, government support and willingness of employees to use a BIM-based building permit process, potential time savings with code compliance checks, and level of information standardisation [9]. In addition to affecting the speed of obtaining a building permit, these factors affect all processes during the facility’s lifetime. Accordingly, it is necessary to work on their optimisation and digitisation urgently.

This paper presents an analysis of the experiences of countries where the BIM-based permit process has been implemented. Reviewing the existing literature, interviews with construction industry experts, reports and case studies, the advantages and challenges of this method are presented, together with the factors affecting adoption.

2. The concept of BIM-based permit process

Regarding the digitization of the construction permit system, it is possible to determine four primary levels of development. The first level is the system of issuing building permits in the outdated traditional way - on paper. Such a process is primarily inefficient and error-prone, leading to inconsistencies in estimates throughout the construction process. The second level refers to electronic building permit systems that are partially digitized, where building permit applications can be made online through documents in "pdf" format, allowing users to download forms and upload documents but not exploiting the full potential of digitization. A further step is complete digitization with interoperable machine-readable documents, modelling information about objects and automating processes in a BIM environment [10], [11].

![Four levels of permit process development](image)

The fourth level represents the digitization of construction permits in the BIM environment integrating with GIS technologies for a more significant degree of automation. Both technologies can collect valuable data about the built environment. However, with different characteristics, special attention should be paid to their interoperability [13], [14].
2.1. Case studies of countries that have implemented the BIM-based permit process

Norway and Singapore have the highest degree of digitisation of construction permits, with projects that have been in practical use for over ten years and have undergone several revisions to meet current needs. The benefits of digitisation in construction permit systems include faster and more efficient processing of applications, reduced paperwork, and improved transparency [15]. In Singapore, the Building and Construction Authority’s “CORENET e-Submission system” enables electronic submission and processing of construction permit applications in a centralised and standardised way. Singapore has made significant efforts to encourage the implementation of BIM to promote the adoption of BIM across the industry and improve productivity and quality. Since July 2015, architectural and engineering electronic submissions in BIM format have been mandatory for all new building projects with a gross floor area of over 5,000 m² [16]. In Norway, the Norwegian Building Authority developed “ByggSøk” and “ByggNett” project as solutions for verifying filled-in application forms related to specific types of applications. “ByggSøk” is an online application portal for building permits that enable applicants to submit and process their applications electronically. “ByggNett” is a web-based solution that provides access to information about building permits and other relevant regulations and standards [17].

Based on the 2021 report “Digitalisation of the construction sector” by the European Union, the level of digitalisation in the construction permit systems of member countries is provided. The report identifies five member states, Germany, Estonia, Netherlands, Austria, and Finland, that have integrated BIM into their building permit systems, enabling an automated process with 3D models [10]. In Estonia, the project “BIM-based process for building permits in Estonia” was launched in collaboration with the Estonian Ministry of Economic Affairs and Communications, where 3D digital twin plays an essential role in forming and arranging the design of the built environment and checking all kinds of restrictions such as zoning plans, existing underground infrastructure, or noise barriers [18]. In Finland, over 60% of Finnish municipalities have joined the online service platform “Lupapiste,” which enables digital interaction between citizens, companies, and authorities based on permits for the built environment. The pilot project, completed in 2018 after the success of the “KIRA-digi” project, showed that all the information required for issuing a building permit could be accessed and interpreted directly from the BIM model [19], [20]. In the Netherlands, several projects for digitising building permits have been launched recently, of which the “EuroSDR GeoBIM” project stands out. This project focuses on data integration, interoperability, data quality, and user requirements. The project team is working to develop best practices, guidelines, and tools that will enable the integration of geospatial and BIM data [13], [21], [22]. Twelve other countries have a digitised system of issuing construction permits without BIM, while only two countries still rely on a traditional paper-based system [10].

Software companies and governments worldwide are developing an automated code compliance checking platform, which, in addition to BIM and artificial intelligence, can analyse a building model against all relevant building, fire, or energy codes. Among the first are the governments of Singapore and the United States [23]. A model of an automated code compliance process is shown in Fig. 2.

![Fig. 2. The automatic code checking process that is based on BIM [23]](image-url)
The United Kingdom has formed a network for digitising Requirements, Regulations, and Compliance Checking Processes in the Built Environment - Digital COMpliance (D-COM). In 2019 they accomplished a state-of-the-art review describing academic and industry implementations of "Automated compliance checking" (full and partial implementations). This document sets out the UK's goals for progress until 2025, the target date for the public sector adoption of openBIM (Fig. 3.). The importance of digitalisation is emphasised, given that the traditional way of checking takes time and increases costs and errors. This plan recommends a step-by-step approach, starting with the engagement of all stakeholders in the project, piloting, industrialisation and community outreach. In order to fulfil the goal, constant progress, government support and funding from the state are needed [24].

![Proposed model of the automated compliance checking process - plan for 2025](image)

3. Advantages of the BIM-based Permit Process

3D digital twin plays an essential role in forming and arranging the design of the built environment and checking all kinds of restrictions and codes. Reviewing research and case studies of mentioned countries showed the advantages of the BIM-based permit process presented in this chapter. The same advantages were defined by Noardo et al. [12], who did a literature review on BIM building permits, analysed case studies of various methods from different countries, and defined: increasing efficiency, transparency and reduced costs.

The electronic issuance of a construction permit significantly speeds up and simplifies the processes of construction projects. The optimisation was achieved by coordinating with modern international standards, technologies and practices for efficient construction project implementation. The benefits of digitisation in construction permit systems include faster and more efficient processing of applications, reduced paperwork, and improved transparency. A mechanism of transparency is ensured through the precise determination of procedures.

Increasing automation with less human work was proposed, involving BIM software and machine learning algorithms. This integration can reduce the manual work required to process applications, resulting in faster permit processing times and fewer errors. Increased levels of automation also help reduce costs and improve the accuracy of the permit application process [25]. Noardo et al. (2020) presented a method for semi-automating the project compliance process. The method was tested on a
case study of the design of a residential building in Rotterdam, whose architectural model already existed, in order to best reflect the actual situation with BIM models in practice. The results show that it can successfully identify non-conforming design elements. The method can reduce the time and effort required for manual checks and improve the accuracy of the review process [26].

The data accuracy advantages follow the BIM environment that allows precise 3D models, which increases the accuracy of data on the object's geometry and its characteristics. The data validation system uses the rules defined in the legislation, which ensures that the data entered into the system is accurate and correct. Introducing BIM methodology into the building permit process also allows data to be updated in real-time during construction, ensuring data accuracy and reducing errors. Several mentioned studies have attempted to use artificial intelligence technology to extract the regulatory information necessary for automated code checking automatically. All these advantages contribute to greater accuracy of data in issuing construction permits, which can contribute to better planning and management of the construction of buildings [27].

4. Challenges of the BIM-based Permit Process

The adoption of BIM in the building permitting process has the potential to improve the AEC industry significantly. However, some fundamental challenges are being faced - current technical deficiencies and the need for standardization and digitization of technical regulations. Due to the many different regulations in each country, with the frequent updating of the regulations, developing an automatic code-checking system requires significant work. Eventually, the overall efficiency of a construction project depends heavily on the actions and decisions of the authority.

Resistance to change involves difficulties in convincing stakeholders to adopt new technologies or processes. At the same time, the lack of legal support and government policies relates to the need for more explicit guidelines and frameworks to guide its implementation. The paper emphasizes the importance of cooperation between the client, the architect, the engineer and the local authorities responsible for issuing the building permit. A collaborative approach also reduces errors and delays in the permit application process [28], [29].

Fig. 4. The business model for Talin City Government [30]
A new business organization model must be developed for successful BIM adoption, as it was for the Talin City Government. Talin's business model is shown in Fig. 4., and had the primary task of mapping the functions of the departments involved in the permit-issuing process. It enables the creation of detailed checklists for comparing relevant application parameters against the national building code. Nevertheless, it all depends on if the submitted BIM project is standardized. Therefore, it is necessary to create national BIM standards, including precise IFC format minimum requirements [30]. Based on the experience of the existing methods, to use the verification system, it is necessary to increase the quality of human work by improving the training and education of the involved participants. Such an improved model would be a helpful input and a first step towards further developing tools for automatic model validation, following more apparent constraints, definitions and criteria.

5. Conclusion

The emergence of all modern technologies, primarily BIM, has triggered much research and proposed methods. A common problem is implementing BIM in public institutions and obtaining specific permits and legal documents. The issuance of building permits plays an essential role in the AEC industry and is the leading indicator for measuring a country's business. This process needs to be updated in many countries, with a low share of digitisation and process optimisation.

The paper analyses the application of Building Information Modelling technology in issuing building permits to optimise a process that is often time and financially demanding, with many users and steps involved. Using BIM requires the cooperation of all stakeholders and can reduce the amount of paperwork and errors that occur in the process. Integrating BIM software and machine learning algorithms, manual work can be reduced, contributing to greater data accuracy in issuing construction permits. Advantages include increased efficiency, improved accuracy, reduced costs, and delays in obtaining permits. In contrast, challenges include the establishment of standardisation and digitisation of technical regulations, resistance to change, and the necessity of training participants in the process. However, success depends on various factors, adequate support from the authorities, and all stakeholders' cooperation. The paper presents the experiences of countries that have applied this method: Singapore, Norway, Estonia, Finland and the Netherlands.

The study concludes that the BIM-based permit process has the potential to improve the permit process for construction projects significantly, but its success depends on various factors. The most commonly identified factors affecting adoption are grouped into categories: top management and leadership, a workflow of the processes, technology and software availability, people and skills, standards and legal requirements, collaboration and communication. The directions for further research have a wide range, but what needs to be improved in the current research are methods and guidelines on practically applying all proposed methods in public institutions and defining the application's precise steps and algorithm.

Acknowledgements

The research has been conducted within the project "Scientific theoretical and experimental research and improvement of educational process in the field of civil engineering", developed at the Department of Civil Engineering and Geodesy, Faculty of Technical Sciences, University of Novi Sad, Serbia.

References


