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2.2 BIM technology in Ukraine and its SWOT analysis

This paper undertakes an in-depth SWOT analysis aimed at assessing the strategic implementation of Building Information Modeling (BIM) technology in Ukraine's construction industry. The objective of this analysis is to systematically evaluate the internal and external factors influencing the adoption of BIM, providing a clear framework for understanding its potential impact and areas for improvement.

To achieve this, the authors have developed a comprehensive SWOT matrix that identifies and examines the strengths, weaknesses, opportunities, and threats associated with BIM technology in the Ukrainian construction context. The strengths highlight the inherent advantages and positive attributes of BIM, such as enhanced collaboration, improved project visualization, and increased efficiency. Conversely, the weaknesses focus on the internal challenges and limitations, including high initial costs, a steep learning curve, and resistance to change within the industry [65].

The opportunities section explores the external possibilities that could be leveraged to enhance BIM adoption, such as government incentives, advancements in technology, and growing market demand for sustainable construction practices. The threats address the external risks that could hinder BIM implementation, like market competition, regulatory barriers, and technological obsolescence.

The analysis is grounded in a robust methodology that includes an extensive review of existing literature, the authors' professional experiences, and up-to-date market reports. This triangulated approach ensures a thorough and balanced assessment of all factors within the SWOT matrix.

Furthermore, the paper calculates fundamental indicators that characterize the strategic position of BIM within the Ukraine construction market. These indicators provide quantitative insights that complement the qualitative analysis, offering a more nuanced understanding of BIM's current status and future potential.

Based on these findings, the authors have defined a matrix of strategic tasks and actions. This strategic framework outlines practical recommendations aimed at

promoting and developing BIM technology in Ukraine. These actions include training and education initiatives, policy advocacy for supportive regulations, investment in technological infrastructure, and fostering industry-wide collaboration [66].

Overall, this paper not only highlights the current landscape of BIM implementation in Ukraine but also serves as a strategic guide for stakeholders looking to enhance the adoption and integration of BIM in the construction industry. By addressing both the opportunities and challenges, the proposed strategies aim to drive the growth and innovation of the construction sector through the effective use of BIM technology (fig.1).

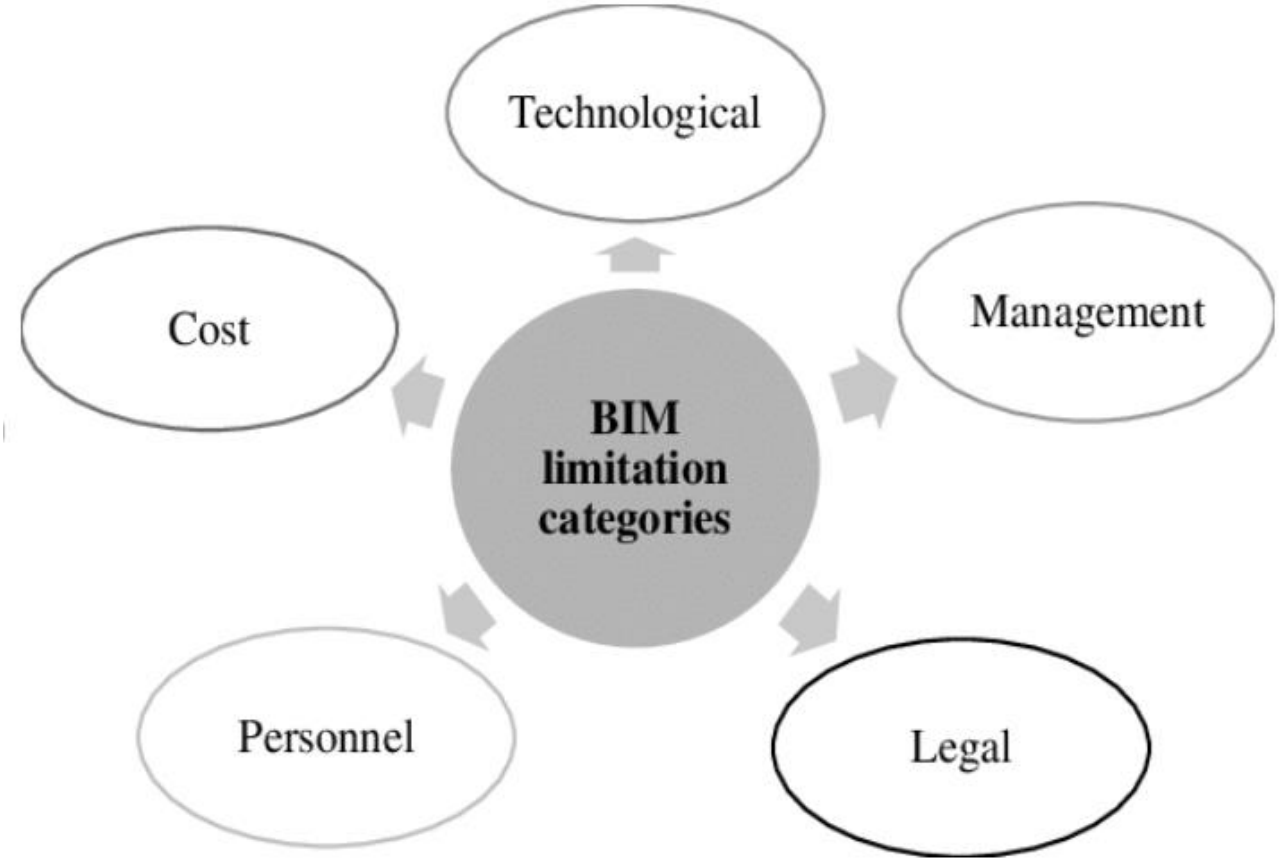

Figure 1. BIM limitation categories.

Currently, Building Information Modeling (BIM) is recognized globally and in Ukraine as the fastest-evolving concept in construction management. In numerous countries, BIM is progressively becoming the standard for construction projects. However, in Ukraine, BIM technology is still under discussion and considered an alternative to traditional methods of planning and executing construction projects. Significant concerns persist regarding the mandatory implementation of BIM

technology in public works contracts. The construction market reveals considerable misunderstanding about BIM, a lack of experience among most participants in the construction process, and notable caution regarding its adoption [67].

Despite these challenges, global literature highlights the substantial advantages of BIM. Techniques for acquiring 3D building information involve using digital building information models and simplifying them both geometrically and semantically. BIM models are object-oriented, semantically rich, and continuously updated, enabling detailed queries of building components from various perspectives. The essence of BIM is not just in obtaining information but in simplifying, systematizing, and effectively utilizing the information contained within the model. Unlike traditional CAD models, BIM models encompass both geometric and semantic data, evolving throughout all stages of a building's life cycle.

This distinction marks a significant advancement, as BIM allows for more comprehensive and dynamic project management. The integration of semantic information means that BIM can support more informed decision-making, enhance collaboration among stakeholders, and improve the overall efficiency and accuracy of construction projects. Consequently, while Ukraine faces challenges in widespread BIM adoption, the potential benefits underscore the importance of overcoming these barriers and embracing this innovative technology.

Due to the global advantages and growing popularity of Building Information Modeling (BIM), the authors of this paper decided to analyze the current situation in Ukraine. Their objective is to examine the strengths and weaknesses associated with the introduction of BIM technology in the country, as well as to identify the opportunities and risks it presents. To conduct this analysis, the authors utilized a SWOT analysis, a tool primarily used in strategic planning and various management areas [68].

The paper highlights the challenges faced by both the Ukraine public administration and participants in construction projects concerning BIM implementation. Additionally, the authors explore potential future trends in the development of BIM technology in Ukraine, aiming to provide insights into its

evolving landscape and the strategic actions needed to foster its growth and integration within the industry.

The SWOT analysis is a widely utilized tool in strategic management, particularly in the initial stages of crafting an organization's strategy. As a diagnostic instrument, it is employed to assess an organization's resource capabilities and deficiencies, its market opportunities, and the external threats it faces. The acronym SWOT stands for Strengths, Weaknesses, Opportunities, and Threats, reflecting the analysis's focus on both internal and external factors (fig. 2).

Figure 2. SWOT analysis approach.

The SWOT analysis has two main dimensions: internal and external. The internal dimension encompasses organizational factors, including strengths and weaknesses. Strengths refer to the positive attributes and resources within the organization, while weaknesses denote the internal limitations and challenges. The external dimension involves environmental factors, identifying opportunities (positive external factors) and threats (negative external factors).

By using SWOT analysis, organizations can gain insights into how to leverage their strengths and address their weaknesses to capitalize on external opportunities and mitigate potential threats. This dual focus helps in creating a balanced and comprehensive strategic plan. The four categories of factors generated by the two dimensions are:

1. External positive (Opportunities) – Development opportunities in the environment.

2. Internal positive (Strengths) – Strengths of the organization.

3. External negative (Threats) – Environmental hazards.

4. Internal negative (Weaknesses) – Weaknesses of the organization.

In this paper, the research performed by author aims to assess the opportunities offered by the introduction of the BIM technology to evaluate the opportunities and risks associated with the introduction of BIM technology in Ukraine. They assess the strengths and weaknesses of support for the construction and investment processes using BIM. By combining the analysis of internal and external factors, the aim is to determine the best ways to utilize the potential of BIM technology in the Ukrainian context [69].

Furthermore, the authors seek to measure the internal strength of BIM technology, its strategic attractiveness, and the probability of achieving strategic success. This comprehensive analysis provides valuable insights into how BIM can be effectively implemented and supported in Ukraine, taking into account the specific conditions and challenges of the local construction industry [70].

The analysis will present the advantages and disadvantages of BIM technology as strengths and weaknesses, respectively, while also identifying the opportunities and risks associated with its implementation. This comprehensive evaluation will be conducted in three stages:

- **Stage I**: Identification and Assessment of Factors

Task: Identify factors related to the implementation of BIM, categorizing them as either positive or negative for the construction project and its environment.

Assessment: Evaluate these factors on a numerical scale from 1 to 5, where 1 represents a very weak influence and 5 represents a very strong influence.

- **Stage II**: Assessment of the Strategic Situation of BIM

- Task: Analyze the strategic position of BIM technology in the construction industry, considering the previously identified factors.

- **Stage III**: Identification of Strategic Tasks and Actions

- Task: Combine and analyze the strengths and weaknesses of BIM technology with the opportunities and threats from the environment.

- Objectives:

- Leverage the strengths of BIM to maximize the benefits from external opportunities.
- Overcome the weaknesses of BIM by utilizing existing opportunities in the environment.
- Use the strengths of BIM to avoid external threats.
- Minimize the impact of BIM's weaknesses to mitigate environmental risks.

This structured approach ensures a thorough evaluation of BIM technology, providing actionable insights and strategies for its effective implementation in the construction industry.

According to the United States National Institute of Building Sciences (NIBS), "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». The primary function of BIM technology is to support activities throughout the entire lifecycle of a building by providing detailed information on both the building's geometry and descriptive data about the structure and its individual components [71].

The advancement of BIM and other digital technologies in the construction industry has significantly improved construction processes and accelerated project implementation. Technologies such as Building Information Modeling (BIM),

Augmented Reality (AR), Virtual Reality (VR), and the Internet of Things (IoT) (e.g., near-field communication (NFC) and radio-frequency identification (RFID) sensors) have introduced new hardware and software tools into the construction industry. These technologies facilitate the automation of construction processes, enhance monitoring of construction activities, and improve information flow and quality inspections [72].

One of the main advantages of BIM is its ability to consolidate data in a single location, the BIM model, which includes a three-dimensional geometric representation of the building. Centralized data collection throughout the design, construction, and operational phases allows for further analysis, generating new insights and simulations to identify clashes and interdependencies. Additionally, new methods of data visualization using visual and mixed reality enhance communication and provide on-site information.

A key distinction between BIM and traditional construction processes lies not only in the 3D geometric presentation and centralized data collection but also in the mindset and approach of the participants involved. For instance, cost analysis benefits from the BIM model by enabling quick extraction of necessary information and data for predictive models. All project participants have access to the data throughout the entire construction cycle, allowing for real-time adjustments and up-to-date information on cost analysis and its changes [73, 74].

Moreover, BIM allows for easy and quick verification of the geometry and information included in the model. This capability significantly aids in detecting potential clashes early in the pre-execution stage, enabling discussions on alternative solutions or error correction before construction begins. BIM stands at the forefront of digital transformation in the Architecture, Engineering, and Construction (AEC) industry, streamlining operations such as collaboration and design review while addressing challenges related to speed, cybersecurity, and data exchange integrity.

The United States is the global leader in BIM adoption, making the dominance of North America unsurprising. However, Europe holds the second position, leveraging American models while also developing its own dynamic advancements in BIM technology. Australia and Oceania follow, excelling particularly in design modeling.

Asia features strong leaders such as Korea, Hong Kong, China, and Japan in the BIM landscape [75].

In contrast, South and Central America exhibit slower BIM adoption despite close influence from the USA and Canada. Only a few countries in this region, excluding large nations like Argentina and Brazil, have introduced BIM in public procurement over recent years. BIM adoption in the Middle East and Africa is also relatively low. Private investors in these regions are keen on using BIM for projects, but public investors limit its use to infrastructure investments, such as the construction of airports or passenger service terminals (e.g., Istanbul Grand Airport, Bahrain International Airport, and Abu Dhabi Midfield Terminal).

In Europe, Western and Northern countries have been early adopters of BIM, with the United Kingdom and Scandinavian countries emerging as market leaders. Southern and Eastern European countries are adopting BIM at a slower pace. This pattern is also evident in government initiatives, with countries like Finland, Norway, Great Britain, France, and Italy leading in the implementation of BIM solutions in public procurement [76, 77].

Ukraine falls into the group of countries that are still planning to introduce BIM standards or mandates in public procurement, resulting in a slower adoption rate. Currently, Ukraine lacks widely used BIM standards and substantial government support or mandatory requirements in public procurement. Nonetheless, market awareness is growing, especially among designers, and several public procurement projects, mainly focused on BIM model design, have already been announced and executed [78].

The SWOT analysis reveals that the current market conditions in Ukraine are favorable for the implementation of Building Information Modeling (BIM). This favorable position arises from the presence of more strengths than weaknesses and more opportunities than threats. However, despite this positive outlook, rapid advancements in BIM adoption within the Ukrainian construction industry are unlikely.

The most effective strategic approach for implementing BIM technology in Ukraine appears to be an aggressive development strategy, suitable for "maxi-maxi" situations. This strategy focuses on maximizing the utilization of both strengths and opportunities to facilitate the widespread and dynamic adoption of BIM in everyday construction practices. It is essential to leverage the strengths of BIM whenever the external environment offers suitable opportunities.

To promote BIM, it is crucial to engage leading companies in the construction market by highlighting the potential for reducing investment costs, thereby encouraging the adoption of BIM. Additionally, the introduction of specialized BIM programs in universities can address the current skills gap. By offering dedicated courses, these programs will help produce a workforce proficient in various BIM applications over the next few years.

Furthermore, strategic initiatives should include:

- **Industry Partnerships**: Collaborating with leading construction firms to showcase successful BIM projects and their cost-saving benefits.
- **Government Support**: Advocating for government policies and incentives that promote BIM adoption in public and private projects.
- **Awareness Campaigns**: Conducting workshops, seminars, and conferences to raise awareness about the advantages of BIM among industry stakeholders.
- **Continuous Learning**: Establishing continuous professional development programs to keep practitioners updated on the latest BIM technologies and practices.

By implementing these strategies, Ukraine can create a robust foundation for the successful integration of BIM technology, ultimately leading to more efficient, cost-effective, and innovative construction practices.