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Analysis of Digital Tool Implementation in Building Operations †

Jozef Švajlenka *, Pavol Packo and Denis Konovalov

Department of Construction Technology and Management, Faculty of Civil Engineering, Technical University of Kosice, 04200 Kosice, Slovakia; pavol.packo@student.tuke.sk (P.P.); denis.konovalov@tuke.sk (D.K.)

* Correspondence: jozef.svajlenka@tuke.sk

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Abstract

Digitalization is becoming one of the key trends in contemporary construction, playing a particularly important role in the building operation phase. This phase represents the longest period of a building's life cycle and is simultaneously associated with high operational costs. The aim of the presented research was to analyze the views of experts and professionals working in the field of building management and operation on the use of digital tools, their perception of the level of digitalization, and the potential for further development. The research was conducted in the form of a questionnaire survey. The results show that in most cases, basic software tools prevail, while the use of advanced platforms such as CMMS (Computerized Maintenance Management System) or CAFM (Computer-Aided Facility Management) systems remains limited. Only one quarter of respondents actively use IoT sensors, which represent an innovative element with high potential for efficient building operation and sustainability. Paradoxically, some respondents perceive even the use of basic software as representing significant digitalization. The most digitalized areas include financial administration, security systems, and energy management, while digital building passports and workspace management remain on the periphery. The findings highlight the uneven application of digital tools and the need for their broader implementation, which can significantly contribute to the efficiency and sustainability of building management.

Keywords: digitization; sustainability; construction industry

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1. Introduction

The digitalization of the construction industry is among the central topics of current research and practice [1,2]. In addition to the design and construction phases, increasing attention is being directed toward the operational phase, which represents the longest part of a building's life cycle [3]. This period is associated with the highest operational costs, which can be effectively optimized through digitalization. In the context of global requirements for reducing environmental burdens and achieving sustainability goals, it is essential to focus on modern tools that enable efficient management of technologies [4], energy flows [5], and human resources in building operation.

At present, a growing trend can be observed in the implementation of intelligent technologies such as the Internet of Things (IoT) [6–8], Computerized Maintenance Management Systems (CMMSs), Computer-Aided Facility Management (CAFM) platforms [9,10], and digital building passports [11,12]. These tools have the potential to significantly reduce

costs, improve efficiency, and enhance the environmental performance of buildings throughout their life cycle. In Slovakia and the broader Central European region, however, the level of implementation of these technologies has not yet reached the standards observed in Western Europe.

The aim of this study is to analyze, within a defined scope, the opinions of professionals working in the field of building management and operation regarding the current use of digital tools to identify their subjective perception of the level of digitalization, as well as to determine the areas with the greatest potential for further development.

2. Methodology

The research was conducted through a questionnaire survey targeting experts and professionals working in the field of building management and operation. The total research sample consisted of approximately 40 respondents, including facility managers, technical supervisors, as well as administrative staff involved in building operations.

The questionnaire comprised a set of questions focused on three main areas. The first area aimed to identify which digital tools respondents currently use in their professional practice. The second area examined how respondents perceive the level of digitalization in their working environment and which tools they consider to be digital. The third area focused on identifying the segments of building operation that, according to the respondents, show the highest level of digitalization and, conversely, where there is potential for further development.

The collected data were processed using descriptive analysis and interpreted within the context of current trends in digitalization in the construction industry and facility management.

3. Results and Discussion

The results of this study provide, within a defined scope, an overview of the state of digitalization in building management and operation among the surveyed respondents.

In the first area, examining the use of digital tools, it was found that the vast majority of respondents rely on basic software solutions, primarily the Microsoft Office suite. Approximately one third of respondents reported using more advanced systems, such as CMMS or CAFM platforms, which enable centralized management of maintenance and other building management processes. A significant finding is that only about 25% of respondents actively use IoT sensors, which represent an innovative tool with high potential to enhance operational efficiency and support building sustainability.

The second area of this study concerned the level of digitalization and its subjective perception by respondents. It was revealed that a considerable portion of participants considers the use of standard office software platforms as a significant manifestation of digitalization. This attitude indicates a relatively low awareness of the possibilities offered by modern digital technologies. Conversely, the group of respondents utilizing more advanced tools and sensors assesses digital technologies more accurately and perceives digitalization as a complex process extending beyond basic software. This discrepancy creates a paradox: the subjective belief in a high degree of digitalization does not necessarily correspond to objective reality.

The third area focused on identifying segments of building operation with the highest degree of digitalization. Respondents indicated that the most digitalized area is financial administration, particularly processes related to invoicing, payments, and cost tracking. This outcome is unsurprising, as financial processes are among the areas where digitalization has been most rapidly adopted and delivers immediate benefits. A significant level of digitalization was also observed in security systems, such as surveillance cameras and access control systems, which contribute to the protection of people and property. Energy

management emerged as another highly digitalized area, reflecting the increasing emphasis on efficient energy use and minimizing the environmental impact of buildings.

In contrast, digital building passports, which should ideally be widely used, exhibited a lower degree of digitalization. Their importance both in terms of legislative requirements and the need for comprehensive information management throughout a building's life cycle represents a critical aspect of building operations. The lowest level of digitalization was identified in the management and reservation of workspaces, indicating that this segment is not yet broadly implemented, although its future potential is substantial.

The study results highlight several important aspects of digitalization in building operation. First, it is evident that although digitalization is becoming essential, its implementation remains fragmented and uneven. Basic software solutions predominate; while they facilitate administrative tasks, they do not deliver substantial benefits in terms of operational efficiency or sustainability.

The paradoxical perception of digitalization by respondents reveals an information gap and a conservative approach to innovation. This phenomenon may result from insufficient training, a lack of motivation from management, or concerns about investment costs. In the context of global trends, where the use of IoT, artificial intelligence, and BIM integration in facility management is increasingly adopted, these findings signal the need for more systematic support for digitalization.

It is also noteworthy to identify areas where digitalization produces immediate effects. Financial processes and security systems are among the segments where digitalization yields rapid returns [13,14], explaining the high level of implementation observed. Energy management is becoming a key factor for sustainability [15], as effective monitoring and management of energy consumption is one of the most efficient ways to reduce the environmental impact of buildings [16].

Conversely, areas such as digital building passports and workspace management represent opportunities for future development. Their broader implementation would enable more comprehensive lifecycle management, enhance transparency, and support building adaptability in line with smart city principles and sustainable development goals.

The implementation of digital tools in building management faces several obstacles, such as high initial costs, a lack of qualified professionals, resistance to change, and challenges in integrating new technologies with existing systems. These factors slow down the wider adoption of advanced solutions like IoT sensors and CMMS platforms [17], which could significantly improve efficiency and sustainability in building operations. At the same time, concerns about data security and protection from cyber threats may further reduce organizations' willingness to invest in these technologies. However, in the future, we expect growing integration of IoT, analytical tools, and artificial intelligence, which will enable predictive maintenance and energy consumption optimization [18,19]. Cloud platforms and interoperability between various systems will simplify building management and provide more flexible access to data. Additionally, the development of digital twins will allow for the simulation and optimization of building operations in real-time, improving both efficiency and sustainability. These trends indicate that, despite current challenges, the digitalization of building management will continue to grow, becoming an integral part of modern construction practices.

4. Conclusions

This study revealed that digitalization in the building operation phase is, within the surveyed sample, predominantly utilized in a basic form, with limited implementation of more advanced solutions. Most respondents rely on simple software tools, while IoT sensors and comprehensive CAFM systems are employed only marginally. Furthermore, subjective

perceptions of digitalization often do not align with its actual level, highlighting the need for education and increased awareness of the potential offered by modern technologies.

The most digitalized areas—finance, security, and energy management—reflect a focus on immediate benefits in terms of cost savings and enhanced safety. Areas such as digital building passports and workspace management remain underdeveloped, although their importance is expected to grow in the future. The findings of this study emphasize the need for a systematic development of digitalization in building operations, which can contribute not only to increased efficiency and cost reduction but also to achieving sustainable development goals in the construction sector.

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