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ISSUES RELATED TO THE IMPLEMENTATION OF BUILDING INFORMATION MODELING IN CONSTRUCTION PROJECTS

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Purpose: The innovation of using BIM systems for construction projects can be a factor stimulating the development of the construction industry. Although BIM systems have been known for several decades, their implementation rate is considered low. The aim of the research was to identify issues that may influence the effectiveness of BIM implementation and to propose concepts for certain solutions to improve it.
Methodology: The literature review included an analysis of books, professional journals, and information published on the Internet. The economic practice research included: participant observation combined with document review in four companies using BIM at various levels of maturity; expert interviews with managers from four other companies using BIM.
Findings: Specific features of construction projects that influence the use of BIM were identified, BIM concepts were summarised in context, the links between the life cycle of a building and a construction project in relation to BIM were defined, an attempt was made to determine the full maturity of BIM implementation, and factors hindering the implementation of BIM in companies were summarised. The market offer was analysed and a model for selecting BIM software was proposed. The advantage of the research methods used, in the authors' opinion, is their diversity, which allows for mutual verification of the obtained results, even despite the relatively small number of observations and interviews conducted.
Research limitations: The limitation of the conducted research was its narrow focus on a relatively small group of companies, lacking companies with a high level of BIM maturity and those using BIM for facility management.
Practical implications: The identified conditions resulting from the nature of the investment process and the construction project may influence the practical approach to BIM implementation. Maturity assessment criteria can be used as a tool to identify the stage of BIM implementation in a company. The identified factors hindering BIM implementation can be the basis for identifying and removing barriers in the company. The proposed software selection model can serve as a suggestion for developing your own rules of conduct.
Originality: The relationships between the investment process and the construction project were identified, while defining the specifics of the construction project in the context of BIM implementation. Relationships between the construction project cycle and the life cycle of a facility in BIM. Criteria for assessing a company's readiness to use BIM at the highest level

of maturity. Factors inhibiting the implementation of BIM. A model for selecting BIM software. The results may be useful for managers of companies implementing construction projects.
Keywords: BIM, Building Information Modeling, Construction projects, Computer-aided projects, BIM implementation.
Category of the paper: Research paper.

1. Introduction

BIM is a computer technology that has been used and developed for decades. It emerged through the evolution of computer-aided design (CAD) systems (Building Information…, 2002; Borkowski, Kruk, 2021). As it evolves, BIM is becoming an increasingly popular approach in the field of architecture, engineering and construction (AEC) industry. It can be argued that it is a global standard in that area (Frank, Cohee, Vinh, 2009). Nowadays, the use of computer-aided management and implementation of construction projects has become an unquestionable need, even when implementing projects of small scope and complexity.

The initial rationale for undertaking research on BIM was the increasing demands on the implementation of construction projects, as observed by the authors (one of whom is a construction practitioner). They analyzed announced tenders for the construction of buildings and other structures and concluded that the requirements of contracting entities were very high regarding the basic parameters of project evaluation. Relatively low costs and short implementation deadlines are required, while maintaining the established requirements regarding the scope and quality of the project results. Practical research confirmed that, at the same time, the complexity of construction projects is increasing.

Moreover, according to the REPORT (Przyszłość budownictwa w Polsce, 2024) Construction is a key economic sector, accounting for nearly 10.5% of Poland's GDP in 2023. The construction sector currently employs over 700,000 companies. This also accounts for 1.3 million jobs, including related industries. Since the economic crisis of 2022-2023, the construction industry has been struggling with economic downturns.

Any improvements in the implementation of construction projects that can increase efficiency, profitability, and safety are desirable, thus contributing to the development of the construction sector. Implementing BIM technology dedicated to construction project implementation could be one such improvement. Although the awareness of BIM technology in Poland is gradually growing (BIM w Polsce, 2021), however, practical pilot studies have confirmed that the capabilities of this technology are not fully understood and utilized in the practical implementation of construction projects in Poland.

The use of BIM systems is in line with the current trends of digitalization of enterprises and is gaining increasing interest among managers. At the same time (Parylak, 2024), despite the investment of resources, 54% of companies stated that revenue growth from digital transformation fell short of expectations, falling short of 35% of targets. The situation is similar with cost reduction, with 65% of companies reporting that the achievement of targets fell short of 35%.

An additional factor driving research and practical action in implementing BIM is the requirement to build and operate facilities in accordance with environmental, energy-efficient, and sustainable requirements. Digitalization through BIM addresses these expectations and enables meeting standards where traditional methods of design and facility management are no longer sufficient.

The need for increasingly widespread, even imperative, BIM implementation also stems from legal requirements. In July 2020, the Ministry of Development, Labor, and Technology presented a report on the implementation of BIM methodology in Poland and in public procurement (Mapa drogowa..., 2020; Kornecka, 2021). A plan (referred to as a 'roadmap') for implementing BIM in the public procurement sector, which assumed that introducing the use of BIM in larger tenders (i.e., those worth over EUR 10 million) would be possible as early as 2025. BIM would be mandatory for all public procurement contracts from 2030. At the same time, the *BIM Standard PL - Draft rules for the preparation and implementation of building investments in Poland, compliant with the PN-EN ISO 19 650 standard and the national construction law. Document version 2.0* was published (BIM w Polsce, 2022).

The aim of this article is to present the current state and conditions of BIM application in construction projects, based on theoretical and practical research findings. BIM computer tools are available on the market. As demonstrated above, there is a need for increasingly better construction project management. However, among other things, due to the high degree of complexity and the generation of huge amounts of data, there is a problem with the implementation and use of BIM technology in practice.

The study aimed to identify key issues and causes of this situation, as well as to identify strategic solutions that would increase the use of BIM.

2. Methods

The research was conducted using three methods. The literature review included analysis of available books, e.g. (Anger, Łaguna, Zamara, 2021) and periodicals, as well as information published online. There are dedicated BIM portals available online, collectively presented on a separate portal (Najlepsze strony BIM…, 2025). Knowledge about BIM is developing rapidly, and the latest trends can be found online.

To empirically identify the factors determining the use of BIM in the ZPB and its implementation methods, literature research was supplemented with research on business practice.

The following methods were used:

- Participant observations combined with the analysis of project documentation. These were conducted at four companies carrying out construction projects and using BIM at various stages of its implementation.
- Expert (in-depth) interviews with individuals using certain BIM elements. These interviews were conducted at four additional companies carrying out construction projects.

3. Interest in BIM issues in the context of CAD

Literature research has shown that BIM is attracting increasing interest from researchers and business practitioners. Comparing trends in online searches for the terms 'BIM' and 'CAD' reveals that in Poland, the average number of search queries for the term 'BIM' in the Google search engine increased approximately threefold over the 18-year period between 2004 and 2022, from 20% to 60% of the peak in November 2019, as shown in the chart downloaded from Google in Figure 1.

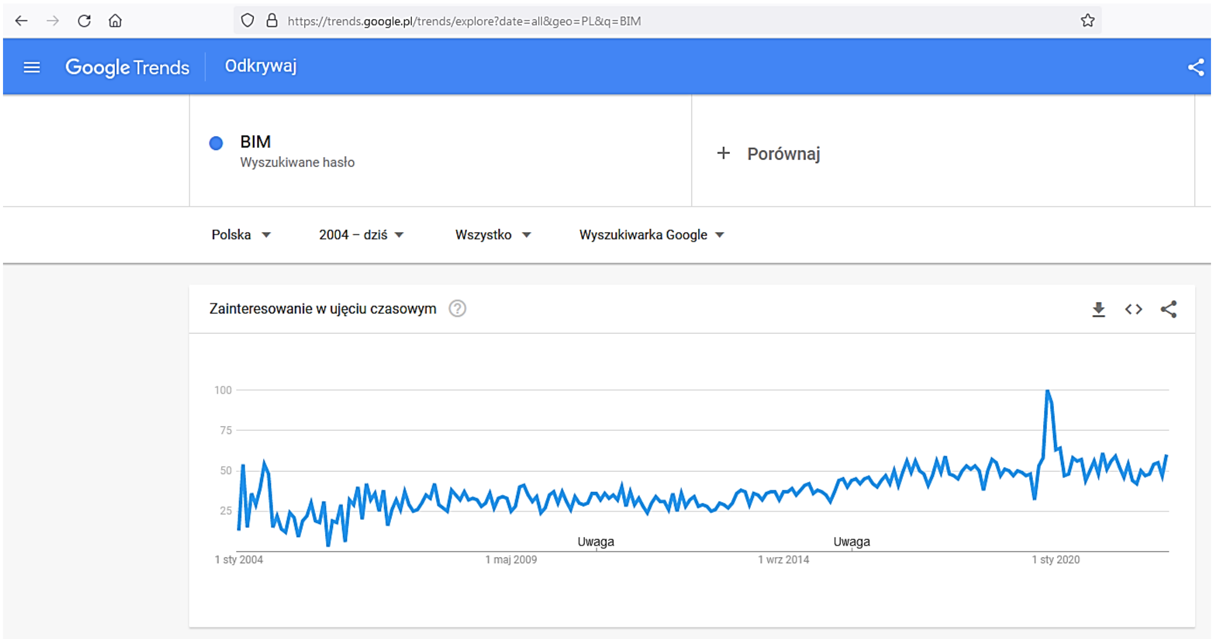

Figure 1. The level of interest in the term ‘BIM’ in the Google search engine for Poland in the years 2004-2022.

Source: https://trends.google.pl/, 27.03.2022.

During the same period, the average number of queries for ‘CAD’ and ‘AutoCAD’ in Poland dropped from 60% and 80%, respectively, to 20%, as shown in Figure 2.

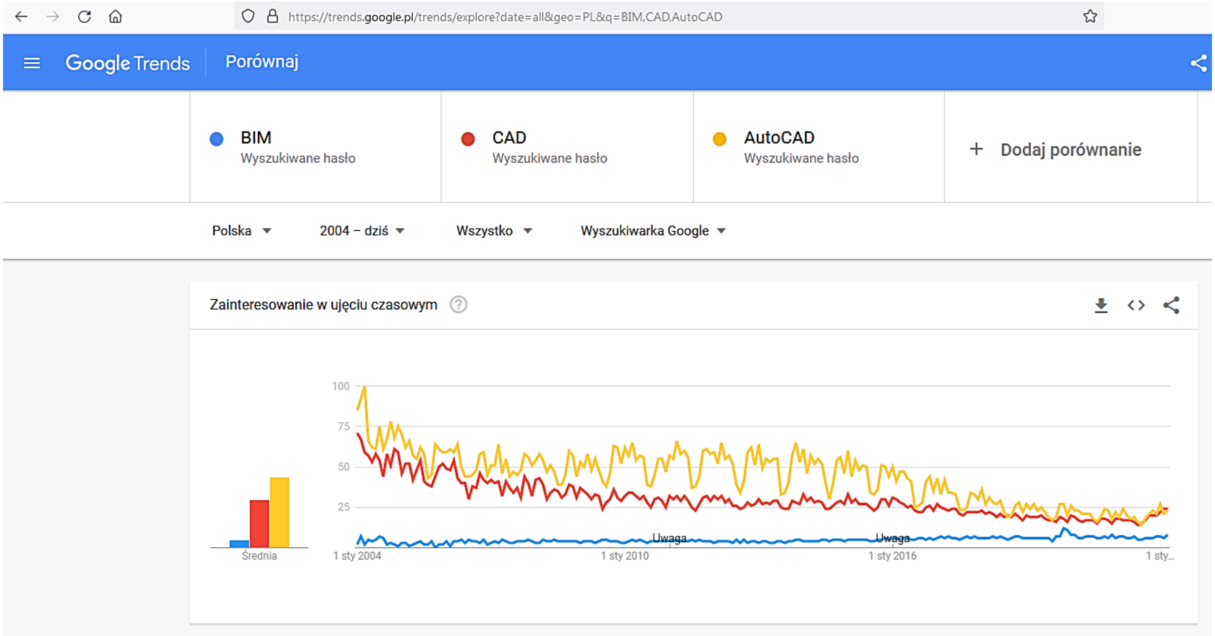

Figure 2. Interest in the term 'BIM' compared to 'CAD' and 'AutoCAD' in Google searches for Poland in 2004-2022.

Source: https://trends.google.pl/, 27.03.2022.

Globally, the number of queries regarding the term 'BIM' in the years 2004-2022 showed even greater dynamics than in the case of Poland, with an increase from a value of around 5% in 2004 to approximately 80% in 2022, peaking in April 2020, as shown in Figure 3.

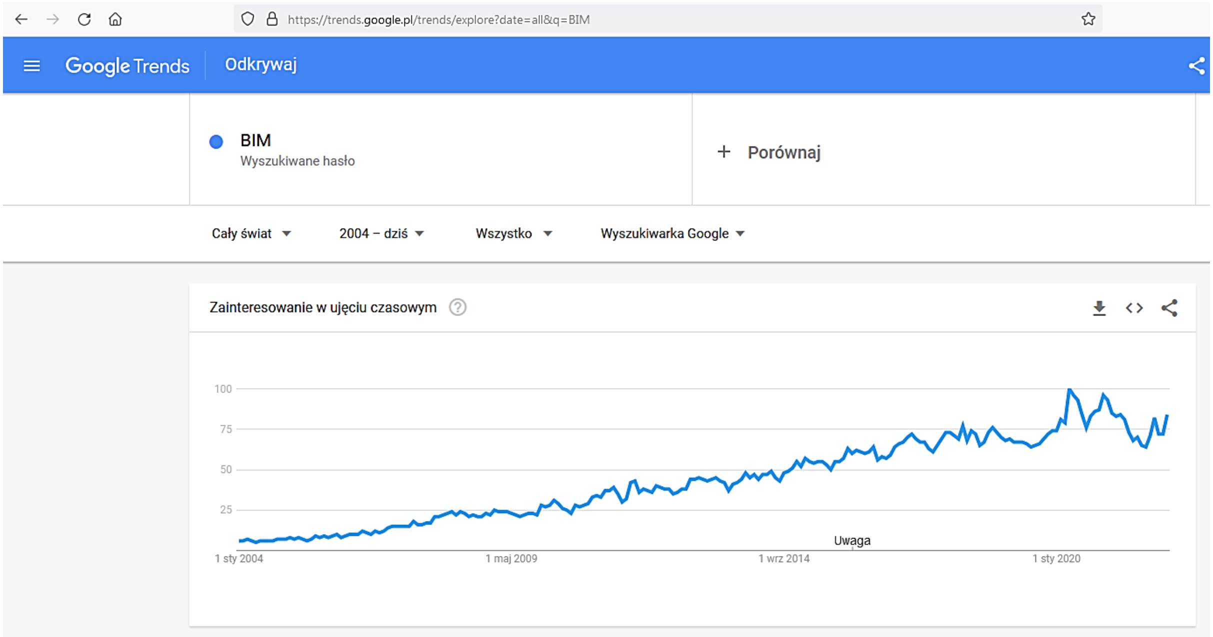

Figure 3. The level of interest in the term 'BIM' in the Google search engine for the world in the years 2004-2022.

Source: https://trends.google.pl/, 27.03.2022.

For the number of queries related to the term 'AutoCAD' between 2004 and 2022, there was a clear downward trend globally, from a value of around 100% in 2004 to approximately 35% in 2022. For the term 'CAD', a decline from approximately 80% in 2004 to approximately

45% of the peak value in 2013 was observed, followed by a reversal of the trend and a steady increase to 100% in 2022, as shown in Figure 4.

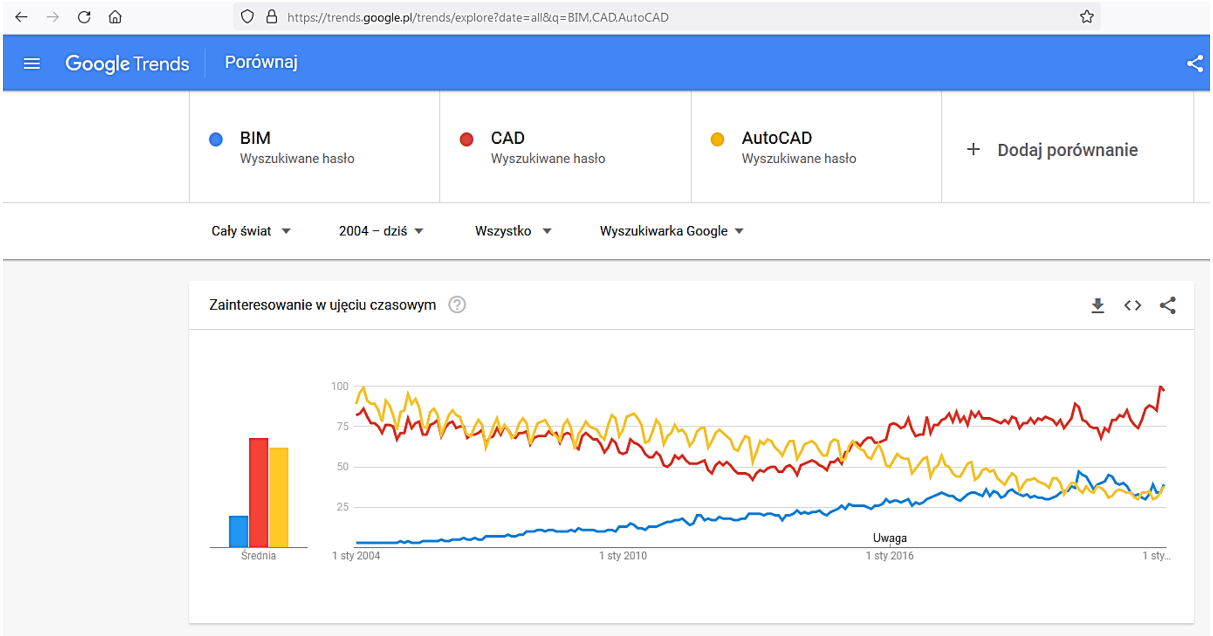

Figure 4. Interest in the term 'BIM' compared to 'CAD' and 'AutoCAD' in Google searches for the world in 2004-2022.

Source: https://trends.google.pl/, 27.03.2022.

Comparing the number of queries related to 'AutoCAD', 'CAD', and 'BIM' reveals a significantly greater increase in interest in BIM over the analyzed period of 2004-2022.

4. Investment process, construction design - specifics of implementation

The investment process is a broad range of structured, one-time, successive activities and actions. The result is a building, a civil structure, or building infrastructure of varying complexity. The operation of the resulting facility constitutes a separate set of operational activities and actions, usually carried out by a different organizational unit than the one that carried out the investment process. Within the investment process of a complex facility, such as the construction of a nuclear power plant, several or a dozen projects are implemented in accordance with the PMI and IPM PRINCE methodology. In the case of a less complex facility (e.g., a single-family home, an office building), the investment process constitutes a single project. Figures 4 and 5 showing the construction of the office building illustrate the project implementation and investment process.

Figure 4. An office building being built as part of a construction project.
Source: own work (7.05.2025).

Figure 5. An office building being built as part of a construction project - project progress.
Source: own work (4.06.2025).

In Polish construction practice, there is also the concept of a construction design in the sense of construction documentation, i.e. technical documentation meeting specific requirements in accordance with the Construction Law Act of 7 July 1994 (Dziennik Ustaw Dz.U.2025.418, 2025) and the Regulation of the Minister of Development issued on its basis regarding the detailed scope and form of a construction design.

A construction project, an investment process, is a sequence of many activities characterized by numerous features, that have been collected using literature (Wirkus, Trzciński, 2011; Wirkus et al., 2014; Głodziński, 2017; PRINCE2, 2017; Obolewicz, Baryłka, 2021; PMBOK guide, 2021; Krupa, 2022) and own observations:

a) It is usually commissioned by an external investor (client), within the framework of a signed contract.
b) It has a relatively long implementation time. For small construction projects, it generally does not exceed a period of several months, while for larger or more complex projects, it can take several or even a dozen years, e.g., the construction of a nuclear power plant. A project's implementation period includes a number of stages. The success of each stage often depends on the successful completion of the previous ones. The implementation time is a criterion for assessing the project's success.
c) The need to define a work schedule with the correct, logical sequence of activities while taking into account the parallelism of work (see photographs 1 and 2).
d) The high complexity and intricacy of the tasks. The complexity of the project stems from the technical and material complexity of the buildings being developed, the large number of external cooperation links required to produce the buildings, and the large number of technical, environmental, and social conditions that must be met. This generates a large amount of information both from the investor and during the project implementation process. The complexity of the project requires the involvement of many people and a large number of entities participating in the project implementation. This complexity is compounded by the fact that the company often implements several projects simultaneously, relying on the same resources.
e) The need to coordinate collaboration and numerous activities and results generated by numerous independent subcontractors. This creates a need for rapid and comprehensive information exchange between those involved in the project, often located in different, remote locations.
f) The widespread occurrence of changes in project implementation, which may result from the need to eliminate errors made during the design phase, as well as the need to modify structural or material solutions during construction, changes resulting from material delivery rules, or conflicts with building installations. Project implementers often have no control over the source of these changes.
g) High implementation costs and the pressure to minimize them. The investor's often irregularly funded executive budget creates the need to cover costs from its own resources. The final metric for the project contractor is the profit margin achieved relative to the costs incurred.
h) High risk originating within and outside the project environment.
i) The need to engage highly qualified personnel. Construction project activities must be performed by individuals with appropriate professional training and construction licenses. They must also be members of relevant industry chambers.
j) Continuous monitoring of the project's needs and consideration of the client's comments.

k) Engaging (negotiating, contracting) and coordinating the work of numerous subcontractors to ensure they complete their portion of the work correctly and on time.
l) The occurrence of numerous collisions, conflicts, and claims between subcontractors.
m) The need to consider and comply with industry standards and legal regulations.
n) Numerous approvals for connection designs are necessary with network operators (water, gas, sewage, and energy), as well as obtaining permits and final decisions for the construction and operation of the facility from state and local authorities. Mandatory inspections are conducted by the District Building Inspectorate, the State Fire Service Inspectorate, the National Labor Inspectorate, and the National Environmental Protection Inspectorate.

The goal of construction project management is to utilize available methods, techniques, and tools to achieve the project's goals, which include completing the project within the established budget and on time. Delays in construction projects are a common occurrence, often leading to significant cost increases throughout the investment process.

The success of a construction project depends on many factors. However, as confirmed by practical research, proper preparation of the construction process, including design and approvals, in the preparatory phase, where information and decision-making processes dominate, can significantly impact the project's success at the execution stage and the success of the entire investment process (Wirkus, Trykosko, 2011). The basis for project success is the ongoing availability of full information about the project's progress by various people involved in its implementation, e.g., what is happening in individual project sections, whether they are coordinated, who is responsible for what, etc. Having this information allows for control over all aspects of project implementation. Given today's investor requirements and environmental conditions, it is difficult to manage a project and achieve its success without computer support.

5. Defining BIM

As mentioned, BIM technology has been in development for several decades. A key year in its development can be considered 2002, when Jerry Laiserin published a series of articles (Laiserin, 2002) that popularized the concept of BIM. Simultaneously, software vendors reached a consensus on the technology's name. With the appearance of the BIM White Paper published by Autodesk (2002), BIM became a popular term and an oft-repeated acronym. (Borkowski, 2023).

BIM is a broad term, and depending on its target audience, it is not always understood and perceived in the same way. In the literature, the term BIM is used differently by authors depending on the context and the scope of their analysis. However, in business practice, the understanding of this concept in the surveyed companies is varied and rather incomplete, primarily associated with 3D CAD design, which is understood as a technology useful for architects in design.

Based on definitions found in the literature, the characteristics of BIM were summarized (Laiserin, 2002; Frank, Cohee, Vinh, 2009; Borkowski, 2024). Depending on the approach and the analyzed context, it can be concluded that BIM is:

a) A set of integrated information and decision-making processes (design, construction, and management of the completed building) involving all participants in the investment process, i.e., investors, architects, technical design engineers, construction managers, supervisory inspectors, and property managers. They utilize digitally coordinated project information based on a shared digital model of the building. This shared model, which is used throughout the entire lifecycle of the building, enables coordinated collaboration and decision-making among all participants in the investment process.
b) Information and Communications Technology (ICT) for modeling and exchanging information about buildings, encompassing a wide range of technologies used to collect, access, process, and exchange information via digital means.
c) Techniques and computer programs for developing digital models of buildings (e.g., buildings, roads, engineering structures, steel structures, installations, equipment, etc.). This model is a digital twin representing the physical and functional characteristics of buildings, containing geometric, technical, cost, and other information required during the design, implementation, and operation of a building.
d) Is a methodology (a set of methods, tools, procedures, and agreements) for managing a construction project based on a digital, multidimensional, modifiable representation of the building - a model.
e) A computer system that manages a vast amount of generated data in a centralized database containing comprehensive information about the building, relevant to each participant in the investment process and to each stage of the process, from concept, through design and construction, to operation and eventual demolition. This data is directly coordinated with each other - changes to one parameter are reflected in all other related parts of the database. The computer system allows for the creation of a digital copy of the building and simulation of solution variants, taking into account numerous additional aspects, such as cost estimation, environmental impact, etc.

In summary, BIM creates a 3D digital model of a building, containing detailed information about the building's geometry, spatial relationships, geographic data, and component properties, along with additional information about materials, costs, and schedules. It serves as the foundation for collaboration between the design team, contractors, and the owner/operator of the completed facility. With BIM implementation, architects, engineers, contractors, and facility owners can easily create coordinated, digital design information and documentation; use this information to accurately visualize, simulate, and analyze construction performance and cost efficiencies; and complete the project more efficiently, faster, and more cost-effectively, with fewer errors and conflicts, and with a lower environmental impact.

6. Project life cycle and the life cycle of BIM objects

The study aimed to identify the differences between the life cycle of a facility and the life cycle of a construction project. Depending on the implementation method adopted (e.g., design-build) and the complexity of the facility, a typical project life cycle includes the following stages:

1. establishing development conditions based on the existing local development plan or applying for a decision,
2. preparing design documentation (building design, detailed designs),
3. obtaining a decision approving the building design and a building permit,
4. preparing the construction site,
5. carrying out construction works (construction of the shell, finishing the building), acceptance of individual construction stages,
6. completing the works, landscaping,
7. preparing as-built documentation, notification/occupancy permit.

In the case of complex buildings, some stages (e.g., construction works) may be implemented in a single project or multiple projects. The construction project life cycle encompasses a much narrower scope of activities than the facility life cycle, which in the vast majority of cases is also significantly longer in duration.

A typical BIM facility life cycle is illustrated in Figure 5. Depending on the complexity of the building, this cycle may involve several or even dozens of projects of varying scope. For example, a project encompassing construction design, separate projects within the design of disciplines, or separate projects during the building's construction phase. The premise of the BIM approach is that all these projects are implemented based on the same digital building model, which is created at the beginning of the building's life cycle and is further detailed and potentially modified in subsequent projects.

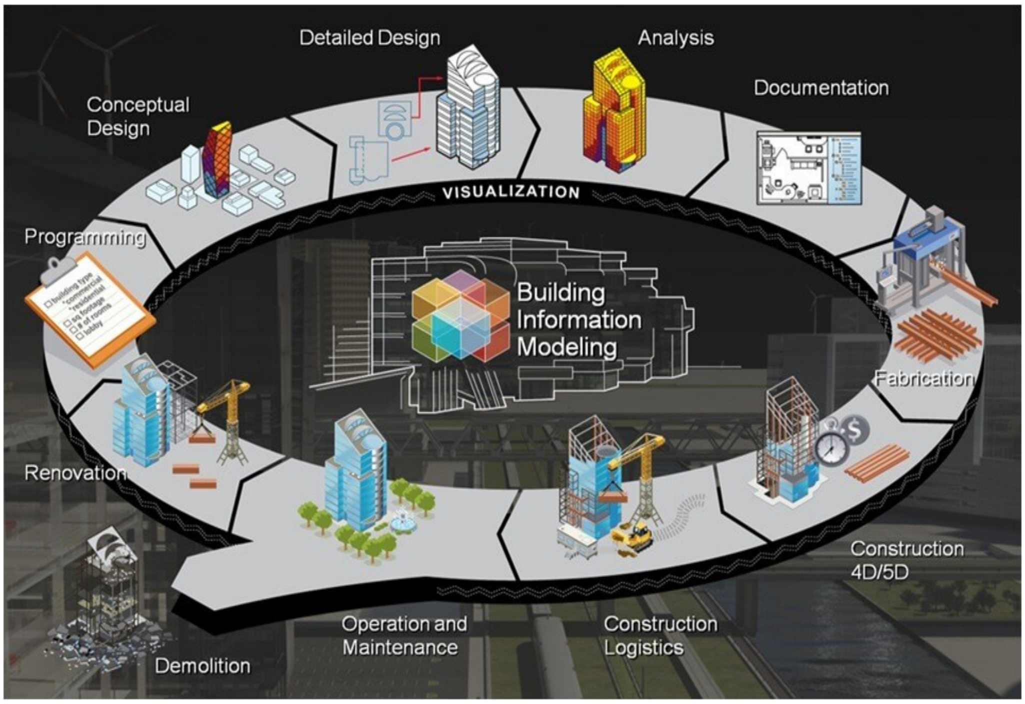

Figure 5. Object life cycle in BIM.

Source: https://projektowaniebim.pl/wp-content/uploads/2013/04/Schemat2.jpg, 05.04.2025.

During the preliminary conceptual design phase, a spatial digital model is created that visualizes the building in progress. Once the building is constructed, the BIM model becomes a digital twin of the actual building, containing a digital representation of the building's physical and functional characteristics. Data about the actual building and any changes made to it during its lifecycle should be transferred to the digital replica in real time, ensuring the digital twin is up-to-date and thus helpful in facility management. The current model should also serve as the basis for subsequent projects modernizing the building's components during the building's operational phase.

The issue of using a BIM model during the operational phase of a building is still poorly addressed in the literature (Durdyev et al., 2021). Furthermore, practical research has not identified a facility managed using a BIM model. If property managers used computer-aided management, they used autonomous facility management systems with isolated data.

According to the BIM technology concept, facility managers should have real-time access to the digital model. Data from the model should provide building managers with greater insight into the building's functional functions and technical and installation solutions. It should suggest when and what preventive maintenance, modernization, or renovations should be performed, how to repair faults, and how to route new installations through the maze of cable and pipe installations. The use of a BIM model should support every operational decision, thus enabling more efficient management and leading to new operational benefits.

A significant challenge throughout the project and facility lifecycles, which translates into BIM adoption, is coordinating data between different contractors. This problem is compounded by the fact that contractors may constitute separate legal and organizational entities and use different computer systems. This issue also represents a significant barrier to BIM implementation throughout the facility lifecycle.

7. Enterprise maturity in using BIM

BIM maturity models are a method used to measure, assess, and visualize the level of BIM implementation in an enterprise, providing a metric that indicates the stage of development of BIM computer modeling. BIM maturity models, like other models of this type, utilize a multi-level progression, moving from an initial phase through several more advanced intermediate phases to a phase considered fully mature at a given time, which can be evaluated over time.

The research aimed to define a set of criteria – measurement indicators – for assessing the maturity level.

The level of advancement in BIM use in the surveyed enterprises was low, which prevented the definition of full BIM maturity. This was achieved using the views of various authors (Sun et al., 2021; BIM Maturity Level, 2025; BIM Maturity Levels Explained, 2025) and own practical investigations.

Literature analysis confirmed the lack of a generally accepted definition of BIM maturity. The research assumed that BIM maturity refers to a company's ability, in collaboration with business partners (subcontractors), to effectively apply BIM technology, along with tools, techniques, and practices that support the successful management of construction projects using BIM. From a process perspective, BIM maturity is a continuous process of periodically identifying, measuring, implementing, and continuously improving the use of BIM technology. Reaching full maturity is a gradual process. Knowledge of the current level of BIM maturity allows for assessment and determination of practical steps to take to achieve a higher level of excellence in BIM application.

A staged presentation of a BIM maturity model should describe individual process maturity levels, from a poorly developed process to a highly mature process. The literature suggests three- or four-level BIM maturity models (BIM maturity level, 2025), where level zero indicates no use, or even a lack of awareness, of BIM technology.

The research focused on describing measurement metrics for assessing the highest, optimal level, which has not yet been fully defined (BIM Maturity Levels Explained, 2025). This level characterizes a company that:

1. It uses software, a computer system that meets various requirements at different stages of the entire project lifecycle, such as the degree to which it enables parametric 3D modeling of the object, conflict resolution during the design phase of buildings, structures, and installations; cost, progress, safety, and change management during construction, etc.

2. It is possible to manage the entire lifecycle of a building, from design, through construction, to maintenance.
3. All employees involved in the project are fully proficient in using the functionalities and tools that constitute BIM.
4. Everyone involved in the project has access to and the ability to add information to the database appropriate to their role in the project. It is possible to work on the same model simultaneously, eliminating the risk of conflicting information.
5. Project implementation is based on a digital model of the building, stored and modified in a centralized repository. The model data file can reference other databases containing additional information about the modeled building.
6. Contractors and co-contractors, such as industry specialists, collaborate using the same, shared digital model of the building throughout the entire lifecycle of the building.
7. Compatibility and interoperability with other computer systems supporting the construction project are ensured.
8. Clear legal regulations are in place that guarantee the fundamental rights of all project participants, including access and the division of responsibilities for the use of BIM, the principle of distributing revenue generated by BIM, and contractual specifications regarding the use of BIM.
9. Digital project documentation is fully implemented.

8. Factors inhibiting the implementation of BIM

BIM technology, as mentioned earlier, is becoming increasingly popular, but its implementation isn't always satisfactory for company management. This topic is still the subject of research and analysis, seeking answers to questions about the factors and relationships between them, and their impact on the implementation and dissemination of BIM in construction (Pinkosz, Borkowski, 2023; Chowdhury et al., 2024; Wang et al., 2025).

Drawing on literature research (Hall et al., 2022) and our own (Kosiedowski, Wirkus, 2021) also practical experience, we summarized the constraints and factors hindering BIM implementation in enterprises. These are summarized in Table 1, broken down into factors originating within the enterprise and those originating in its environment.

Table 1.
Factors inhibiting the implementation of BIM in companies implementing construction projects

Item	Factors inhibiting the implementation of BIM in the enterprise	
	sources from within the company	**sources in the company's environment**
Economic factors	insufficient financial resources for the purchase, implementation and maintenance of BIM hardware and software	high costs of purchasing hardware, software, implementing, operating and maintaining BIM
Technical factors	• lack of and need to purchase compatible hardware, • lack of and need to purchase appropriate facilities.	• hardware/software deficiencies among project subcontractors, • constant development and hardware changes, requiring constant hardware additions and upgrades.
Organizational factors	• lack of awareness among company management about BIM capabilities, • lack of a defined company strategy for BIM implementation, • company employees lacking BIM qualifications, • processes implemented (e.g., construction sites) that are unfriendly to digitalization or BIM, • possession of certain programs that employees are accustomed to and consider sufficient.	• lack of market availability of hardware/software, • lack of consulting support from the software provider, • lack of employees (designers) qualified to work with BIM, • lack of willingness to use BIM solutions by subcontractors, • lack of compatibility and interoperability with other computer systems supporting construction project implementation and subcontractors' programs, • lack of regulations regarding the division of responsibilities for BIM use, • need to use paper documentation with subcontractors and authorities.
Social factors	• employees' failure to recognize the benefits of using BIM, • employees' own resistance to change (BIM implementation), • employees' accustomedness to the current way of working.	• resistance from subcontractor employees to changes (BIM implementation), • reluctance of individual industry subcontractors to give up their prerogatives.
Legal and other factors	• difficulty monitoring data entry by industry professionals (if applicable to own company), • lack of regulations regarding employee copyrights, •concerns about information security in ongoing projects, • incompatibility of file formats (extensions) currently used by computer programs.	• difficulties with monitoring data entry by industry professionals (if applicable to subcontractors), • lack of regulations regarding copyrights of subcontractors.

Source: own work.

9. Market offer and selection of BIM computer programs

There is a wide range of software programs available on the market that support BIM-based construction project management. These programs offer varying functionalities and differ in terms of their use and costs. With such a wide range of options, selecting the right software becomes a challenge, ensuring it is truly useful - meaning it best meets the needs of project implementers while maintaining relatively low purchase and operating costs.

The research study reviewed the market offerings of BIM software and established a model for selecting BIM software that meets the expectations of management and employees of companies implementing construction projects. This will contribute to greater dissemination and practical use of the software by contractors.

There are websites that collectively compile and share information about existing BIM software worldwide. For example, the platform "Top 10 BIM Software Tools in 2025" compiles the 10 best BIM project management programs in 2025, as carefully considered by the authors. Another list is the 6 best programs (Top 6 Programs, 2025). Alternatively, "Which BIM program to choose? TOP LIST – Bim Corner" (2025). These lists are compiled by different authors in different countries, so they don't always overlap.

The BIM programs listed on these websites, considered by specific experts to be the best on the market at a given time, can help you narrow down your search for the required software. The information contained on these websites can suggest what to focus on and where to direct your detailed research. In addition to listing the software, the websites also describe the most important features and intended use of the software.

Example 1: A brief description of Revit by Autodesk: *Complex MEP (mechanical, electrical and plumbing) projects. Enables parametric, sustainable, and energy modeling. Efficient and flexible. Highly dependent on complex system resources* (Top 10 BIM Software, 2025). An illustration showing the creation of a 3D model in Autodesk Revit is presented in Figure 6. Detailed information about the program's functionality is available on the websites of the software manufacturer or distributor, along with cooperation offers.

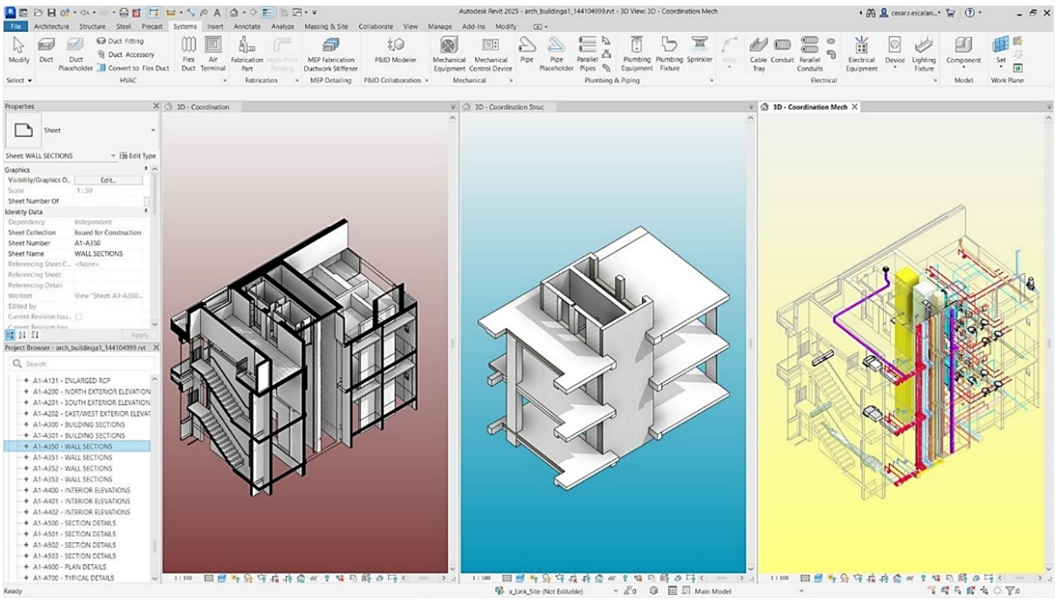

Figure 6. An example of creating a 3D model using a BIM system application in Autodesk Revit.

Source: https://www.autodesk.com/products/revit/features?msockid=17904cc2a47364bb106b5adca561658e, 28.06.2025.

Example 2: A brief description of Trimble Connect: it's a free BIM program for individuals (a paid version is available for businesses). It's available in browser and desktop versions. The application allows you to view a 3D model from different perspectives. You can also display non-geometric properties assigned to an object. The program offers the ability to analyze all data simultaneously (Data Table), group it, and export it to a CSV file. The paid version allows you to add information to an object (Which BIM program should you choose? 2025). Figure 7 illustrates information sets and connections based on the 3D model throughout the object's lifecycle using Trimble Connect.

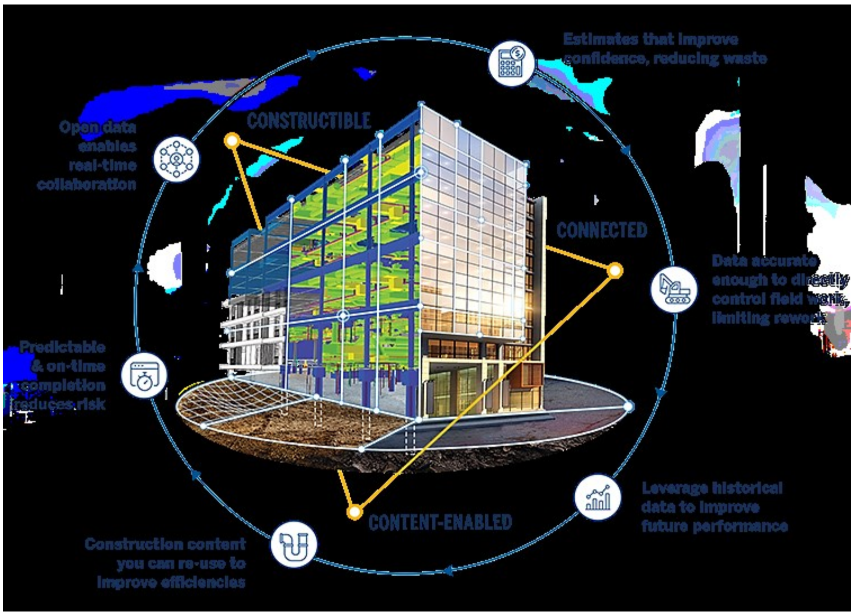

Figure 7. Example of data sets and information links based on a 3D model in the object life cycle using Trimble Connect.

Source: https://buildingpoint.com.au/trimble-connect/, 28.07.2025.

Example 3: A brief description of Bentley OpenRoads Designer (ORD): This program is derived from the InRoads family of programs from the American company Bentley, based on the Microstation CAD software. The program's core philosophy is based on the principles of object-oriented programming and parent-child relationships. A set of such attributes can be created manually within the program or in a separate .xlsx file, which is loaded directly into ORD. (Which BIM program should I choose? 2025). Figure 8 illustrates the creation of a digital twin of a bridge structure in Bentley OpenRoads Designer (ORD).

Figure 8. An example of creating a digital twin on a 3D model during the facility lifecycle using Trimble Connect.

Source: https://aecmag.com/digital-twin/bentley-systems-itwin-phase-two/, 28.07.2025.

A review of the software market also uncovered a BIM program designed for use during the building operation phase. The offer is aimed at building owners and managers. The program involves not so much the use of a digital model created during the design phase of a building, but rather the collection of building data and its transfer to a digital replica in real time. This will create a digital twin that facility managers can use to optimize all aspects of building operation (BIM for facility management, 2025).

In the professional practice of one of the authors, low awareness of the existence of BIM was observed in two housing cooperatives operating in Gdańsk, where there was no awareness of the advantages of using BIM in the operation and maintenance of housing resources, let alone the need to take an interest in this type of software and technology.

From the vast amount and variety of software available on the market and the varying costs of acquiring it, choosing the right computer system that will be applicable to a given enterprise and meet the needs of construction project developers using BIM can be difficult. Choosing a specific computer system is a strategic decision, which will have long-term consequences, and switching to another software will be difficult and expensive. Software vendors' publications are very promising and encouraging, but they lack detailed descriptions of application, and new software versions are constantly being released. In the context of the research problem related to the aforementioned issue, a model for selecting BIM software was developed based on previous experience with selecting computer systems for production purposes (Wirkus, Tubielewicz, 2023).

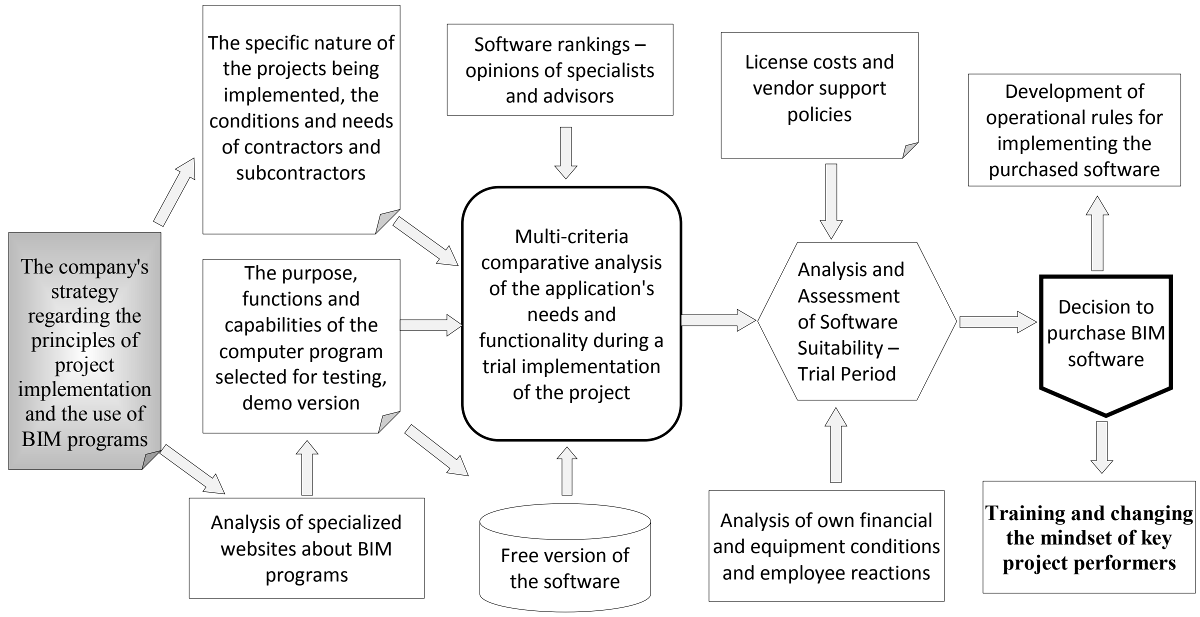

Figure 9. A model of procedure for selecting software to support the implementation of construction projects.

Source: Own work based on (Wirkus, Tubielewicz, 2023).

The model presented in Figure 9, together with the description, indicates the steps and sequence of procedures as well as the factors taken into account when selecting the appropriate software, taking into account the specificity of construction projects.

Due to the large number of proposed software, it is crucial to precisely define the needs, expectations and requirements of the organization implementing the project together with its business partners regarding the functionality and capabilities of the software.

The presented model takes into account what most software manufacturers offer: the ability to download free versions and test the program's basic capabilities for a specified trial period while implementing a real-world project. In many cases, the capabilities of free programs are extensive, even significantly similar to those of paid applications. This gives future users the opportunity to analyze specific software to meet their needs. This approach can be time-consuming, but it allows for a reliable and accurate assessment of its suitability and the benefits of using the software for a given type of project. With the belief that a given application is effective in the chosen project area and some experience using the free basic version, you can confidently make the right choice and purchase a license for a more advanced version.

When selecting software based on the needs, expectations, and requirements of those implementing a construction project, the following criteria should be considered:

- the type and size of the company,
- the IT infrastructure available,
- the competencies of the company's own employees and key subcontractors in the use of computer technology,

- the specificity, complexity, and size of the projects being implemented, as well as the relationships with key subcontractors in their implementation,
- the company's level of digital maturity.

When assessing the functionality and capabilities of a specific computer system, considerations should include:

- Adaptation of functionality to the needs of ongoing projects.
- Flexibility and adaptability to the changing needs of ongoing projects.
- Modularity enabling expansion to specific project requirements.
- Intuitiveness and ease of use.
- Ease of learning for employees and assistance in mastering the application, which will influence willingness and systematic use of the software.
- Compatibility with other applications already used within the enterprise.

Managing a building throughout its entire lifecycle encompasses a wide range of activities that are difficult to automate or encompass within a single BIM program. Rather, it's best to consider a BIM computer platform. This platform should encompass applications useful in various areas of a construction project and at various stages of its implementation.

The final evaluation criterion for software selection will be its purchase price and the financial resources the company can allocate for its purchase. The results of the analysis of the project's computer-aided needs, in the context of the functions of a given computer system, should be proportionate to its price. Software vendors have varying policies in this regard. Depending on the license and software distribution method, users can purchase a desktop version of the software or subscribe to a cloud-based application (model SaaS, Software as a Service), which reduces the cost of using the software and allowing access to the project at any time, regardless of the contractor's location. It is possible to obtain an acceptable purchase price, depending on the software's functionality, the number of future users, access time, etc.

10. Summary and conclusions

1. The high, growing demands of construction project clients (e.g., expected low project costs and relatively short deadlines) necessitate the use of innovations aimed at improving the efficiency, productivity, effectiveness, and safety of construction projects. Implementing digital BIM technology in project implementation offers broad prospects for improvement. Understanding the true value of BIM and awareness of its applications and benefits, and the idea that it is the future of construction project implementation, is increasingly common in Poland.

2. Practical pilot studies have shown that an increasing number of buildings in Poland are being designed using 3D BIM technology, slowly replacing 2D CAD technology. However, it cannot be definitively stated that this translates into the use of BIM throughout the entire lifecycle of a building.
3. The legal requirement that BIM be required for the implementation of projects financed from public sources will undoubtedly stimulate the adoption of BIM in some companies.
4. A clearly formulated strategy for BIM implementation, along with identified benefits and risks, and a consistent attitude of company management, convinced of the benefits of BIM implementation and actively supporting implementation activities, may be a factor that can mitigate the aforementioned inhibiting factors to some extent.
5. A prerequisite for effective BIM implementation in an enterprise is selecting the right computer system from the wide range available on the market. To choose the right application, it's advisable to thoroughly understand its functionality in terms of requirements, needs, and the specifics of the construction projects being implemented. This can be accomplished by using free software offerings from software vendors.
6. At the stage of preparing the implementation of BIM, it is crucial to recognize the problems occurring in the implementation of construction projects and to recognize the benefits that BIM implementation can bring.
7. At the stage of BIM implementation, it is desirable to start the implementation with more than one project and create work templates for subsequent projects implemented in BIM.

References

1. ACCA Software (2025). *BIM Maturity Levels: from stage 0 to stage 3*. Retrieved from: https://biblus.accasoftware.com/en/bim-maturity-levels-from-stage-0-to-stage-3/, 18.07.2025.
2. Anger, A., Łaguna, P. Zamara, B. (2021). *BIM dla managerów*. Warszawa: PWN.
3. Autodesk (2022). Building Information Modeling. *Autodesk Building Industry Solutions.* Retrieved from: https://www.laiserin.com/features/bim/autodesk_bim.pdf, 15.07.2025.
4. Autodesk (2025). *Building information modeling (BIM) provides a platform for building management to glean quantifiable and actionable insights to improve operational efficiency*. Retrieved from: https://www.autodesk.com/solutions/bim-facility-management?msockid=17904cc2a47364bb106b5adca561658e, 14.07.2025.
5. AXELOS (2017). *Managing Successful Projects with PRINCE2*.
6. Bim Corner (2025). *Jaki program BIM wybrać*? TOP LISTA. Retrieved from: https://bimcorner.com/pl/program-bim, 14.06.2025.

7. *BIM for facility management: Optimize building management and performance.* Retrieved from: https://www.autodesk.com/solutions/bim-facility-management, 08.09.2025.
8. Borkowski, A.S. (2023). Evolution of BIM: epistemology, genesis and division into periods. *Journal of Information Technology in Construction.* Retrieved from: https://www.itcon.org/papers/2023-34-ITcon-Borkowski.pdf, 11.05.2025.
9. Borkowski, A.S. (2024). Konstruktywne cechy BIM – parametryczność, interoperacyjność, wielowymiarowość. *Builder, 1/24*. Retrieved from: https://builderpolska.pl/, 11.05.2025.
10. Borkowski, A.S., Kruk, M. (2021) Subiektywna analiza porównawcza technologii CAD i BIM w świetle projektowania architektoniczno-urbanistycznego. *Builder, 10/21*. Retrieved from: https://builderscience.pl/article/152631/pl, 15.04.2025.
11. Durdyev, S., Ashour, M., Connelly, S., Mahdiyar, A. (2021). Barriers to the implementation of Building Information Modelling (BIM) for facility management. *Journal of Building Engineering, 4/2022*. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/ S2352710221015941, 10.04.2025.
12. Dziennik Ustaw Dz.U.2025.418 (2025). Retrieved from: https://sip.lex.pl/akty-prawne/dzu-dziennik-ustaw/prawo-budowlane-16796118, 15.07.2025.
13. Frank, B., Cohee, R., Vinh, P. (2009). *Gaining Competitive Advantage by Using Digital Prototyping to Support Building Information Modeling*. *AUTODESK® MANUFACTURING WHITE PAPER.* Retrieved from: https://download.autodesk.com/temp/pdf/digital_prototyping_and_bim_whitepaper.pdf, 15.07.2025.
14. Głodziński, E. (2017). *Efektywność w zarządzaniu projektami budowlanymi: perspektywa wykonawcy*. Warszawa: Oficyna Wydawnicza Politechniki Warszawskiej.
15. Hall, A.T., Durdyev, S., Koc, K., Ekmekcioglu, O., Tupenaite, L. (2022). Multi-criteria analysis of barriers to building information modeling (BIM) adoption for SMEs in New Zealand construction industry. *Engineering, Construction and Architectural Management, 30(9)*. Retrieved from: https://www.emerald.com/ecam/article-abstract/30/9/3798/99506/Multi-criteria-analysis-of-barriers-to-building?redirectedFrom=fulltext, 9.03.2025.
16. International Project Management Association (2017). *Individual Competence Baseline for Project, Programme & Portfolio Management*.
17. Kornecka, A. (2021). Mapa drogowa BIM. *Builder, 6*, pp. 74-76. Retrieved from: https://builderpolska.pl/wp-content/uploads/2021/06/MAPA-DROGOWA-BIM.pdf, 14.06.2025.
18. Kosiedowski, W., Wirkus, M. (2021). Bariery i ograniczenia wdrażania technologii BIM – wyniki badań pilotażowych. *Builder, 10*, pp. 28-31. Retrieved from: https://www.researchgate.net/publication/354730750_Bariery_i_ograniczenia_wdrazania_technologii_BIM_-_wyniki_badan_pilotazowych, 14.04.2024.
19. Krupa, B. (2022). Przebieg procesu inwestycyjnego w budownictwie. *MAZOWSZE Studia Regionalne, 43*, pp. 53-64. Retrieved from: https://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.ojs-doi-10_21858_msr_43_03, 15.05.2025.

20. Laiserin, J. (2002). *Building Information Modeling —The Great Debate*. Retrieved from: https://www.laiserin.com/features/bim/, 10.06.2025.
21. Ministerstwo Rozwoju i Technologii (2020). *Mapa drogowa dla wdrożenia metodyki BIM w zamówieniach publicznych*. Retrieved from: https://www.gov.pl/web/rozwoj-technologia/mapa-drogowa-dla-wdrozenia-metodyki-bim-w-zamowieniach-publicznych, 14.07.2025.
22. Ministerstwo Rozwoju i Technologii (2022). *BIM w Polsce*. Retrieved from: https://www.gov.pl/web/rozwoj-technologia/bim-w-polsce, 14.07.2025.
23. Newsblog.pl (2025). *Najlepszych 6 programów do modelowania informacji o budynku dla projektantów i budowniczych*. Retrieved from: https://newsblog.pl/6-najlepszych-programow-do-modelowania-informacji-o-budynku-dla-projektantow-i-budowniczych, 14.06.2025.
24. Obolewicz, J., Baryłka, A. (2021). Inżynieria zarządzania budową. *Inżynier budownictwa, 12*. Retrieved from: https://inzynierbudownictwa.pl/inzynieria-zarzadzania-budowa, 14.06.2025.
25. Parylak, A. (2024). *Transformacja cyfrowa a branża budowlana w Polsce*. Retrieved from: https://www.ey.com/pl_pl/insights/digital-first/cyfryzacja-w-branzy-budowlanej-to-priorytet-ai-fy25, 15.07.2025.
26. PlanRadar (2021). *BIM w Polsce: naturalny rozwój i odgórna implementacja*. Retrieved from: https://www.planradar.com/pl/bim-w-polsce-naturalny-rozwoj-i-odgorna-implementacja, 18.04.2025.
27. Produktywny Projektant (2025). *Najlepsze strony BIM – przewodnik po polsko- i anglojęzycznych źródłach wiedzy*. Retrieved from: https://produktywnyprojektant.com/najlepsze-strony-bim-przewodnik-po-polsko-i-anglojezycznych-zrodlach-wiedzy/, 14.06.2025.
28. Project Management Institute (2021). *The standard for project management and a guide to the project management body of knowledge* (PMBOK guide) (ed.7).
29. PZPB (2024). *Raport „Przyszłość budownictwa w Polsce"- czego potrzebuje dziś branża, by móc się rozwijać?* Retrieved from: https://pzpb.com.pl/raport-przyszlosc-budownictwa-w-polsce-czego-potrzebuje-dzis-branza-by-moc-sie-rozwijac/, 10.07.2025.
30. Snaptrude (2025). *Top 10 BIM Software Tools in 2025 (Features, Pricing, Pros & Cons).* Retrieved from: https://www.snaptrude.com/blog/top-10-bim-software-tools-in-2025, 15.03.2025.
31. Sun, C., Xu, H., Wan, D., Li, Y. (2021). Building Information Modeling Application Maturity Model (BIM-AMM) from the Viewpoint of Construction Project. *Advances in Civil Engineering*. Retrieved from: https://onlinelibrary.wiley.com/doi/10.1155/2021/6684031?msockid=17904cc2a47364bb106b5adca561658e, 15.02.2025.

32. United BIM (2025). *BIM Maturity Levels Explained- Level 0, Level 1, Level 2, Level 3*. Retrieved from: https://www.united-bim.com/bim-maturity-levels-explained-level-0-1-2-3/, 18.07.2025.
33. Wirkus, M., Roszkowski, H., Dostatni, E., Gierulski, W. (2014). *Zarządzanie projektem.* Warszawa: PWE, p. 373.
34. Wirkus, M., Trykosko, R. (2011). Właściwie przygotowanie przedsięwzięcia budowlanego głównym czynnikiem osiągnięcia jego sukcesu. *Budownictwo i inżynieria środowiska*, *No. 2/3*, pp. 407-418. Retrieved from: https://bibliotekanauki.pl/articles/403191, 15.05.2025.
35. Wirkus, M., Trzciński, R. (2011). Skuteczne zarządzanie roszczeniami w budownictwie. *Budownictwo i inżynieria środowiska*, *No. 2/4*, pp. 685-697. Retrieved from: https://bibliotekanauki.pl/articles/403205, 15.05.2025.
36. Wirkus, M., Tubielewicz, K. (2023). Wybrane aspekty doboru oprogramowania do zarządzania projektami produkcyjnymi. In: R. Knosala, (Ed.), *Inżynieria zarządzania. Cyfryzacja produkcji. Aktualności badawcze, 5* (pp. 113-123). Warszawa: PWE.