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## As-built BIM in real estate management: the change of paradigm in digital transformation of economy

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# As-built BIM in real estate management: the change of paradigm in digital transformation of economy.

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**Abstract.** International Facility Management Association (IFMA) traditionally divides the management of real estate into asset, property and facility management. The paper explores how the emergence of building information modelling (BIM) has influenced the distribution of information about the building among the stakeholders. As-built BIM in industrial buildings is a significant part of digital transformation of industrial assets and emergence of Industry 4.0. The tendency of transferring the ownership of information from facility manager to asset manager as well as the increase of transparency is analysed in the recent literature. The development of as-built BIM has given the possibility to the owners of real estate to become not only the owners of the assets themselves but also the owners of digital assets. In order to clarify current situation in the scientific community, the research interest in building information modelling among the studies mentioning facility management, asset management and property management has been analysed. The role of information about the building components as well as practical examples of operational expenditures reduction are explored and discussed.

## 1. Introduction

In the era of absence of building information modelling (BIM) the role of the information owner about technical condition of an object was traditionally dedicated to the facility manager as a party responsible for maintenance of the building [1]. The party responsible for management and maintenance of the building while using BIM-technologies gets an access to criticalities that take place in documentation and preservation of existing assets [2]. Integrating building information modelling into automation systems has proved the efficiency in cost savings and reduction of management complexity [3].

The emergence of Building Information Modelling has influenced the whole sector of construction [4]. Even though currently most of the studies in this area are dedicated to the construction [5] or in most cases to the design stage, as well as the most popular software such as Autodesk Revit, the industry is slowly moving to applying the benefits of BIM to the whole lifecycle of the building [2, 6]. Moreover, there are the first evidences of integrating blockchain technology into the management of data ownership [7]. Nevertheless, the owners of the assets in real estate sector are not interested in the ownership of digital twin of the asset and underestimate the value of this information as well as potential savings in maintenance of the building and management of the assets as they are mostly not informed enough about the possibilities and advantages of digital twins [8].



Building information modelling brings construction sector nowadays to the focus not only of the technical studies but also business, economics and management [9]. At the same time built environment keeps on digitalizing [10] and being considered as a complex technical system as the word “system” turns out to be one of the most frequent keyword in BIM-related articles. It occurs more than 2600 times in the Scopus articles of years 2017-2019 mentioning “BIM” and “building information modelling” and according to Zhao [9] the frequency of the word “system” in network of co-occurring keywords is the second highest after BIM itself.

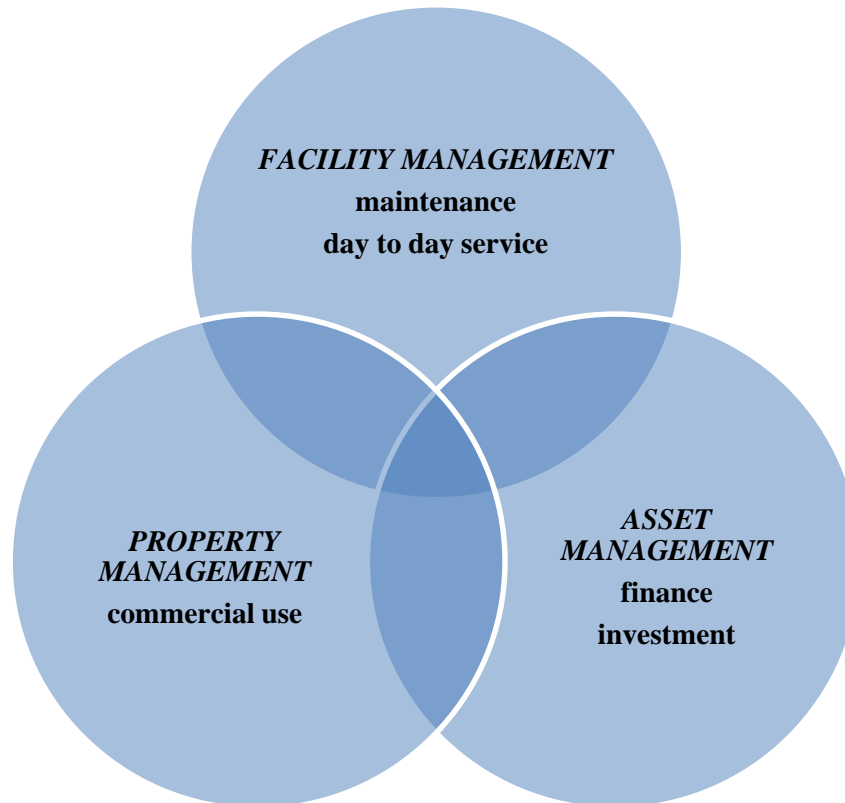


Figure 1. Traditional distribution of roles in building management according.

This research explores the current state of the information ownership in building management as well as ongoing tendency of switching the role of the information owner.

The problem of optimizing the asset management process is especially urgent for the large industrial agents which act in the most profitable and high-tech segment of real estate [11]. If the maintenance of the production components and real estate in which they are situated is not organized efficiently, the downtime of production grows, consequently bringing huge monetary losses for each day of downtime. Ultimately, the owner of the real estate receives income for the time of the renting of the property, while carrying both fixed and variable costs according to time. Decision time and the correct prediction of operating costs become the most crucial factors for the owner or management company.

## 2. Methods

The ongoing digitization of economy covers all the sectors of human activity including real estate and such fields of study as asset management or facility management. Rapid development of digital technologies create a gap due to lack of practical models of application as well as conceptual models in which a general approach can be formulated. The method of this research is dedicated to conceptual design and mainly to the formalization of the description of the subject area and existing restrictions. In order to clarify the concept the information about the building is considered from several points of view

such as asset, facility and property management and data paradox emerging on strategic, tactical and operational level is considered.

As the research is focused on the ownership of information in building management, all the current actors mentioned above in the introduction have been analyzed separately.

The next chapter has been organized in the following subcategories:

- role of information in asset management;
- role of information in facility management;
- role of information in property management;

The review has been mostly held using the articles included in SCOPUS database. The current state of information ownership in management of the buildings has been assessed using such techniques as horizontal analysis of publication activity, which is normally used in financial studies.

In our opinion the solution towards which the industrial companies have an opportunity to move in order to optimize the maintenance efficiency is creation of digital twins of their assets including all the components of production as well as the real estate basis in which production is located.

### 3. Results

The results of the review are organized respectively to the subdivision mentioned above.

#### 3.1. Role of information in facility management

The survey of the literature in SCOPUS database has shown the following results (see figure 2):

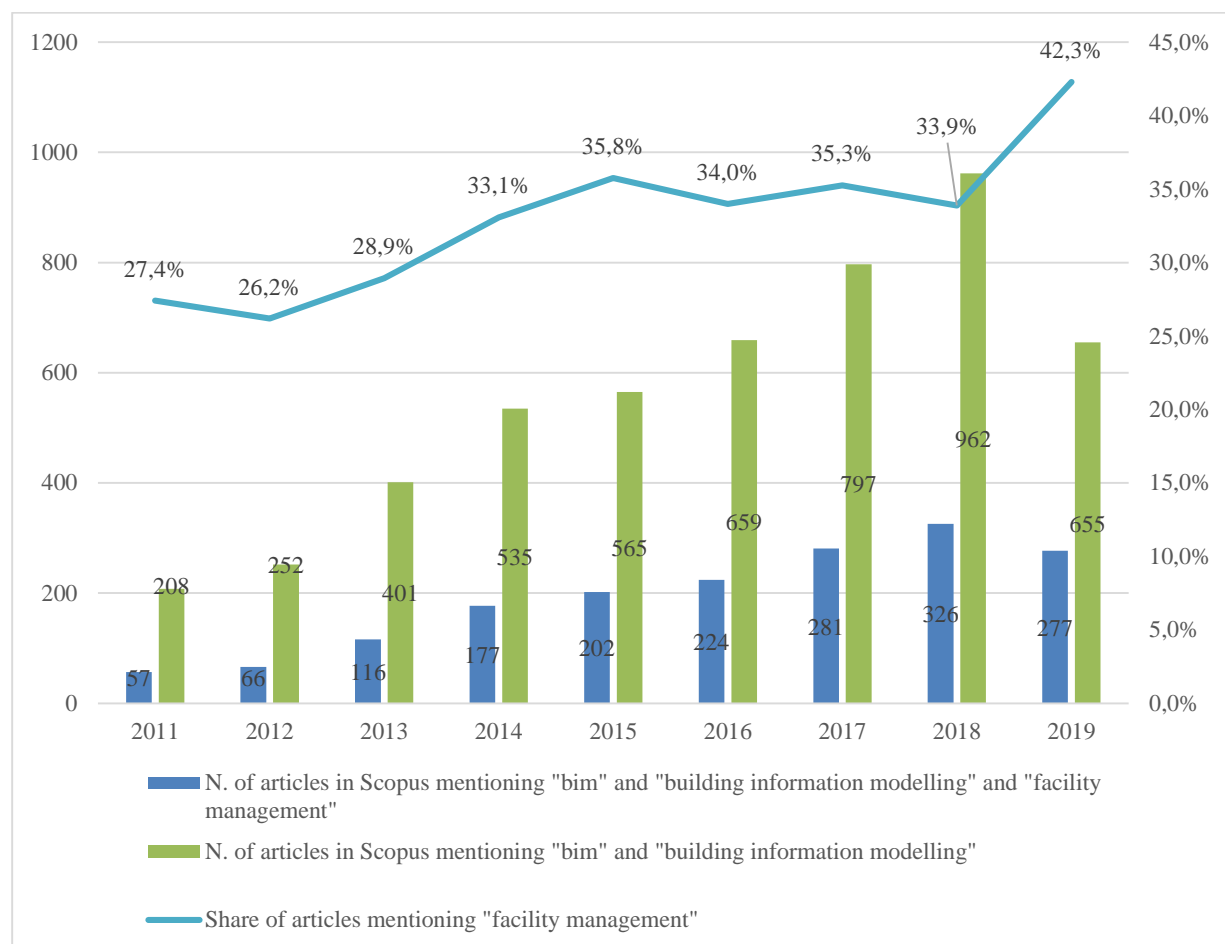


Figure 2. Research activity in topic of facility management among the articles mentioning BIM as of August, 2019

The graph above demonstrates that research interest in facility management among the investigations related with BIM keeps on growing for the last years. Among articles mentioning BIM by the year 2019 almost each second paper mentioned facility management. Some studies report significant increase in the number of BIM-related articles focusing on maintenance of the buildings [12].

Major reviews in the topics of Facility Management in BIM conclude that the main gaps are greater consideration of long-term strategic aspirations; amelioration of data integration/interoperability issues; augmented knowledge management; enhanced performance measurement; and enriched training and competence development for facilities managers to better deal with the amorphous range of services covered by FM [13]. Parn et al. point out that BIM technologies facilitate efficiency of facility management and enhance whole lifecycle planning in BIM environment. The researchers also come to conclusion that automation within the BIM-FM integration process will revolutionize the understanding of the building lifecycle, changing the way in which buildings are conceived, developed, built and utilized.

Among the benefits of integrating BIM in facility management several studies [14] mention locating business components, facilitating real-time data access, visualization and marketing, checking maintainability, creating and updating digital assets, space management, planning and feasibility studies for noncapital construction, emergency management, controlling and monitoring energy, personnel training and development. Even though some of the possibilities mentioned above can be realized without digital twin, there several positions that are only possible with digital twin: facilitating real-time data access, visualization, creating and updating digital assets.

Analysis of modern digital technologies leads us to a conclusion that it is possible to concentrate the most part of changes and costs at the design stage, thereby significantly reducing the number of possible changes at the stages of production and operation, therefore, minimize the total amount of costs. This approach allows the consumer of the asset, being connected to the process of its creation at an early stage, dynamically and efficiently manage changes in the target characteristics of the asset and take into account new restrictions that arise throughout its entire life cycle. A key change in the role of the buyer of the asset turns out to be participation in the formation of consumer properties of the asset, and its value management throughout the asset's life cycle. Moreover, all the technical and economic parameters of the asset, their change during the entire life cycle become known already at the stage of its creation.

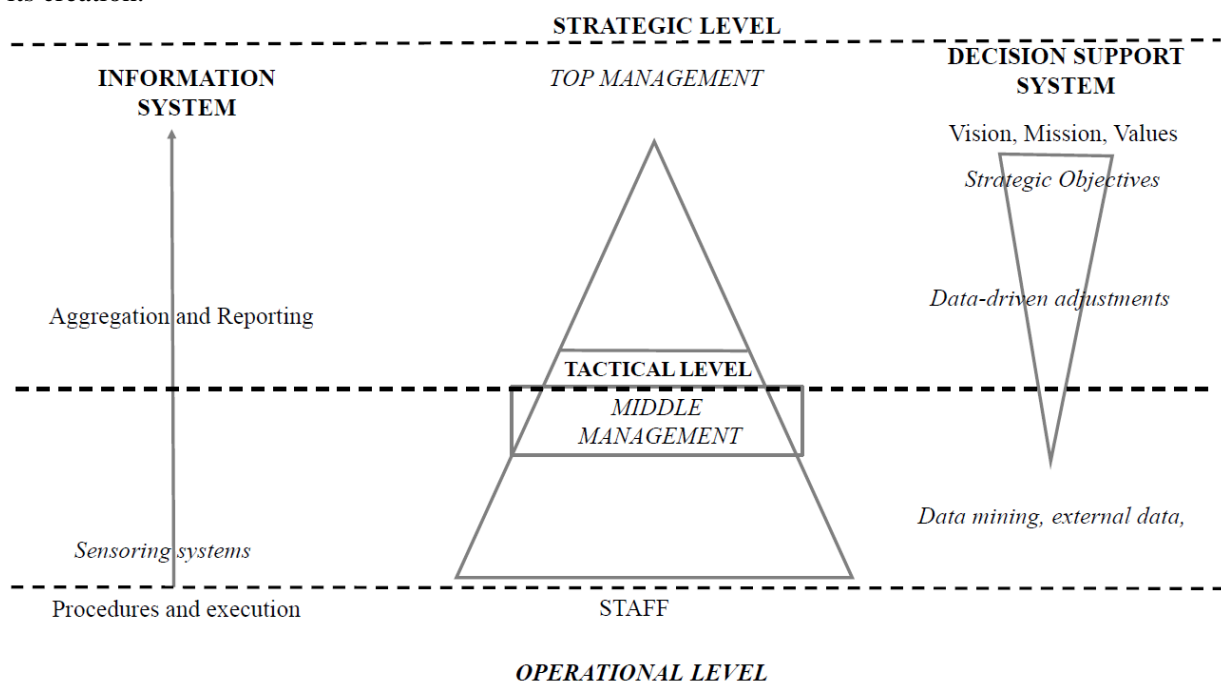


Figure 3. Strategic, tactical and operational levels in facility in management

Building components such as internal engineering systems have a growth trend in applying innovative technologies [15] such as BIM. Nevertheless, the topics of applying these technologies for operation stage are less frequently discussed. If we think on facility management as a number of services as: services to people, service to business, service to buildings the quality of information can be observed as part of the organization of the system of information usable for managing a building or a set of assets. In Figure 3 the classical definition of Information System is reported and the general idea of the role of Information System for Facility management can be seen: Data Reduction through aggregation and exception reporting. The definition brings to the consideration of an important aspect linked to the Data Paradox that can be seen in modern systems, based on sensors and points of collection of data: data have a huge potential but the information stream can be not functional for the management of operation because of redundancy. That is why digital twin of the building need to be highly rationalized model focused only on useful information but not on all the available data. The same type of approach can be seen in the middle image in Figure 3. The pyramid of information flow connects the transaction database to the strategic and executive management, ideally defining a stream of information that can be useful, aggregating data, for any level of management of works. This is to consider the information systems in its decision support role: modelling future scenarios, through simulations, connecting external data from clients of providers, mining data for marketing use and tailoring services for the end uses.

Practical applications of BIM in facility management [16] reveal significant maintenance efficiency improvements and cost savings. One of the indicators in above mentioned study is search for information which was reduced by 30%. Another indicator is the time spent locating specific defective components, researching data related to those components, and formulating a maintenance plan has been reduced by an estimated 50%. Another case study on university campuses [17] has proved that integrating BIM in facility management increases the savings on electricity consumption. The topics of energy saving have proved to be efficiently considered using lifecycle approach [18].

Actual reports of the representatives of industry on the Going Digital 2019 conference of Bentley company state that application of BIM in the reconstruction stage of several Lipetsk iron and steel factory components has shown significant monetary savings in 3D modelling case and up to 76 days reduction on reconstruction time of the components. Therefore, even initial attempts of implementing BIM in maintenance, which is not yet the digital twin has proved its efficiency.

The practical benefits mentioned above are the actual evidences of the positive consequences of facility management digitalization. Application of similar approaches into the whole industrial asset including both real estate and production part can similarly improve search for information, maintenance time and other KPIs affecting the downtime of the production.

### *3.2. Role of information in asset management*

Rapid development of digital twin investigations in built environment also attract asset managers from economic point of view. An asset with digital twin is easier to manage and predict. At the same time an asset portfolio sometimes also requires information modelling on the upper level of built environment information modelling – GIS, for example in cases related to site selection [19,20].

Even though the research interest in the asset management field among the investigations mentioning BIM keeps on growing reaching almost a quarter by the year 2019 it is still almost two times less than the mentions of facility management as it can be obtained from the comparison with figure 2 in the previous subchapter. It can be explained by the fact that facility management is more related to technical management of the built environment and maintenance and the theory of digital twins starts adaptation to management of buildings from the technical part while the economic issues and management of assets adapts more slowly.

According to the graphs shown below the research interest in asset management among the articles mentioning BIM grows faster rather than in facility management. The owner of real estate asset as well as the owner industrial asset has an ability to own not only the asset itself but also the digital twin of it,

therefore potentially reducing management costs and also saving costs on information which was traditionally produced by the facility manager or the party responsible for the actual maintenance of the asset. Digital technologies provide an owner of the asset with fundamentally new possibilities of its cost management.

Recent studies on integrating digital twin concept in asset management studies [21] show following evidences: digital twin acts as a system lifecycle mirror, by predicting performances and long-term behavior of the system and by granting data digital continuity along the different lifecycle phases of the system. Another highlighted benefit is improved maintenance decision making. We consider a huge potential in creation of digital asset as it is able to add value to the industrial asset itself. For instance, banks, insurance companies and investors can evaluate all operating costs and the cost of possible renovations with a very high degree of certainty, and assess the likelihood of emergency situations.

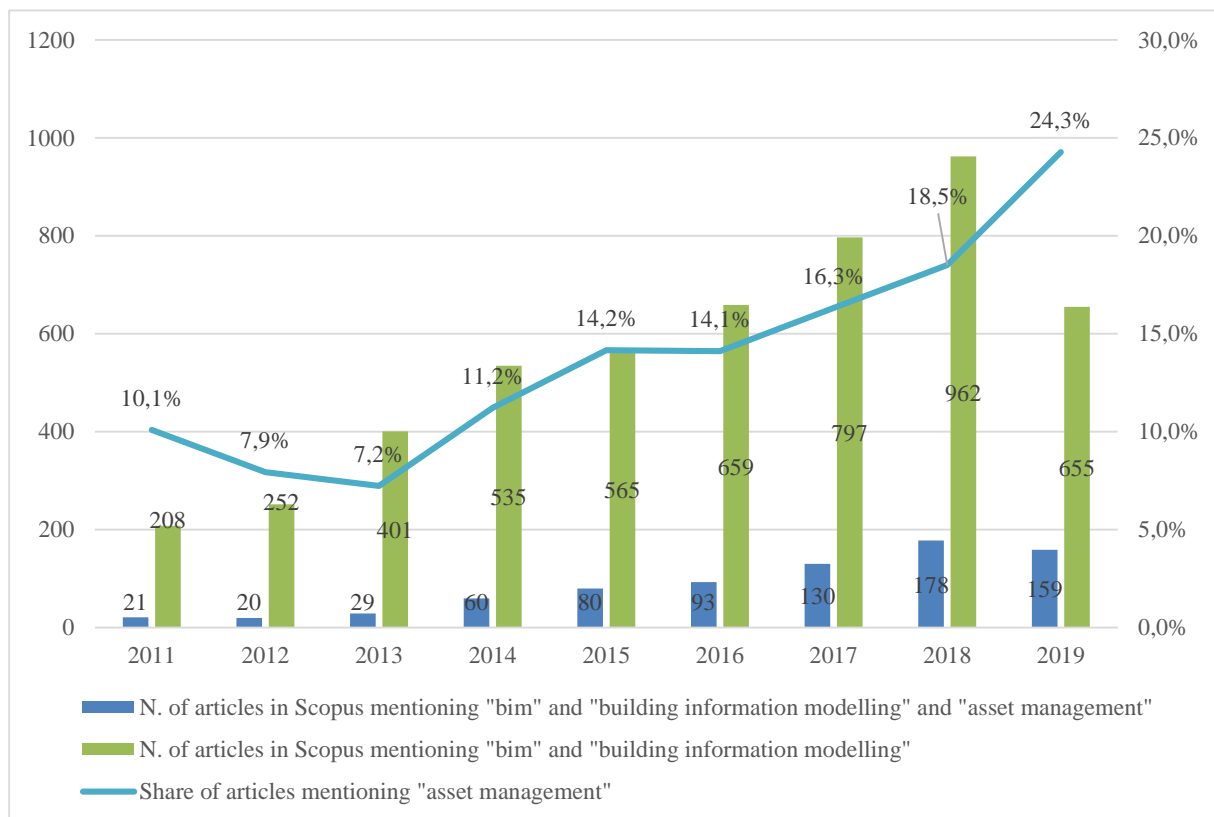


Figure 4. Research activity in topic of asset management among the articles mentioning BIM as of August, 2019

### 3.3. Role of information in property management

From the property management point of view the crucial goal is to minimize the downtime of the asset. Therefore, it becomes extremely important to have tools for efficient workspace planning and moving costs. Issues of BIM-models creation for existing buildings are widely discussed. [22, 23] According to Becerik-Gerber et al. [9] building information modelling technologies have huge potential in becoming such tool. The BIM model can be used as a space management tool as well as optimize moving costs. This will optimize the capitalization of the real estate asset and the use of space. In addition, rational space management can increase the productivity of personnel working in the building. The figure below represents the research interest in the topics of BIM among the article mentioning property management. Like in all the other cases, property manager is not interested in all the unnecessary data, which can be

generated using sensors or other tools, but only in useful information according to basic principles of digital twin.

The graph below demonstrates an increase in research interest in the topics of BIM but still less than in asset management case and much less than in facility management case. It can be explained by the fact that property management focuses on commercial use of real estate so the construction-related digital technologies such as BIM are less in the field of interest for property management specialists rather than facility management for example which deals more with technical maintenance of a real estate object.

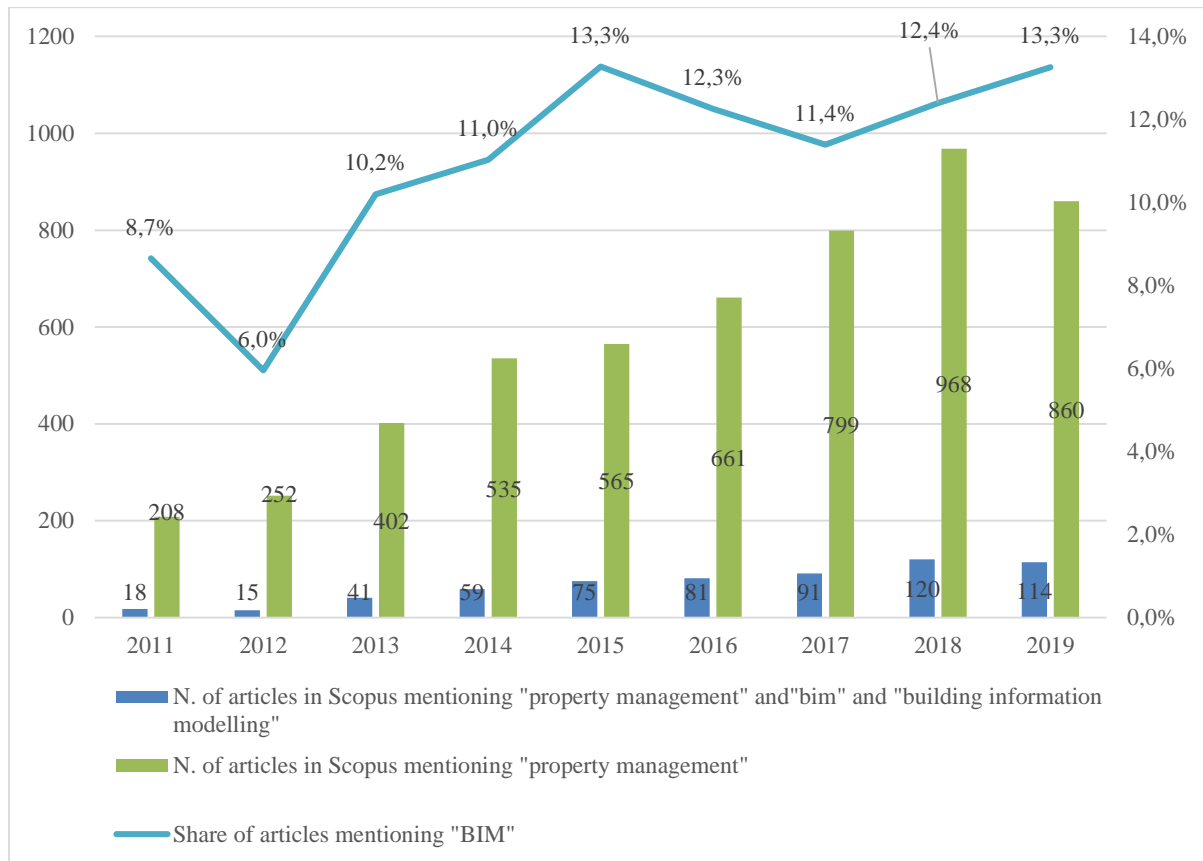


Figure 5. Research activity in topic of property management among the articles mentioning BIM as of September, 2019.

#### 4. Conclusions

Traditional understanding of the distribution of roles in building management has started to change with the emergence of building information modelling. The owner of the building is now able to purchase the building not only physically but also with the digital twin, consequently becoming the owner of information about the building. This new qualitative characteristic of an object becomes an asset itself. BIM model of the object associated with financial information about the object (the cost of construction, ownership, etc.), provides a possibility to explicitly and practically evaluate any decisions. The increase of transparency in building management with the emergence of BIM is going to lead to a situation when the producer is warning the owner about the failure but not reacting to it mostly as all the stakeholders are acting in the same open-book field.

Analysis of the literature revealed that there is a significant increase in research interest in BIM-related articles among the investigation connected with facility management and asset management. As BIM has started its way from design and construction stage initially accumulating savings in terms of capital expenditure, it is now only in the early stage of adaptation for the operation phase. Nevertheless,



the owners of assets which are mostly not quite informed about as-built BIM potential start to understand which advantages can it bring in terms of cost and time savings for operational expenditure.

Further research shall be focused on the practical applications for economic and BIM models integration. As the discussed topic lies on the intersection of several stakeholders' interest such as asset owner, facility manager, maintenance workers, actual users of real estate, etc. it is necessary to develop a unified model of interaction of all the interested parties in order to achieve proposed optimization of operational expenditures.

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