# The Current State of BIM on Existing Buildings: The Case of Germany

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**Abstract:**

At 44 %, the occupancy costs of a building are the most significant cost component in the life cycle of a building. The digitalization of the Architecture, Engineering, and Construction (AEC) industry in Germany, particularly through the Building Information Modeling (BIM) method, presents opportunities for delivering facility management (FM) services more efficiently. BIM is primarily used in the planning and construction phase of buildings. In contrast, the usage of BIM in FM – that is, BIM-based FM – is limited to less than 1% of all buildings internationally. Though universities and research institutes focus primarily on the planning and construction phase of buildings, there is a trend of exploring BIM in FM. This study aims to develop a neutral, cross-manufacturer understanding of the complexities of BIM, including BIM in FM for existing buildings in Germany, and to identify both fields of action and target audiences, which may be key to broader use of the BIM method in the future. Data were collected from an online survey of German private and public sector organizations that was conducted in the first quarter of 2022. These data include the opinions of facility managers, architects, engineers, building contractors, project managers, architects, and expert planners on the application of BIM to as-built buildings. The study found that the chief obstacle to BIM-based FM for existing buildings was the increased effort required for data acquisition and the lack of exchange between planners and operators. The survey conducted in this paper provides valuable information for decision-makers and FM organizations about the use of BIM in existing buildings.

**Keywords:** facility management (FM), building information modeling (BIM), BIM-based FM, as-built buildings

## 1. Introduction

The built environment is the most significant economic capital of industrial nations. The total value of all buildings in Germany is approximately 9.2 billion euro. Construction of these buildings is presently managed by an industry that, although qualified in certain areas, has not yet demonstrated satisfactory performance in all essential areas. Digital transformation is in full swing and productivity rates are rising across sectors, such as in the automotive or mechanical engineering industries. However, improvements in the Architecture, Engineering, and Construction (AEC) industry are still lacking (Sommer, 2016). The successive digitalization of the AEC industry in Germany, particularly in Building Information Modeling (BIM) and sensor technologies, has created opportunities for delivering facility management (FM) services in a more efficient way (Wills and Diaz, 2022). BIM has been gradually implemented in infrastructure projects in Germany since 2020 (Bundesministerium für Verkehr und digitale Infrastruktur, 2015). Through BIM, information can be used from a building's planning phase to its use phase. While working with BIM, it is particularly important that project stakeholders collaborate because mistakes, discrepancies, and duplicate work in the AEC industry can be avoided if the parties involved in a project work together. A BIM-based working method enables networking and cooperative planning, as well as the execution and management of buildings (Wills *et al.*, 2018). However, until now, BIM has been primarily used only in the planning and construction phases of buildings (Succar, 2009). Despite their well-known advantages, BIM-based approaches in FM are rare (Bender *et al.*, 2018; Bartels, 2020). Practitioners have enjoyed government support for the use of BIM – for example, by the "Road Map for Digital Design and Construction" from the Federal Ministry for Digital and Transport –, but BIM applications are only mapped out internally and do not involve all parties. A legal obligation to apply the BIM method will not come into force in Germany for federal buildings until the end of 2022. In comparison, a legal obligation to use BIM has existed Scandinavia since 2006 to 2010, and the United Kingdom since 2016 (Herrmann and Westphal, 2017). Germany is thus an outlier for its conspicuous lack of BIM-based methods.

The objective of this paper is to investigate the status quo of BIM in the German real estate industry in general, and its application to existing buildings in particular, from an intrinsic view of BIM stakeholders. Moreover, the study focuses on BIM-based working methods, which in turn serve as an indicator of collaboration between the stakeholders of a building. Data are taken from an online survey of 76 German private and public sector organizations that was conducted in the first quarter of 2022. The data include the opinions that facility managers, architects,

engineers, contractors, project managers, architects, expert planners, and BIM managers shared about using BIM and its associated working method throughout a building life cycle.

The first part of this study analyzes the criteria by which the respondents and organizations were classified. The second part of the survey investigates the BIM-based working method. The results of the study are compared to previous surveys from 2013 and 2017 to provide decision-makers with valuable information on the use of BIM throughout a property's life cycle and highlight further research for BIM-based FM. Finally, the paper concludes with a summary and with an overview of potential future research directions.

## 2. BIM and FM Literature Review

BIM consists of three branches. The first branch is the building information model, which is a structured data set that forms an intelligent digital representation of all data relevant to a building. The second branch is building information modeling, which is the collaborative process of combining diverse building-relevant data and of creating building information models. The third branch is the system of building information management, which includes the coordination of activities (e.g., building-relevant workflows, such as media supply or maintenance) between a building's stakeholders that help to increase the quality and the efficiency of building management (Wills *et al.*, 2018; US Institut of Building Sciences, 2007). The term Building Information Modeling describes "[...] the process of creating, modifying and managing such a digital building model using appropriate software tools" (Borrmann *et al.*, 2021, p. 4). In addition to the value of using BIM and FM described by Ashworth and May (2022), the main benefits can be summarized as follows: 1.) it provides consistent models for all stakeholders involved in the life cycle of a building and 2.) it is an information technology that has various software applications for the support of FM processes. Moreover, a BIM-based working method enables early validation and simulation of buildings, thus delivering constructive, functional, ecological, design and economic information. The BIM-based working method improves decision-making by making reliable information available (Both *et al.*, 2013, p. 26). BIM in FM can be applied to the following soft facility services: space management support (occupancy planning); contract management (transfer of tenant data into the BIM model); or realizing FM sustainability targets according to "German Facility Management Association" (GEFMA) guideline 160 "Sustainability in Facility Management" (Wills *et al.*, 2018). Furthermore, it can be applied to the following hard facility services: maintenance and repair (Hu *et al.*, 2018; GEFMA, 2019); the planning of remodeling and new construction measures; and simulations for energy optimization (GEFMA, 2019). Combinations of hard and

soft facility services can also be supported by BIM, as Chiu and Lai (2020) investigated (e.g., for building service engineering). To use BIM in FM, FM-relevant information for facility service provisions must be considered as early as in the planning phase of buildings (GEFMA, 2019). The requirements, therefore, must be integrated into the Employers Information Requirements (EIR), which aim to ensure that the appropriate quality and quantity of information are available in the right places simultaneously (VDI Verein Deutscher Ingenieure, 2020; GEFMA, 2019). The detailed requirements of FM stipulated in the EIR can help stakeholders avoid conflict (Kassem *et al.*, 2015; Becerik-Gerber *et al.*, 2012). However, BIM faces the following difficulties: higher planning expenditures (especially in early project phases); training costs for participants; the need to purchase new solutions; demand for additional management capacity to ensure that the data model functions properly; and the proper involvement of all stakeholders in the implementation of the BIM method (Albrecht, 2014). At the international level, BIM in FM is limited to less than 1 % of all new and as-built buildings (GEFMA, 2019). In addition to the reasons that Teicholz (2013) cited for the rare use of BIM in FM, it may also be attributed to the lack of information required for facility service delivery and the poor quality and quantity of information (Giel and Issa, 2016; Bartels, 2020). Additionally, standards are lacking and companies rarely appreciate the benefits of the life-cycle approach (CAFM Ring e.V., 2017). Moreover, FM-relevant data are not known in the planning phase of buildings but must be provided by the client. Paradoxically, the client is not assigned to perform facility services until the building's use phase (Wills and Diaz, 2022). In practice, FM receives more information than is relevant for actual facility service delivery (Kassem *et al.*, 2015), and unnecessary information requires more management and structuring (Dias and Ergan, 2020). The integration of data to existing buildings creates another barrier to utilizing BIM in FM (Altohami *et al.*, 2021). Although BIM makes more information available to FM, this information is not necessarily represented in FM-compliant semantic formats (GEFMA, 2019). Krämer *et al.* (2022) note that most universities and research institutions focus on the design and construction phases, rather BIM in FM, what might be another reason for the underrepresentation of using BIM in FM.

## 3. Methodology

### 3.1. Survey

To determine the status of BIM in Germany, an online survey among German private and public sector organizations was conducted in the first quarter of 2022. The survey questions were adapted from the surveys conducted by Both *et al.* (2013) (N=176) and Herrmann and Westphal

(2017) (N=312). These previous surveys enable comparison between this study's results and the results of previous studies on BIM and the BIM-based working method. The 2022 survey's main objective was to create a neutral database on the use of the BIM-based working method in the real estate industry and, more generally, on the state of BIM in Germany. Respondents filled out the surveys between January and April 2022. A link to the survey, along with a cover letter briefly explaining the survey topic, structure, and time required, was sent to the target group by e-mail (N=1,510). The selection criteria for determining the target group were based on the application of BIM in a real estate business context. Therefore, private and public sector organizations listed in real estate (society of property researchers Germany), facility management (GEFMA, CAFM-Ring, RealFM) and BIM associations (buildingsmart, Planen Bauen 4.0, BIM Deutschland), societies, and organizations were selected as potential participants. Additionally, the survey was shared via the target group's relevant platforms and viewed 799 times. By the end of the collection period, 76 valid responses had been submitted, and then the results were evaluated. "Google Forms" was used for the review because its configuration management allows for the logical linking of questions. This service made it possible to change the length of the questionnaire by using logical connections to change the answer options available for respondents to select. Specific versions of the questionnaire were designed for BIM users, BIM switchers, and non-BIM users. First, the respondents indicated to which of these categories they belonged. The survey sought respondents' opinions about the benefits of the BIM-based working method and what obstacles must be overcome in the future. BIM users and BIM switchers were asked about the pros and cons of BIM and about the scope of its application. Furthermore, respondents were asked to which life cycle phase their organization applied the BIM-based working method. Non-BIM users were asked about the reasons for not working with BIM and possible incentives for introducing a BIM-based working method.

The first portion of the survey categorized the participants. The participants, therefore, had to answer qualitative and quantitative free-text and multiple-choice questions. In the second part of the survey, the participants were asked about the state of BIM in Germany, their familiarity with BIM and the BIM-based working method, and their opinion on BIM as applied to existing buildings. Questions were presented in both single and multiple-choice formats, as well as free-text. Pre-defined answers in the form of statements that the participants could select helped to simplify the execution of the survey.

The survey's objective was protected by defining clear data entry requirements for closed questions. The questionnaire was completed by independent testers prior to the start of the survey to test for content consistency. Because the questions sought subjective experiences, purely quantitative evaluations are not meaningful would not have been productive. The answers of the respondents reflect the degree of satisfaction that those in the respective categories have with the BIM-based working method.

### 3.2. Surveyed organization and respondents

Tab. 1 shows the data that the respondents provided. 70% of the participants are planners; 11% are contractors; and only 3% are facility managers. The small proportion of facility manager respondents likely skewed the survey's representativeness only to a minor extent because the topic of BIM in existing buildings is also relevant in the disciplines of architecture and project management, the latter already including aspects of FM.

Tab. 1: Categorization of survey participants

| Categories | Number of responses | Percentage |
|---|---|---|
| planners (general and expert planners, architects) | 53 | 70 % |
| project controller / project manager | 3 | 4 % |
| executors (prime contractor, construction company) | 8 | 11 % |
| public sector | 1 | 1 % |
| facility management / construction operations | 2 | 3 % |
| builders and investors | 1 | 1 % |
| other | 8 | 11 % |

The buildings that the respondents manage are located in Germany (N=100%), Switzerland (N=15%), Austria (N=12%), other European countries (N=20%), and non-European countries (N=25%). Fig. 1 shows the business operating areas of the organization where multiple answers were possible. Organizations with 31 to 300 employees make up 51% of respondents and is the most heavily represented organization. Organizations with more than 300 employees make up 20% of the pool. Many of the participants hold a higher position in the organization. For instance, "Owner" is the most frequent job title among respondents (i.e., 20 out of 76 titles). Employees in management make up 24% of participants, followed by Project Managers at 22%. The category "Other" includes various employees who deal with BIM implementation in the company.

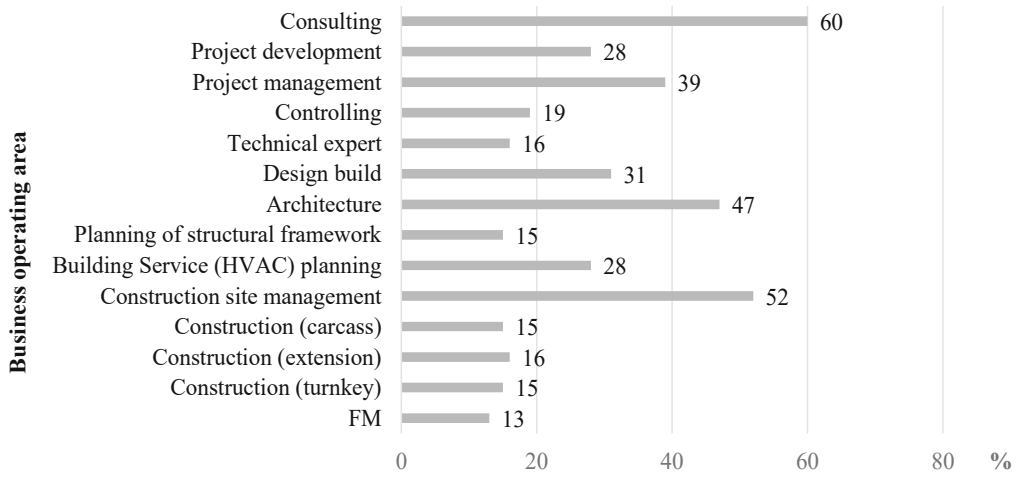


Fig. 1: Business operating areas

## 4. Results

### 4.1. Familiarity with BIM

To evaluate their level of familiarity with BIM, the participants were first asked whether they were already working with BIM and when they first heard of BIM. As shown in Fig. 2, 78% of the participants already use BIM. This percentage marks an increase from 2017 and 2013. Only 14% of the participants do not use BIM, which is an increase from previous studies, and 8% of the participants plan to introduce BIM. Furthermore, 84% of respondents stated that they had heard of BIM more than five years ago, and 13 % three to five years ago.

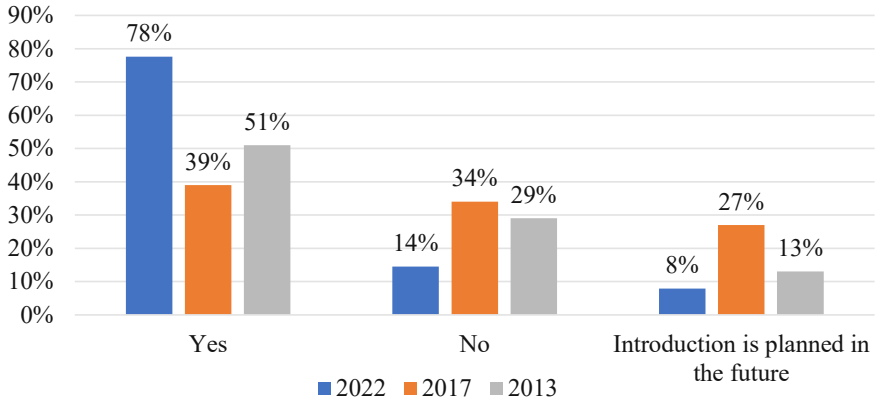


Fig. 2: Familiarity with BIM

Non-BIM users were then asked their reasons for not using this method. The primary reason for not introducing BIM (90 % of responses) is that the strategic approach of their organization, which has not changed since the last survey in 2017, does not accommodate it. Those respondents (N=11) were then asked a free-text question about their reasons for not using BIM.

The two main reasons provided are that, 1.) the costs for the software license to use BIM are too high, and 2.) compensation may not provide enough of an incentive (N=6). Moreover, clients are not asking for BIM (N=6). Non-BIM users also mentioned the lack of incentives as a barrier to implementation even if the building owners were to request it (60%).

### 4.2. BIM-based working method

This section of the survey addresses the goals, obstacles, and advantages of the BIM-based working method. Additionally, other aspects of BIM-based working methods, such as methods for the exchange of data, are addressed. The participants were asked about the pros and cons of collaboration between project stakeholders; 64% of the respondents stated that one of the pros of the BIM-based working method is improved coordination with project partners while 52% stated that the value of the entire project increased as a result. Another benefit that some reported is a reduction in the amount of time spent completing follow-ups and other related procedures. With respect to the cons of the BIM-based working method, 45% of the participants agree that the Fee Structure for Architects and Engineers (HOAI) makes BIM less appealing. Notably, 100% agree with the statement: "The service provision and remuneration for the creation of digital building models are not sufficiently considered in the Fee Structure for Architects and Engineers." Another disincentive for many participants is that different contracts are drawn up for different phases in a building's life cycle. In fact, 34% of 52 respondents are disappointed with the fact that cross-life cycle contracts are not used. One explanation for the lack of this kind of contract is that values covering the entire life cycle of the building have never been created.

Additionally, the lack of investment capital for BIM-based working methods was cited as a minor problem. Specifically, investment capital lacking for BIM is funding for software, tools, and training courses. However, 67% of the respondents disagree with the thesis that "There is no capital for using the BIM-based working method and new investments." On the other hand, 85% of the respondents believe greater data accuracy, improved communication (63%), and a reduction in the potential for errors (97%) are the main advantages of using the BIM-based working methods, which is consistent with the survey results from 2017. In terms of the software environment, Open BIM is preferred. Thus, 62 % of the participants use software products from different manufacturers. To date, the open data exchange format Industry Foundation Classes (IFC) is primarily used for data exchange. While IFC was rarely used in 2013, 84% of the respondents use it now.

### 4.3. Change of working by BIM-based working method

After the identification of goals, obstacles, and advantages of the BIM-based working method, this section of the study focuses on the ways in which working with BIM has changed. To this end, accounts of positive or negative experiences with the BIM-based working method were requested. The participants reported predominantly positive experiences with BIM and only reported negative experiences concerning value creation within a company. The effectiveness of BIM is following a more positive trend today than five years ago. While today 69% of the respondents state that efficiency has increased with the help of BIM, in 2017, it was only 52%. Finally, the focus turned to the future. Fig. 3 portrays the answers of the respondents to the following question: "BIM: More of a curse or a blessing?" As reflected in Fig. 3, 62% of the participants see a future for BIM, while 27% consider the method an essential working tool that will increase efficiency.

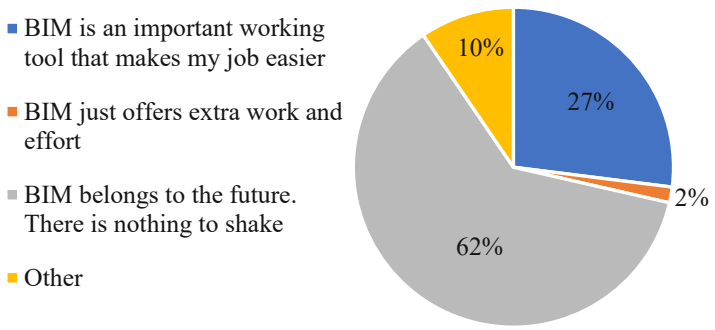


Fig. 3: Future awareness of BIM

### 4.4. Challenges for the implementation of BIM in existing buildings

Contrary to the expectation that BIM is predominantly used in new buildings, 63% of 65 respondents state that they use BIM across the life cycle for new and existing buildings. Just 22% stated that they would like to operate BIM solely on existing buildings, and only 14% use BIM only at the beginning of the life cycle of a building. Fig. 4 shows the use of BIM by different building types.

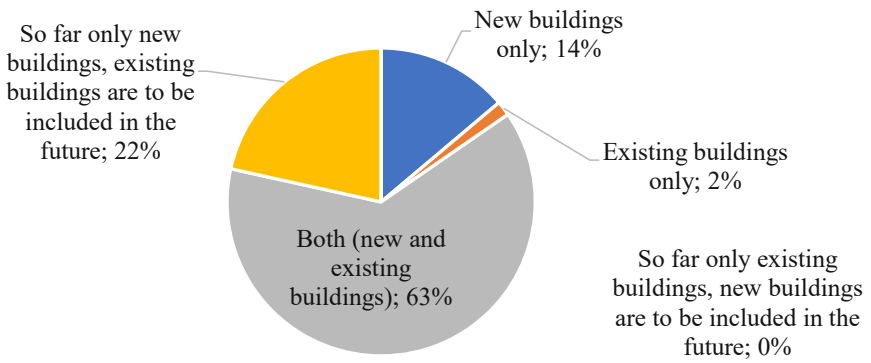


Fig. 4: Applicability of BIM in a building life cycle

Those who use the BIM-based working method only on new buildings (9) were asked to provide their reasons for not using BIM for existing buildings. The respondents were allowed to supply multiple answers. The results are shown in Fig. 5.

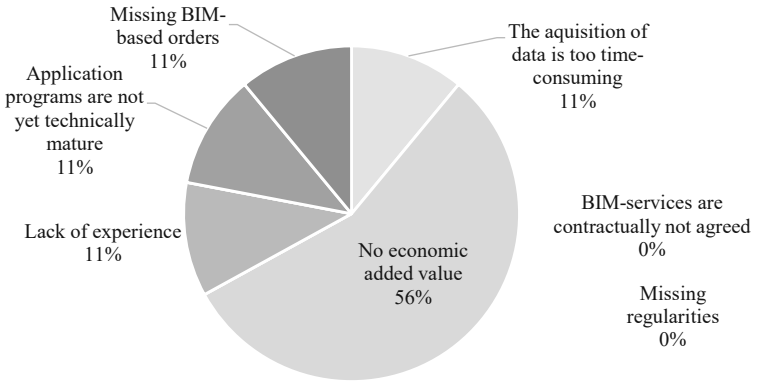


Fig. 5: Reasons for not using BIM in existing buildings

The main argument for not using BIM on existing buildings was that it does not add economic value (5 out of 9 statements). Moreover, the participants stated that BIM services for existing buildings are not bound by contracts and lack regulations.

Finally, participants were asked to explain the biggest obstacles to introducing BIM in existing buildings. A common response was that data collection requires additional effort and the databases are often insufficient. This response suggests that the transition of the as-built model to FM is unreliable. An evaluation of these responses can identify the incentives that will motivate companies to apply BIM to existing buildings. The participants recommended the introduction of BIM in existing buildings only if the client requests this and digitized as-built plans exist. Furthermore, the creation of the basic model should be remunerated, and application programs for BIM in FM should be better developed. Facility managers also stated that required information is often low-quality and transmitted improperly, which is inefficient and leads to extra work.

## 5. Discussion and conclusion

This paper empirically investigates the familiarity with and usage of BIM that 76 representatives from the German real estate industry reported. A questionnaire was used to investigate what kind of obstacles the implementation of BIM faces. In addition, areas for improvement are discussed, for example, addressing the problem of insufficient data preparation. The present study forms a basis for further investigations, especially for future property management. In addition, this study should help to provide all stakeholders of a property with an up-to-date evaluation of BIM in the German real estate industry. The results of the survey indicate that awareness of BIM is steadily growing. The fact that the survey was filled out predominantly by founders of companies and other people in leadership roles suggests a growing interest in the industry. Compared to 2013 and 2017, the prospects of BIM implementation in the coming years are promising. Though many participants cite enhanced efficiency, such as improved coordination with project partners and a reduced number of multiple inputs, as a benefit of BIM, they also claim that HOAI is a significant barrier to implementation. It, therefore, seems that the creation of new digital building models should be better examined along with proper remuneration.

Compared to a survey conducted in 2021 regarding the use of BIM in Turkey, BIM is already used much more frequently in Germany. While only 11% of respondents in Turkey use BIM, this figure is seven times higher in Germany (Tezel *et al.*, 2021). Moreover, a study from 2022, in which the research activities on BIM in FM are placed to the standardization activities of the respective countries shows that the pioneer in research and standardization is the UK. Moreover, many publications on BIM in FM coming from Italy. However, these are purely research papers, as case studies will not be applied in Italy until 2025 due to the lack of legal regulations on BIM in FM. At this point, Germany is already ahead of the legal obligation to use BIM from the end of 2022 (Pinti *et al.*, 2022).

The surveys conducted for this paper have indicated that BIM, as well as the BIM-based working method, are already well-known. The results of the survey from 2022 indicate a growing awareness of BIM in comparison with the results from 2017 and 2013. Furthermore, organizations use BIM more often than before. This study shows that BIM is indispensable for all companies along the construction value chain. In order to make the implementation of BIM more attractive to companies and to make it more application-friendly, incentives and remunerations must be offered. For this reason, it is essential to find out what obstacles BIM

faces in building operations so that the appropriate recommendations can be made. Though the survey was sent equally to all groups of participants, facility managers were underrepresented.

The low participation of facility managers may indicate that BIM is less important or less practiced in FM in general and in its application to existing buildings in particular. It is also possible that the low participation of facility managers does not indicate a lack of interest in BIM but rather in the survey itself. A study is therefore needed to explain the use of BIM on existing buildings in greater detail and suggest ways to make the benefits of BIM more appealing. The real estate industry is still in its infancy compared to other sectors of the economy where virtual reality is already improving development processes, and the potential of virtual applications is exceptionally high. An improvement of using BIM on existing buildings requires contracts and regulations of using BIM services.

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