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OAJI (USA) = 0.350

SOI: [1.1/TAS](#) DOI: [10.15863/TAS](#)

International Scientific Journal Theoretical & Applied Science

p-ISSN: 2308-4944 (print) e-ISSN: 2409-0085 (online)

Year: 2023 Issue: 01 Volume: 117

Published: 17.01.2023 <http://T-Science.org>

Issue

Article



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ANALYSIS OF INTERNATIONAL EXPERIENCE IN ASSESSING THE EFFICIENCY OF BIM TECHNOLOGIES IN CONSTRUCTION

Abstract: *The technological process forces a person to create new inventions and compose new methods in all spheres of life. Real estate valuation is no exception - at the moment, the methodology of this industry is very outdated, which leads to controversial issues in some cases. So, for example, a building in a dilapidated state was offered to be bought at a price many times higher than its objective value.*

In addition, the authors analyze the effectiveness of this technology using the experience of other countries as an example. Consideration of such an issue of introducing BIM technologies in real estate valuation will greatly simplify the process of determining the cost of housing or premises. In addition, it will allow the potential buyer of real estate to receive complete information about the building, which makes the process of buying and selling real estate more transparent, as well as increasing profits and profitability, reducing costs, increasing productivity, and reducing the overall cost of the project.

Key words: *information model, building, real estate appraisal, real estate, foreign experience, application of BIM technology, BIM functions, purpose of BIM, building model, prospects for real estate appraisal.*

Language: *English*

Citation: *Mirisaev, A. A., Tursunzoda, J. I., Polvonov, D. S., & Sobirov, J. F. (2023). Analysis of international experience in assessing the efficiency of BIM technologies in construction. ISJ Theoretical & Applied Science, 01 (117), 439-445.*

Soi: <http://s-o-i.org/1.1/TAS-01-117-29> **Doi:**  <https://dx.doi.org/10.15863/TAS.2023.01.117.29>

Scopus ASCC: 2200.

Introduction

UDC 004.921

Currently, in many countries of the world (USA, Great Britain, France, Nordic countries, Singapore,

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South Korea, China, etc.), information modeling technologies are being actively introduced in construction. The scale of BIM implementation in these countries is explained, first of all, by the benefits from the use of this technology. These benefits are acquired at various stages of the project implementation and at various levels (at the level of an individual enterprise, industry and the state as a whole).¹

The results of the application of BIM are manifested in the form of high quality project documentation, information storage in a single information resource, improved information exchange and interaction between various participants in investment and construction projects, cost reduction at the construction stage, etc. All this leads to an increase in the economic efficiency of the implementation of projects for the construction of buildings and structures, including cost reduction. These benefits are manifested both at the level of an individual construction organization in the form of an increase in the level of profit and profitability, and at the state level by reducing the cost of facilities built under the state order and, accordingly, saving and more efficient use of state budget funds.

Due to the presence of significant advantages from the use of BIM at the state level, a number of countries have established conditions for the mandatory use of these technologies in the design and construction of facilities at the expense of the state budget. Similar requirements have been gradually introduced by government customers in the United States since 2003, and in a number of countries in Europe and Asia since 2007.

Materials and methods

In 2011, the UK announced a new construction strategy focused on achieving competitive advantage on the global stage. As part of this strategy, a methodically elaborated unified consistent program for the transition to information modeling technologies has been developed and is being implemented. As part of the program, the transition to the mandatory use of these technologies from April 2016 was prepared for all projects financed from the budget, including new construction, reconstruction, and overhaul. This decision, taken at the state level, ensured the accelerated pace of implementation of BIM technologies.

In 2012, in the US, more than 70% of construction market participants announced the use of information modeling technologies in their projects (data from McGraw Hill Construction), in the UK in 2016 - 54% (according to NBS, National BIM Report). According to Singapore's Building &

Construction Authority (BCA), since 2015, more than 80% of all construction projects have been carried out exclusively using BIM technologies. To date, all (100%) design organizations and about 70% of building contractors in Singapore are using BIM on their projects.

In January 2014, amendments were made to the European Public Procurement Directive, where all EU countries were recommended to use electronic forms of work, including BIM in construction, to increase transparency and efficiency in spending budget funds. Currently, the European Commission has organized and financed a working group on BIM (EU BIM Task Group) from representatives of state customers from countries that are members of the European Union. The purpose of the group's work is to develop common rules for all EU countries for planning and implementing state orders for design and construction contracts.

According to some foreign analysts, the introduction of information modeling technology can provide a significant reduction in the cost of construction of facilities financed from the state budget - by 25%, as well as a subsequent reduction in operating costs - more than 35%.

Consider the approaches used by researchers to assess the effects of the implementation of investment and construction projects using BIM in various countries. The analysis of such approaches will form an approach to the analysis of the effectiveness of BIM in Russia.

DISCUSSION

UK EXPERIENCE

An analysis of projects implemented by British companies using BIM technologies made it possible to identify various kinds of effects. The main ones among them are:

- significant cost savings at the construction stage;
- potential savings in operating costs;
- Improving planning accuracy and transparency;
- reduction of time losses for intra-company approvals;
- well-coordinated team work;
- the ability to use innovative design solutions;
- ensuring a common vision of the project goals by all its participants.

According to the consulting company Sweett Group, which analyzed a number of projects implemented using BIM and similar projects implemented in the traditional way, the use of information modeling technologies allows:

¹ REPORT: Assessment of the use of BIM technologies in construction Results of a study of the effectiveness of the use of BIM

technologies in investment and construction projects of Russian companies. Moscow - 2016. 47 pages.

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➤ save on costs about 20% of the total (confirmed in pilot projects implemented as part of the state strategy for the transition to BIM in 2012-2015);

➤ reduce the duration of work by 10-12%, which also leads to a reduction in overhead costs.

In the UK, the need to use BIM technologies to increase the competitiveness of national construction companies in the international arena and achieve global leadership in the field of digital construction has been recognized at the state level. Thus, in 2014, the UK Cabinet of Ministers adopted an updated version of the strategy for the development of the construction industry until 2025 (the first version of the strategy came into effect in 2011). The central goals of the updated strategy were to reduce the cost of implementing investment projects by 33% and reduce the duration of the construction process by 50%.

The official position presented in the strategy is that now, with the increasing complexity and information richness of investment and construction projects, sustainable construction becomes possible only through the introduction of BIM and digital technologies in general, ensuring a reduction in the duration of the project and an increase in its economic efficiency. At the same time, BIM and digital technologies are perceived as the main tool for increasing productivity and reducing risk in the construction sector.

US EXPERIENCE

The United States is one of the countries where not only the use of BIM technologies by organizations in the investment and construction sector is rapidly increasing, but various kinds of studies on the effectiveness of the use of BIM are being conducted, in which the main benefits and risks of switching to information modeling technologies are assessed.

Based on the analysis of various studies of the experience of using BIM in the United States, the main advantages of the technology can be identified:

- visualization (3D);
- Reduction of terms of formation of project documentation;
- parametric linkage of elements of the information model, allowing for automatic sequential adjustment of the project when one of the elements changes;
- automated search and correction of collisions;
- Improving the accuracy of scheduling;
- Increasing the accuracy of cost planning;
- convenience of accumulation and storage of information about the project;
- speed and ease of information exchange about the project between its participants;
- the ability to accumulate developments that

allow multiple use and the relative ease of making changes to the project;

➤ ability to control and reduce costs at the stage of operation;

➤ ability to control environmental performance;

➤ Automated release of project documentation.

In 2007, Stanford University conducted a study of 32 large projects using BIM. Based on the results of the study, the following data were obtained on the effect of the use of information modeling technologies:

➤ Reducing the level of unplanned costs up to 40%;

➤ accuracy of project cost calculation within 3% (without BIM — up to 10%);

➤ Reducing the duration of the formation of estimate documentation - up to 80%;

➤ Saving up to 10% of the contract value due to the high quality of the project and the elimination of conflicts;

➤ Reducing the duration of the investment and construction project to 7%;

Such high results are confirmed by the data of many cases. For example, the construction of the Hilton Aquarium, Atlanta, Georgia (total project cost \$46 million) was carried out using BIM.

During the work on the investment and construction project, the following benefits were achieved:

➤ savings of 600 thousand US dollars due to timely detection and elimination of collisions;

➤ savings of 1,143 hours of working time due to a high level of coordination (savings are estimated at 600 thousand US dollars);

➤ 20% savings on material costs;

➤ As a result, a "net savings" of 200 thousand US dollars was obtained. This amount of "net" savings is calculated on the basis of the total amount of savings, taking into account the assumption that part of the costs could be avoided by correcting errors in traditional ways.

Another example of the effective application of BIM is the Colorado Health Sciences Center project (11-story building, 540,000 sq. ft., \$201 million). The use of information modeling technologies made it possible to obtain the following results:

➤ reduction of requests for changes (RFI) by 37% (up to 74% in various phases of construction);

➤ reduction in the duration of construction and installation works by 2 months compared to the plan;

The reduction in the scope of work for the project team is estimated at 50%.

A study conducted by McGraw-Hill Construction in 2012 found a relationship between the level of benefits derived from the use of BIM and the level of experience in BIM (Table 1):

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Table 1. Difference in BIM performance for novice users and "experts"

Benefit direction	Beginners	"Experts"
Profit Growth	7%	43%
Reducing the time of routine operations	14%	58%
Reducing the number of rework	23%	77%
Facilitate repeat work with clients	19%	61%
Offer of new services	28%	72%
Increasing staff productivity	46%	71%

The results of the study show that with experience in BIM, the level of efficiency of an organization gradually increases.

McGraw-Hill Construction also investigated the issue of assessing the ROI (return on investment). This indicator is one of the most important when making investment decisions. It shows the effectiveness of investments and is calculated as the ratio of profit to the cost of investments. The calculation of this indicator is needed in order to understand the level of expected benefits from investments.

The study revealed that not all enterprises-respondents calculate this indicator: only 21% of respondents reported that the enterprise has assessed the impact of BIM on ROI, the rest measure and evaluate other factors (affecting ROI) - reducing labor costs, reducing the duration of execution works.

It was revealed that the value of ROI depends on the experience with the use of information modeling technologies. So, due to the fact that the transition to a new technology always (this applies not only to BIM, but also to any technical or managerial innovations) causes a temporary decrease in efficiency (resistance to change, a drop in productivity, the need to gain experience with new technology to restore the pace of work etc.), the corresponding dynamics will be typical for the ROI indicator.

Over time, productivity and efficiency rises to and even exceeds the original level.

Key findings from a study by McGraw Hill show:

- change in ROI;
- 87% of experienced BIM users who participated in the study see a positive trend in ROI;
- 93% of users believe there is potential to get more value out of it in the future;

- 12% of respondents reported a decrease in ROI.

At the same time, there is a correlation between experience in BIM and the level of economic efficiency:

- organizations with more experience with BIM indicate higher returns;
- reduction of project duration and, accordingly, costs. More than half of respondents (55%) noted that BIM helps to reduce costs by up to 50%.
- 58% of those surveyed reported a 50% reduction in project duration;
- 48% of respondents note a reduction in the duration of the design phase, 31% believe that this period has become longer;
- Most of the respondents note a significant improvement in the quality of project documentation.

EUROPEAN EXPERIENCE

McGraw-Hill Construction also conducted research on the effectiveness of the use of BIM technologies in European countries. It was found that in 85% of cases the use of BIM was provoked by the requirements of the customer, and in 76% - by the desire to save time and financial resources.

Among BIM users in Europe:

- architects — 47%;
- engineers — 38%;
- related specialties - 24%.

According to the results of the study, 41% of respondents believe that after the introduction of BIM, their profits increased; 55% talk about reducing the cost of the project (of which 39% claim to reduce the cost of the project by more than 25%); 21% report an increase in labor productivity, which leads to a decrease in the number of staff involved. Other results of the study are presented in table. 2.

Table 2. Results of a survey of representatives of the construction industry in Europe

Index	Number of respondents' answers
Reducing Errors	41%
Improving communications between project participants	35%
Improving the company's image	32%

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Reducing the number of design changes	31%
Reducing the cost of construction	23%
Growth of control over expenses, growth of accuracy of forecasts	21%
Reducing the overall duration of the project	19%
Entering new markets	19%

EXPERIENCE SINGAPORE

Singapore is one of the leaders in the use of BIM not only in Asia, but throughout the world. This was facilitated by the fact that Singapore very quickly realized the potential of information modeling technology in construction, and promptly deployed government policies to support its implementation, including financial support for industry organizations implementing BIM. (In 2015 alone, SGD 450 million was allocated for this purpose).

In 2010, BCA (Building and Construction Authority) of Singapore, which manages the construction industry and acts as a ministry, developed a BIM roadmap for Singapore (Singapore BIM Roadmap). The main goal of the roadmap is to increase construction efficiency by 25% by 2020 through the use of information modeling and digital manufacturing technologies. It is also planned to use innovative technologies to reduce the number of low-skilled workers (migrants) at construction sites. And one more specific goal of Singapore is to become a world leader in the speed of project appraisal and issuance of building permits.

Research conducted in 2011 showed that at the time the BIM roadmap was approved, the technology was not yet widespread in Singapore: more than 50%

indicated that only about 20% of their projects were implemented using BIM; 12% of the surveyed companies used BIM for 100% of their projects. (Recall that all design organizations in Singapore are required to work in BIM to pass the examination of projects over 5 thousand square meters).

About 42% of respondents do not track ROI indicators from the implementation of BIM technologies. Among the rest, 24% of respondents see a significant increase in profitability due to the use of BIM, 26% say a slight increase in the indicator, 8% see a decrease.

In terms of benefits at the project level, the most commonly cited benefits of BIM are:

- availability of more accurate information for management (72%);
- reduction in the number of errors (70%);
- improved communication between project participants (60%).

From a company-level benefit point of view, the most commonly cited benefits are:

- improvement of the company's image (82%);
- strategic competitive advantage (66%).

Other research results that quantify the benefits of using BIM technologies are presented in Table 3:

Table 3. Results of a survey among the construction industry in Singapore on the benefits of implementing BIM

Index	Dynamics of the indicator provoked by the introduction of BIM
Project Cost Reduction	10%
Staff reduction	12%
Reducing the cost of organizing information storage	14%
Increasing process automation	16%
Increasing profit	16%
Project Risk Reduction	24%
Improving Planning Accuracy	26%
Improving site security	26%
Reducing the duration of the project	32%
Reducing material costs	34%
Improved process integration	40%
Reducing the number of RFIs	46%
Reducing the number of rework	58%

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Result

An analysis of international experience in evaluating the effectiveness of the use of BIM technologies in construction has shown that in the countries that are leaders in the field of information modeling technologies implementation, quantitative and qualitative effects of BIM implementation are observed.

Research results show that the use of BIM contributes to the growth of profits and profitability, reducing costs, increasing productivity, and reducing the overall cost of the project.

In addition, there is a decrease in the number of requests for information and requests for changes, as well as rework on site, which also reduces the level of costs.

In addition to purely economic benefits, the use of BIM leads to many qualitative benefits that affect the growth of the competitiveness of the enterprise:

- increasing process automation;
- reduction of project risks;
- improving safety at the facility;
- improving the quality of the project;
- Improving the efficiency of communications between project participants.

Conclusion

In general, it can be concluded that the multiplicity of effects of BIM application and their positive orientation should be applied to the achievement of high results in the implementation of BIM and the wide dissemination of technology in the leading countries, which became possible, first of all, due to state support and the presence of a state policy with clearly defined goals. and developed activities in their further implementation of a particular country.

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