Research of the problems of BIM technologies implementation in the investment-and-construction projects of the Russian companies

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Abstract. The construction industry as a significant part of national economy, develops in the direction of accomplishment of the purposes and matters of the state development, connected with improving of the Russian economy competitiveness (first of all, due to the increase in its efficiency) as well in the direction of the digital transformation. The solution of the digital transformation issues in the industry as well as the increase in the efficiency of investment-and-construction projects implementation is in the plane of implementation and distribution of the technologies of information modeling (BIM). In spite of the fact, that orientation for BIM at the national level was chosen in 2014, the industry still shows the signs of unavailability to mass transition to BIM; that is connected with some problems and obstacles. The authors of this article conducted the research in the form of poll, directed to identification of such factors and their importance. 180 respondents (representatives of the enterprises and organizations, authorities, professional associations, whose activity is connected with the implementation of investment-and-construction projects, became the participants of the research. During the processing of the research results the hypothesis was made, that the type of activity of the organization has an impact on its assessment of the importance of the factors, interfering BIM implementation. The purpose of the analysis, which results are provided in this article, was the verification of this hypothesis. The conclusion is drawn on the basis of the received results, that the type of the organization activity has an impact on its assessment of the importance of factors (problems), interfering BIM implementation. Thus, the hypothesis of the research was confirmed. At the same time, it was revealed, that the respondents from the Universities group highly appreciate the problems and obstacles of BIM implementation most of all, in comparison with other participants. The respondents from the Investors group, on the contrary, are inclined to a lower estimate of the problems importance.

1 Introduction

Technologies of information modeling in construction (BIM – from term Building Informational Modeling) is the set of modern methods of the investment project management

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during all the stages of its lifecycle, at which the creation of an information model of the construction object becomes the basis for such management. According to the construction rules 2018 333.1325800.2017 Set of rules "Information modeling in construction. Rules of forming of an information model of objects at various stages of lifecycle", approved in Russia in 2018, the information model is understood as "the set of the documents, submitted in electronic form, graphic and text data on the construction object, placed in the environment of the general data and representing a uniform reliable source of information on the object during all the stages or separate stages of its lifecycle". Respectively, the information modeling is understood as the process of creation of such a model both for the object under construction, and for complete objects. The interest in BIM had increased in recent years [1] and took an important place in the professional and scientific information field [2]. It is caused first of all by numerous benefits of BIM application for various participants of the investment-and-construction project, including:

- substantial increase of the project documentation quality, that leads to the reduction of the idle times, connected with refining of information, need of the project modification and as well as with alterations on the object and thus, reduces the costs and finally increases the quality of construction [3];
- creation and use of a uniform digital source of information on an object during the whole lifecycle (for all the project participants, taking into account the limitation of access rights to various information categories) [4]. That leads to a huge row accompanying, but not less important benefits, connected with the possibility of check on collisions during design, ensuring uniform interpretation of the project purpose for its various participants, lack of sources of doubtful or outdated project information, accumulation of data on the object, that considerably increases the quality of its operation, etc.;
- increase in cost efficiency of construction and operation of the object as the result of more effective use of all types of resources (both material and labour resources, and, as the result, financial resources) as well as the increase in the planning accuracy [5].

The effective use of resources is interesting to any investor and, first of all, for the state which is traditionally a customer, significant for the market in many countries. In such countries as Great Britain and Singapore the transition to BIM was seriously supported by the state; the requirement of implementation of the state order project with the use of BIM [6, 7, 8] became its basis and that resulted in considerable results, connected both with the level of BIM implementation at the enterprises of the industry, and with the economic effect, gained as the result of its use [9]. Moreover, the countries implementing the plans of BIM implementation, developed and approved at the state level include Netherlands, Sweden, Germany, Ireland, Kazakhstan, Canada, Italy, Spain, France, etc. [10, 11].

Russia also took a course on the of BIM implementation in 2014 and held the events, connected with preparation in the field of the regulatory framework and infrastructure (connected with examination passing, implementation of the state construction supervision, etc.) progressively. Since January 1, 2022 the use of BIM for all the capital construction projects with the state participation had to become obligatory according to the Order of the Government of the Russian Federation of 05.03.2021 No. 331. In this regard the Moscow State University of Civil Engineering together with National Consolidation of the Organizations in the Sphere of Technologies of Information Modelling Association organized an express poll, devoted to the identification of the main problems of transition to technologies of information modeling, of such implementation, before the implementation, in the end of 2021. 180 respondents (representatives of the enterprises and organizations, authorities, professional associations whose activity is connected with the implementation of investment-and-construction projects participated in the poll. Its results were summed up in January, 2022 [12]. They proved, that obstacles and problems, which the Russian enterprises

of the investment-and-construction sphere face during BIM implementation, can be conditionally divided into 2 groups: external and internal factors.

The internal obstacles include: the absence of qualified personnel (as the most significant of noted by respondents a problem) directly in the organization, the lack of financial resources for the acquisition of the equipment and software, complexity of independent implementation and the high cost of the consultants services, the lack of requirements of the BIM application from investors and customers and also the resistance to changes which takes place both from non-management employees, and from owners and the managers, which got used to traditional (but already outdated and insufficiently effective) methods of the investment-and-construction projects management.

Obstacles of BIM implementation, external in relation to the enterprises of the industry include: the deficiency of qualified personnel in the labour market, unpreparedness of customers, investors and other contractors to interact with the use of the information model, the high implementation cost, shortcomings of the system of state standards, shortcomings of the regulatory base, complexity in examination passing and shortcomings at the software market.

The revealed obstacles to BIM implementation could become a reference point for the adjusting influences from the state of professional community for gradual decrease in their importance.

However, at the beginning of 2022 the decision on the delay of the requirement of the BIM application in construction of facilities was made in connection with the set of problems of implementation according to the state order for spring of 2023. Some experts claim, that such delay was discussed in advance [13].

The results of application of additional methods of the analysis in relation to the data collected at the end of 2021 are provided in this article.

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So, the identification of interrelation between the opinion of respondents on the importance of obstacles to BIM implementation and the type of its activity became the research purpose which results are provided in this article.

The representatives of the enterprises and organizations, authorities, professional associations, whose activity is connected with the implementation of investment-and-construction projects, the informed on the BIM features and showing the interest in the perspective connected with BIM implementation, became the object of the research.

Identification of the lack of interrelation between the type of activity of the organization and the allocated problems and obstacles of BIM implementation became the object the research.

2 Materials and Methods

Within their research the authors studied the sources, containing information on the main problems and obstacles of BIM implementation in construction in various countries, including the research, devoted to the analysis of benefits and barriers of BIM implementation in Russia [14, 15, 16].

It should be noted, that according to the results of the literature analysis it was revealed, that problems of implementation of the technologies of information modeling in the different countries repeat and crossed each other; sometimes one or several factors come to the

forefront, depending on the approach to BIM implementation in the country (in respect of the state policy), distribution of technologies, etc. The main barriers of BIM implementation, which were revealed during the literature analysis, include the following:

1) lack of support from top management; that is demonstrated in the conservative approach to the project management [17, 18, 19]. Availability of such support by many researchers is specified as a significant factor of successful BIM implementation at the enterprise [19, 20];

2) high cost of BIM implementation, caused by high initial investment costs on equipment procurement, software and personnel training as well [18, 21, 22, 23, 24, 25, 26]. Proceeding from the quantity of reference to the cost in the analysed sources, this barrier should be named as the most widespread and significant one;

3) lack of education and skills necessary for work with BIM both directly among the staff of the organizations, and in the labour market in general [18, 19, 27, 28]. The deficiency of qualified personnel is also noted as a burning matter and leads to some obstacles to BIM introduction (points 4, 5 and 9);

4) slow adaptation of employees of all levels to work with BIM [21], causing the necessity to spend time on training [18, 19, 26], skills, organization of activity and interaction with other staff or representatives of other organizations, etc. As the result, extremely high load of the personnel take place;

5) temporary labour productivity decline [29], connected both with the need to spend time for training and skills for personnel, and with the decrease in rates of work, normal for transition to new technologies, during the experience accumulation period. Besides, during BIM introduction within the transition period the employees often should carry out double work, e.i. to perform the necessary functions in the usual type and to duplicate on BIM-platforms. Such labour productivity decline alsi leads to some decrease in the cost efficiency of the enterprise activity [26];

6) lack of the state support and direct motivation to BIM introduction from the state [22, 23, 25, 30] as well as lack of demand for project implementation by the means of BIM from private investors [18, 24];

7) problems of functional compatibility [18, 23, 25, 27, 30, 31, 32, 33] and fragmentariness of the information model parts, created by the means of various software, various contractors, etc. This obstacle is noted by many authors, therefore, also it is to be considered as extremely significant. Data of an information model are developed by various employees (who are often representatives of various organizations) by the means of the different types of software, directed to accomplishment of certain tasks. Respectively, there are always questions, connected with transfer and integration of data, their use, etc. In addition to the technical aspect of the question, there can be problems, connected with interaction of contractors, establishing interorganizational communications, etc.;

8) lack of norms, standards and tools of BIM implementation [18, 23, 27], focused on the domestic market of each specific country. The matters of the legal and regulatory base, procedural matters are included;

9) resistance to changes in the organization, arising at various levels [18, 24, 32] and connected with the need to study something new instead of work in the usual and familiar format, risk of the increase in labour loading, concern not to cope with work in a new format, changes in the organization culture. As we know, resistance to changes is followed by low motivation to transition to new methods of work [19] and often can be a significant factor of the decrease in the efficiency of new technologies implementation;

10) lack of standards of the use of BIM [18, 24] and accurate methodical recommendations on implementation for the organizations directly [21];

11) other obstacles, such as lack of awareness of BIM [18, 22, 24], matters of determination of the detail level in projects of various scale [34], feature of contracts among the project participants [18].

So, the analysis of literature sources proved the availability of a wide range of obstacles to BIM implementation in construction of different countries. And as a rule, these problems are not unique for any specific country, specialists face them in different countries. However the intensity of the influence of such problem within the distribution of BIM can differ.

The obstacles to BIM implementation in Russia in general coincide with the list of barriers, which were also revealed within during literature analysis. It is confirmed by the results of the researche conducted earlier.

As it was already noted, the data, collected within the express poll in the end of 2021 on the site of the First Joint Eurasian Congress "BIM Community. 2021. People. Processes. Technologies", were taken as a basis for carrying out the analysis. A short questionnaire, which included the question of so-called "passport", necessary for structuring the respondents, belonging to different organizations of this or that type of activity, was created for holding the poll. More detail data on the research tools (questionnaire), characteristics and quality of selection, methods of collection of information are provided directly in the report on the research. The report is published and avaliable in open access [12].

180 questionnaires, completed by different participants of investment-and-construction projects were received as the survey result. The structure of the selection, received as the result of data collection, is provided in Table 1.

Table 1. Information on the structure of the selection on types of the respondents' organizations activity.

Type of the respondent's organization activity	Share, %
architect	1.7%
designer	27.2%
general contractor, contractor	2.8%
builder	3.9%
public/local government office	8.3%
developer	5.6%
investor	2.2%
authority	2.8%
educational institution	27.2%
BIM software developer	6.7%
producers and suppliers of construction products and equipment	2.8%
technical customer	4.4%
operating organization	1.7%
others	2.8%

Source: Report on the results of the research of the problems of implementation of technologies of information modeling in investment-and-construction projects in the Russian companies [12].

Proceeding from the research purpose, directed to the identification of interrelation of the type of activity of the respondents enterprises, which noted the main obstacles and problems of BIM implementation, the research method was defined. Factor analysis of the respondents' answers, concerning the problems and obstacles to BIM implementation at the Russian enterprises of the investment-and-construction sphere became the method. At the same time, the type of activity of the organization was chosen as the factor, capable to influence the determination of the main difficulties and obstacles during BIM implementation.

Respectively, the hypothesis of the research can be formulated as follows: the type of organization activity has an impact on its assessment of the importance of the factors, interfering BIM implementation and the main risks of implementation.

In order to check the hypothesis we need to estimate the answers of each group of respondents, allocated by the form to activity, separately. However, the received distribution of respondents accordong to types of activity at the total amount of selection in 180 respondents does not allow us to perform check of the hypothesis for all the specified types of activity directly, as only 2 groups of respondents have significant weight: designers and educational institutions. Other groups of respondents are small (from 1.7% to 8.3%), and factor analysis of their answers will not yield any significant results.

In spite of the fact that there is a great number of participants of investment-and-construction projects, some of them perform similar functions and/or have similar interests. Relying on that, the respondents were united in the integrated groups for the research objectives. Such integration allowed us to use more representative data, when carrying out factor analysis. The scheme of integration of respondents in groups for the research purposes is provided in Table 2.

Table 2. Integration of groups of the respondents according to similar functionality.

Type of the respondent's organization activity	Share, %	Type of the respondent's organization activity	Share, %
architect	1.7%	Designers and architects (conditional name is "designers")	28.9%
designer	27.2%		
general contractor, contractor	2.8%	Builder, technical customer, general contractor, contractor (conditional name is "contractors")	11.1%
builder	3.9%		
technical customer	4.4%		
public/local government office	8.3%	Public/local government office and bodies of authority and management (conditional name is "state")	11.1%
authority	2.8%		
developer	5.6%	Developers and investors (conditional name is "investors")	7.8%
investor	2.2%		
educational institution	27.2%	Educational institution (conditional name is "universities")	27.2%
BIM software developer	6.7%	BIM software developer for (conditional name is "software developers")	6.7%
production and delivery of construction products and equipment	2.8%	Production and delivery of construction products and equipment, operating organization, other types of activity (conditional name is "others")	7.3%
operating organization	1.7%		
others	2.8%		

Source: Created by the authors.

So, consolidation of architects and designers in one group which made 28.9% of the general size of population as a result of such consolidation is quite logical.

Builders, technical customers, general contractors and contractors (totally a little more than 11%) were decided to form one more group. Their activity is connected with direct implementation of the investment-and-construction project on the building site. It is possible to call them contractors of the project and thus to unite them in the group of the respondents, having similar interests and presumably, similar views on the problems of BIM implementation.

The respondents, who were the representatives of authorities as well as public and local government offices (except for educational institutions), were united in group with the conditional name "State", assuming that their opinion will reflect the position of the state on

matters in point. This group made up 11.1% of the total selection. The respondents, who were the representatives of the educational organizations created a separate, significant group (27.2%) "Universities".

Developers and investors were also united in group "Investors" with a total weight of 7.8%, owing to proximity of their interests.

Software developers made up 6.7% of the selection, and were not united with other survey participants in any group for the further research. That is because of their specific functions and interests: they are not direct participants of investment-and-construction projects, however they are interested in the perspective, connected with BIM implementation, as the producers of the software, who realize some tasks during creation and subsequent use of an information model.

Other respondents, including representatives of the organizations which are engaged in production and delivery of construction products and equipment as well as operating organizations were united in group with the conditional name "Others" and excluded from further review within this research. Interests and functions of the respondents entering into this group differ considerably and the result received during the analysis will not have any value in the scientific or practical aspect.

Then each of the integrated groups was checked for the availability of deviations in answers to the questionnaire questions from the general result. The following operations were performed:

1) assessment of distribution of answers to the questionnaire questions among the respondents of each allocated group was carried out;

2) assessment of the rejection of answers of respondents of each allocated group from distribution of answers of the whole selection was carried out;

3) significant deviations, allowing to draw the conclusion on availability of interrelation among the answers of the respondents and the type of the activity of the organization, which they represent, are revealed.

The research is conducted in relation to the assessment by the respondents of the effectiveness of measures of state regulation of implementation of information modeling and the importance of the internal and external factors, interfering implementation and effective use of the technologies of information modeling in Russian companies.

3 Results

It was offered to the respondents to estimate the effectiveness of the measures of state regulation of implementation of information modeling. The distribution of average assessment by the groups of respondents is presented in Figure 1.

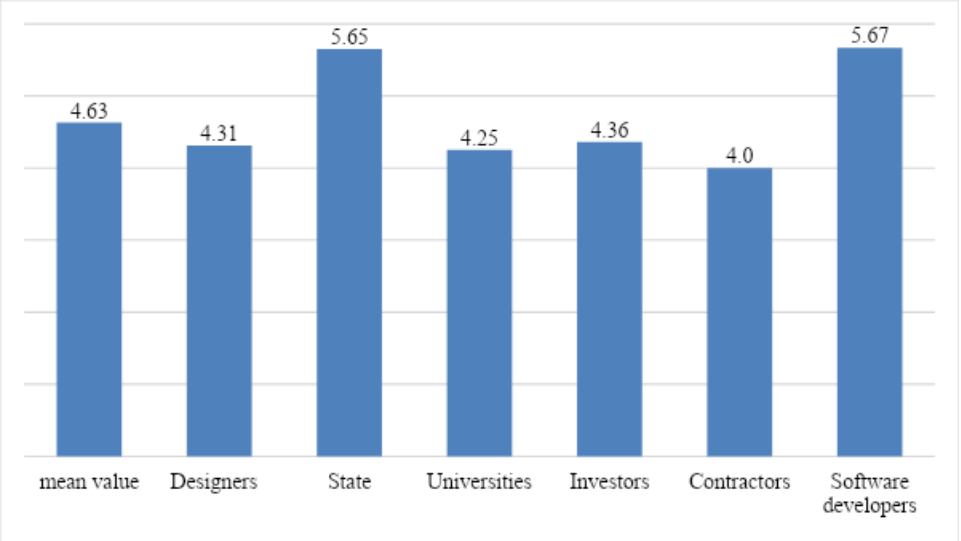

Fig. 1. Assessment of the effectiveness of state regulation measures of BIM implementation by the respondents (in points from 0 to 10): mean values for the groups of respondents. Source: "Created by the authors according to [12]".

Average efficiency of the measures of state regulation for BIM implementation made up 4.63 points (at the opportunity for respondents to give mark from 0 to 10 points). However, the analysis of average assessment, made by different groups proved, that the representatives of only two groups estimate the effectiveness of state regulation above mean value. They are the representatives of the "State" group (that it is possible to consider the results expected) and the representatives of the "Software developers" group (their assessment was 1 point higher than the average assessment for the selection). Other groups of respondents estimated the effectiveness of measures of state regulation of BIM implementation more modestly, and the lowest point (4.0 points on average in the group) is revealed in "Contractors" group. That demonstrates, that the respondents from the "Contractors" group face problems of implementation most often. The solution of such problems is anyway found in the sphere of state regulation: shortcomings of the regulatory base and the system of state standards, matters of passing of state examination.

The question of the importance of some obstacles of BIM implementation, divided into the factors of external and internal environment, was the key questions of the research. It was offered to the respondents to estimate the importance of some factors, internal in relation to the enterprises of the investment-and-construction sphere, interfering BIM implementation in points from 0 to 10, where 0 meant, that the factor is absent as the problem and 10 points proves the critical value of the obstacle. Mean values of the received results are graphically presented in Figure 2.

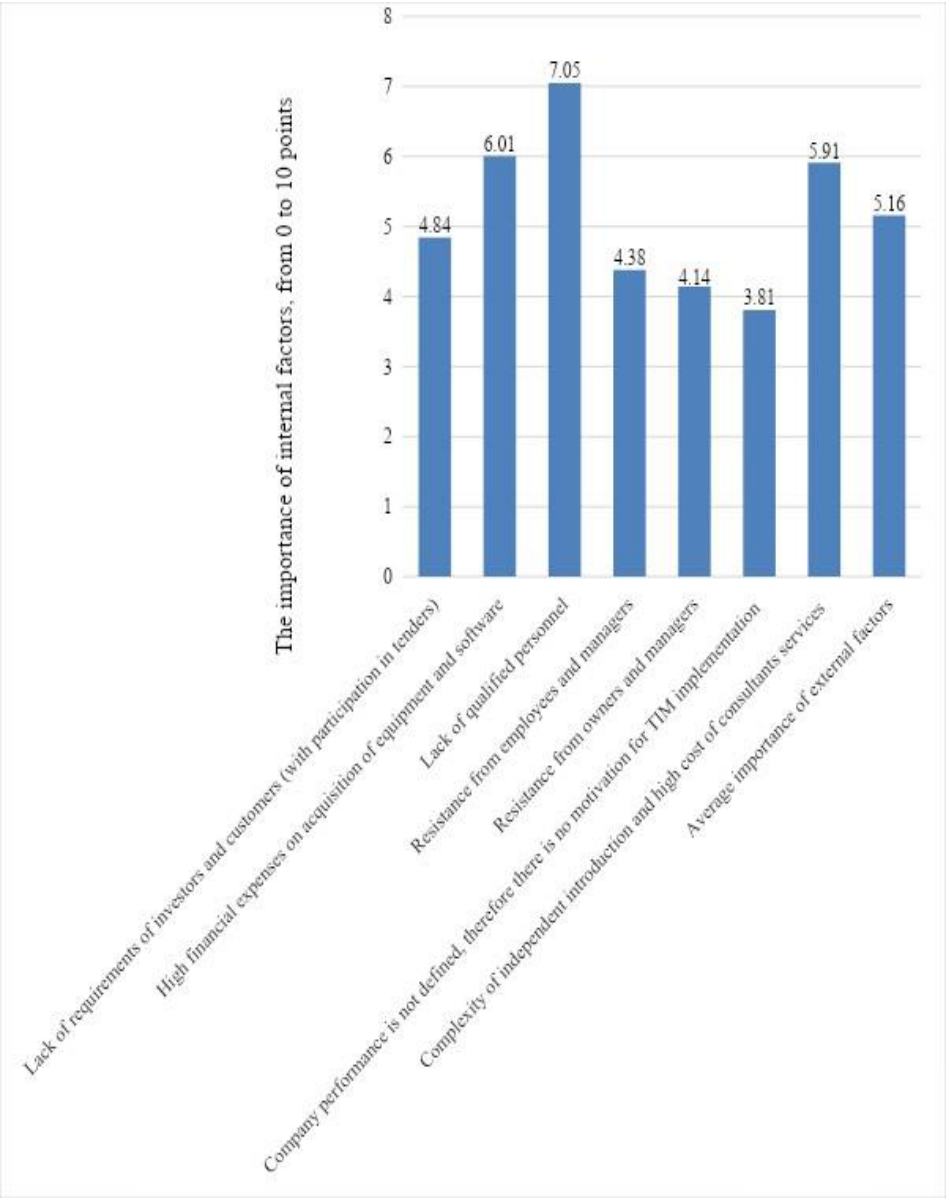

Fig. 2. Assessment of the importance of the internal obstacles (in relation to the organizations of the investment-and-construction sphere) for the BIM implementation by the respondents (in points from 0 to 10): mean values for the selection in general. Source: "Created by the authors".

The most significant problem, according to respondents, is the absence of qualified personnel. This problem is declared as critical at all possible sites (meetings, conferences, round tables, etc., devoted to this problem) therefore, it is possible to call such a result expected. Besides, according to the respondents, direct matters of implementation (the need to incur significant financial expenses on acquisition of equipment and software as well the complexity of independent introduction along with high cost of consultants services) have high importance.

The complexity of independent implementation is connected with the fact, that BIM implementation assumes not only the use of new instruments of work (new software), but also the fundamental change of a set of business processes both in the organization, and in interaction with contractors.

We consider the importance of internal factors for the groups of respondents. The results of the assessment are presented in Table 3.

Table 3. Assessment of the importance of internal (in relation to the organizations of the investment and construction sphere) obstacles of BIM implementation (in points from 0 to 10): mean values for the groups of respondents.

Internal reasons	Average importance of internal factors	Higher education institutions (Universities)	State	Investors	Contractors	Designers	Software developers
Lack of requirements of investors and customers (with participation in tenders)	4.84	5.08	5.55	3.00	5.42	4.47	5.75
Huge financial expenses on acquisition of the equipment and software	6.01	7.08	5.60	5.64	5.33	5.94	3.67
Absence of qualified personnel	7.05	7.55	7.85	7.29	7.50	6.49	6.58
Resistance from employees	4.38	5.00	4.40	4.36	3.83	3.76	5.58
Resistance from owners and managers	4.14	4.73	3.80	4.07	4.17	3.78	3.33
Uncertainty of the company performance, therefore there is no motivation for the implementation	3.81	4.39	4.80	3.64	2.83	3.49	2.92
Complexity of independent implementation and high cost of the consultants services	5.91	6.43	7.75	4.07	5.42	5.65	5.50

Source: "Created by the authors".

It is interesting to note, that the respondents from the "Universities" group are inclined to estimate the importance of the pointed out factors of the internal environment more highly in comparison with an average value. Such results were demonstrated for all the stated factors.

The obstacle, connected with the lack of requirements of investors and customers on the project implementation with application of BIM, is estimated at the average level (about 5 points) by all the groups of respondents, except for "Investors" (the result of this group is 3 points). The survey participants from "Investors" group probably reflected their point of view in the answer in this case. And, as it was specified, the feature of the created selection is that all the respondents are anyway interested in the matters of BIM implementation. That is there were such representatives of the "Investors" group among the respondents, who make demands for project implementation with BIM application. However, all other groups of respondents noted much higher importance of this obstacle to BIM implementation, probably, because they rather often face this problem in the activity during interaction with investors and developers.

The factor of high finance costs on acquisition of equipment and software is noted at the level above than average (more than 5 points, on average 6 points with fluctuations for the allocated groups of respondents). It is noted by all the respondents, except for "Software developers" group. Thus, the representatives of this group do not consider the high cost of the products to be an obstacle to BIM implementation.

According to the survey result, the absence of qualified personnel is the most significant internal obstacle to BIM implementation. The importance of this factor is estimated on average (at the level from 7.3 to 7.9 points) in groups "Universities", "State", "Investors" and "Contractors". The importance of this factor appeared to be insignificantly below for the "Designers" and "Software developers" groups (6.5 points and 6.6 points respectively). It is probable, that the sharpness of the problem of absence of qualified personnel gradually begins to decrease among designers, as designers stand in vanguard of BIM development. Thus, the number of specialists grows in the sphere of BIM quicker among designers, than among other project participants.

Resistance from (1) employees, and (2) from owners and managemers is also noted as a problem. Its importance is at the level slightly below than average (4.38 and 4.14 respectively for the selection on average). Fluctuations of the indicator among the groups are insignificant, resistance from employees is estimated as a little more problematic. It is interesting that in the "Contractors" group resistance from owners and managemers came with small overweight to the forefront (4.17 points) in comparison with the personnel resistance (3.83 points). The results for the "Software developers" group are interesting too; they estimate the importance of resistance from employees more than resistance from owners and managers with a great separation (more than 2 points - 5.6 and 3.3 points respectively). Proceeding from that, it is necessary to assume, that the representatives of this group face resistance from employees rather often; possibly, during software implementation in various organizations.

The assumption, that BIM does not influence the company performance, and therefore the organizations have no motivation for its implementation became the following probable obstacle to BIM implementation. This factor has the smallest value from milestones of the allocated factors. At the same time, it has the greatest value according to representatives of the "Universities" and "State" groups (4.4 and 4.8 points respectively), whereas the direct industry members, including "Investors, "Contractors" and "Designers" estimated the importance of this factor much below (from 2.8 to 3.6 points). Thus, it is possible to conclude, that the industry members in general do not quite agree with the statement about the lack of influence of BIM on the organization efficiency, and do not consider it to be a significant deterrent.

The fact that the problem of complexity of independent introduction and high cost of consultants' services was most highly appreciated by the respondents from the "State" group (at the level of 7.8 points) was the other interesting result of the research. Other groups of respondents attach smaller significance to this problem: about 5.5 points, and "Investors" defined its importance at the level below than average (4 points).

The respondents also estimated the importance of the factors, external in relation to the enterprises of the investment-and-construction sphere, interfering BIM implementation in points from 0 to 10). Mean values of the received results are presented in Figure 3 graphically.

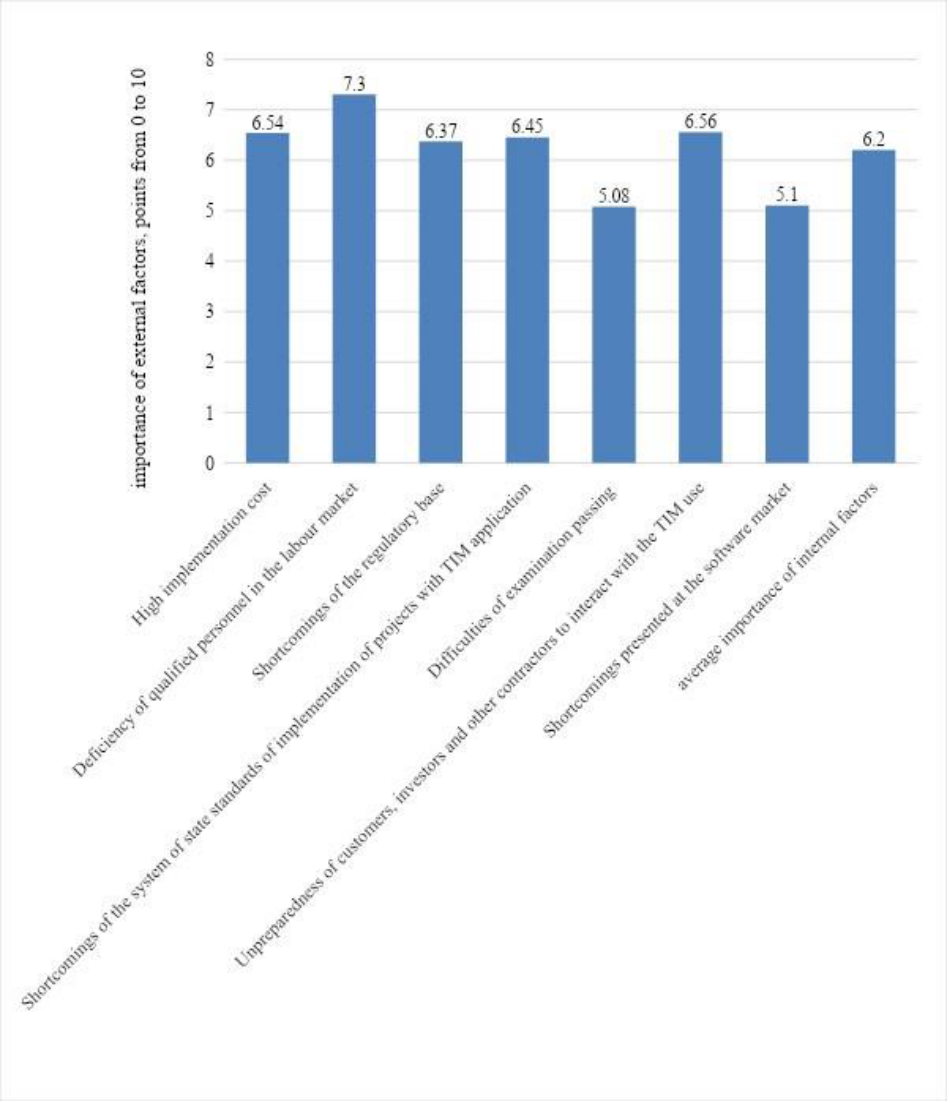

Fig. 3. Assessment by respondents of the importance external (in relation to the organizations of the investment and construction sphere) obstacles of implementation of BIM (in points from 0 to 10): mean values on selection in general. Source: "Created by the authors".

First of all we would like to note that the external problems and obstacles to BIM implementation are estimated as more significant in comparison with the internal ones. So, the importance of internal obstacles to introduction is estimated by respondents at the level of 5.2 points on average for the selection, and external obstales are estimated at the level of 6.2 points. All the external obstacles are estimated at the level from average (from 5 points) and above. The dispersion in the received indicators of the importance of obstacles is little. The exit of problems of deficiency of qualified personnel in the labour market and high implementation cost (7.3 and 6.5 points respectively) to the most important places became the expected result. Besides, there are also shortcomings of the regulatory base (6.4 points), shortcomings of a system of state standards (6.5 points) and unpreparedness of customers, investors and other contractors to work with BIM (6.6 points), e.i. they are practically at the same level on importance.

Let us consider the importance of external factors by the groups of respondents. The results of the assessment are presented in Table 4.

Table 4. Assessment of the importance external (in relation to the organizations of the investment and construction sphere) obstacles of BIM implementation (in points from 0 to 10): mean values on the groups of respondents.

External reasons	Average importance of external factors	Higher education institutions (Universities)	State	Investors	Contractors	Designers	Software developers
High implementation cost	6.54	7.59	6.00	4.79	7.08	6.76	4.42
Deficiency of qualified personnel in the labour market	7.30	7.78	7.75	7.36	7.75	6.69	6.67
Shortcomings of the regulatory base	6.37	7.00	6.55	4.57	6.25	6.02	5.75
Shortcomings of the system of public standards of the projects implementation with the BIM application	6.45	6.84	6.75	4.57	6.17	6.59	5.83
Difficulties in the examination passing	5.08	5.53	5.70	4.71	4.83	4.73	4.50
Unpreparedness of customers, investors and other contractors to interact with the use of the information model	6.56	6.78	6.75	5.71	6.42	6.63	6.25
Shortcomings, presented at the software market	5.10	5.73	6.55	4.29	4.83	4.73	4.50

Source: "Created by the authors".

In this case we can also note the tendency of respondents from the "Universities" group to pessimism and overestimate of the importance of problems of implementation in comparison with other participants of the research. Their average estimates of the importance of external obstacles to BIM implementation for all the factors are above average estimates, made by the other groups. "Investors" in general are more optimistic in comparison with other groups of respondents. They note the importance of external problems at the level below average estimates of other groups (and only on a problem of deficiency of qualified personnel express more serious concern in comparison with average estimates).

High implementation cost is estimated by all the groups of respondents, except for "Software developers" and "Investors", as a significant obstacle to BIM implementation. This factor is estimated by the "Universities" and "Contractors" groups at the level of more than 7 points.

The deficiency of qualified personnel became the most significant problem not only directly at the enterprises respondents, but also in the labour market. Its importance fluctuates for the "Universities", "State", "Investors" and "Contractors" groups in the range from 7.4 to 7.8 points. The indicators of the importance of this problem are lower for the "Designers" and "Software developers" groups. In general, the trend repeats the analysis of the importance

of the problem of availability of qualified personnel directly at the enterprises and organizations of the investment-and-construction sphere.

It is interesting, that in addition to pessimistic representatives of the "Universities" group (7 points), the most appreciation of the importance of the problem of shortcomings of the regulatory base was demonstrated by representatives of the "State" group (6.6 points). "Investors" consider that the importance of this problem is at the level below average (4.6 points); that is the lowest level among all the groups. Nevertheless, this problem exists. In this direction adequate measures can be taken for the decrease in the importance of this obstacle to BIM implementation at the Russian enterprises of the investment-and-construction sphere.

The problem of shortcomings of the system of state standards of implementation of projects with BIM application is estimated approximately at the same level, as the shortcomings of the regulatory base. The features of their estimates of the importance of this problem for various groups are similar.

The problem, connected with the complexity of passing of examination has, by the estimates of respondents the mean value (5 points). The representatives of the "Universities" and "State" groups demonstrated the importance, which is slightly above the average (5.5 and 5.7 points respectively), and other groups, including "Designers", who are directly involved in the examination passing processes noted the importance at the level slightly below average (from 4.5 to 4.8 points).

The problem of unpreparedness of customers, investors, other contractors to interact with the use of an information model can be considered to be serious. The average assessment of its importance is at the level of 6.6 points. The smallest indicator of this problem importance is received in the "Investors" group (5.7 points). The indicator exceeds 6 points for other groups.

The lack of software, presented in the market became the last problem factor of the external environment, considered within the research. Some dispersion of estimates of the importance among the allocated groups is observed for this factor. So, this problem was the most significant (6.6 points) for the "State" group, and the least significant (4.3 points) for "Investors" group. "Contractors", "Designers" and "Software developers" noted the importance of this factor at the close level (from 4.5 to 4.8 points). However, this factor, though it is a problem, can receive an additional push to the development in the conditions of completion of the regulatory base and the system of standards. And in spite of the fact, that in the current situation connected with the lack of access for the Russian companies to some software products in the sphere BIM, there are prospects to the accelerated development of domestic software products. In this case, they have an opportunity of development by higher rates due to decrease in level of the competition in our market. Certainly, the development domestic software in this sphere, focused on the domestic features of implementation of investment-and-construction projects, can be considered as a positive trend.

The authors made an attempt to reveal an interdependence between the estimates of the effectiveness of measures of state regulation of BIM implementation on the one hand and the assessment of the importance of those problem aspects, which are exactly in the sphere of the state responsibility (shortcomings of the regulatory base, shortcomings of the system of state standards of projects implementation with the application of BIM, complexity of the state examination passing) on the other hand. The correlation analysis was carried out for this purpose (with the application of Pearson correlation coefficient). The following results (Table 5) were received.

Table 5. Correlation coefficients between the indicators of the assessment of the effectiveness of measures of state regulation of the BIM implementation and assessment of the importance of the problem aspects, which are in the sphere of state responsibility.

Correlation coefficient between:	Value of correlation coefficient
- effectiveness of the measures of state regulation of the BIM implementation and assessment of the importance of the regulatory base shortcomings	-0.058531913
- effectiveness of measures of state regulation of the BIM implementation and assessment of the importance of the shortcomings of the system of state standards of the projects implementation with application of BIM	-0.133612863
- effectiveness of measures of state regulation of the BIM implementation and assessment of the importance of complexity of the state examination passing	-0.042419222

Source: "Created by the authors".

The interrelation among the indicators is extremely small and there is no sense to speak about its ponderability. However a sort of weak trend is revealed: the respondents, estimating the results of activity of authorities on BIM implementation more highly, are inclined to attribute the importance of the problems, which solution is under authority of the state, slightly smaller (in comparison with other respondents).

4 Discussion

The authors of the article suppose, that readers can have questions, connected with the consolidation of respondents in groups as well as with the exception of consideration of some organizations, such as operating organizations and producers of construction materials and equipment. We in turn understand, that in case of more detailed consideration of the opinion of the respondents, representing customers and builders, can have some specifics in comparison with the position of the respondents, representing general contractors and contractors. However, the available base for carrying out the analysis was 180 questionnaires. In case of such quantity of the organization types, which participated in the poll, the integration became a necessary step for the possibility of carrying out the analysis. The authors are going to expand the amount of the selection during such a research. That will allow to carry out such an analysis without consolidation of respondents to groups. It is also necessary to pay special attention to the research of the position of operating organizations.

5 Conclusion

During the analysis of results of the research the authors succeeded to reveal, that the assessment of the importance of problems and obstacles of BIM implementation by the respondents often depends on the type of activity of the organization, where the representative, who answered the questions, is engaged. So, such interrelation is traced on the following positions most brightly:

- respondents from the "Universities" group are inclined to estimate the importance of all the problems and obstacles of BIM implementation more highly in comparison with other groups of respondents;
- respondents from the "Investors" group are on average more optimistic in comparison with other groups of respondents and, as a rule, they estimate the importance of problems and obstacles below than others;

- the need to incur great finance costs on acquisition of equipment and software (as a factor of the internal environment); directly connected with high market prices on the equipment and software (as a factor of the external environment) has high value for all the groups of respondents, except for the "Software developers" group;
- resistance to changes from employees and from owners and managers of the organizations is estimated approximately at the same level (the separation is insignificant on average) by all the participants, except for respondents from the "Software developers" group. At the same time "Software developers" estimate the importance of resistance from employees above, than the resistance from owners and managers with a great separation – more than 2 points (5.6 and 3.3 points respectively);
- the problem of complexity of independent implementation and high cost of consultants services was appreciated by the respondents from the "State" group most highly – at the level of 7.8 points. The separation from other groups made more than 2 points;
- the serious problem, connected with the deficiency of qualified personnel is highly appreciated by such groups of respondents as "Universities", "State", "Investors" and "Contractors". The assessment of the importance of this problem, made by "Designers" and "Software developers", is lower;
- the respondents from the "Universities" and "State" groups consider the problems, relating to the matters, which are in the sphere of state regulation (shortcomings of the regulatory base, system of standards of work with BIM as well as examination passing problems), to be most significant;
- as for the problem "shortcomings presented at the software market" the dispersion of estimates is observed. Respondents from the "State" group consider the problem to be most significant (6.6 points); "Contractors", "Designers" and "Software developers" estimate its importance at the level close to the average (4.5-4.8 points), "Investors" give it slightly less importance (4.3 points).

According to the received results it is possible to draw the conclusion, that the formulated hypothesis found its confirmation during the research. The type of activity of the organization has an impact on its assessment of the importance of factors (problems) interfering BIM implementation.

The results of this research can be used for the regulation of process of preparation of the enterprises and organizations of the investment-and-construction sphere of Russia for the transition to obligatory application of BIM during the realization of subjects of the state order and to its further distribution. For example, the measures of state regulation as well as the actions, organized by professional community, can have an address character: thay can be supposed to solve a problem in relation to those organization types, where it is the sharpest, first of all.

During the research, which purpose is the identification of interrelation between the respondents' opinion on the importance of obstacles to BIM implementation and the type of its activity it was revealed, that the type of activity of the organization has an impact on its assessment of the importance of the factors interfering BIM implementation.

Thus, depending on the type of activity of the organization, which representative was the respondent, the assessment of importance of these or those obstacles for BIM implementation in the Russian companies of the investment-and-construction sphere changes. The features of organization activity (their functions, specifics of interaction with contractors) lead to the fact, that the same factor of BIM implementation can seem to be a serious obstacle for some organizations by, and can has value below than average for others.

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