Project Management Development – Practice and Perspectives
Fifth International Scientific Conference on Project Management in the Baltic Countries
April 14-15, 2016, Riga, University of Latvia

BUILDING INFORMATION MODELLING (BIM) IN CONSTRUCTION PROJECT MANAGEMENTIN RUSSIA

Irina Nechaeva, National Research University Higher School of Economics[27], Russia

Abstract

Construction industry is one of the main and the most conventional economic drivers which explain the participants or construction project teams' strong resistance to innovation tools and techniques. One of such widespread IT techniques is the process of generating, storing, managing, exchanging, and sharing building information in an interoperable and reusable way, known as building information modelling. The importance of BIM for construction project sustainability during a project life cycle is acknowledged by architectural, engineering, construction (AEC) companies worldwide. However, the efforts of implementing BIM in Russia had hardly been successful till they gained governmental support.

The aim of the present research is to investigate BIM application in Russian construction projects by different project participants during a project life cycle and analyse its first evident results.

Based on real case studies and state roadmap analysis, peculiarities of BIM implementation in Russian construction market sector were identified and the impact of BIM on construction project sustainability and providing value provided for client were revealed. In particular benefits of governmental support for the success of BIM spread in industry are defined and possible pitfalls AEC companies may encounter in construction project management processes are revealed.

Analysis of the findings proves that BIM application allows companies to enhance their performance and competitiveness on the market. As for the key pitfalls, they are rooted in the lack of unified standards for dealing with building information modelling.

Key words: *BIM, lean construction, construction project management* construction project sustainability, project life cycle
JEL code: *M00,O22*

Introduction

According to McGraw Hill Construction the level of BIM usage in the USA is 71%, in the UK – 54% (Smart Market Report, 2012). The interest of the state organizations, the existing program and road map of BIM implementation show that the Russian government understands the use of BIM can bring many benefits and increase the efficiency at different stages of a project life cycle.

The paper seeks to identify the peculiarities of BIM implementation in Russian architecture, engineering and construction (AEC) companies and its impact on the construction project sustainability and value provided for client and other stakeholders.

BIM is most frequently perceived as a tool for visualizing and coordinating AEC work, avoiding errors and omissions, improving productivity, and supporting scheduling, safety, cost and quality management on construction projects. It incorporates all the building components, including geometry, spatial relationships, properties and quantities

The knowledge of BIM implementation and past experience of other countries provides a solid ground for further investigation and comparative analysis.

[27]Corresponding author – e-mail adress: irina-nechaeva@list.ru, telephone:+7-926-161-94-53

The government policy of BIM extension shows the understanding of the extra edges of project time, cost savings provided by this technology at the strategical level. It becomes topical in the context of economic downturn and the necessity to reduce the budgets of state construction projects.

The case studies demonstrate the current status of BIM application and its acceptance by AEC companies. The pitfalls and first benefits were revealed on the basis of pilot projects.

The purpose of this paper is to analyse the current status of BIM implementation in the Russian construction sector and to propose a roadmap of improvements for further effective spread of BIM technology in business processes of project realization.

Literature review of current BIM status in the construction industry

The concept of BIM was developed from the working prototype "building description systems" introduced by Eastman in the 1970s (Eastman, 1976). On the list of countries BIM has become a widely used tool in the realization of construction projects. The leader in BIM implementation is Finland (TEKES, 2008). The other countries occupying the advanced positions are Denmark, Norway, the USA, the UK (Wong, Wong and Nadeem, 2010). Besides Hong Kong, Singapore, South Korea demonstrates a considerable progress of BIM maturity (Wong, Wong and Nadeem, 2010). It is necessary to emphasise the implementation of BIM in the construction field was supported by the governments of these countries and a lot of actions were taken at the operational and state levels.

First attempts to promote BIM technologies in Russia were taken at the end of 2000s by a Working Group of BIM Implementation. Till the 2015th the great work was performed by different participants of Russian construction market. Now Russian AEC companies are at the beginning of the discovering BIM benefits. In this case the big advantage for BIM application is the support gained provided by government.

Different stages of the construction life cycle using BIM are currently at the heart of numerous discussions in the extant literature: design (Azhar, Khalfan and Maqsood, 2012; Azharand Brown, 2009; Ham et al, 2008), detail designand tender documentation (Azhar, Khalfan and Maqsood, 2012; Azhar and Brown, 2009; Cheung et al, 2012;Giel, Issa and Olbina, 2010), construction (Azhar, Khalfan and Maqsood, 2012; Grilo and Jardim-Goncalves, 2010; Ibrahim, Krawczyk and Schipporeit, 2004; Yan and Damian, 2008), operation and management (Azhar, Hein and Sketo,2008, Ibrahim, Krawczyk and Schipporeit, 2004).

The SmartMarket survey in 2010 shows that in some developed countries in Western Europe engineers and contractors are less frequently involved in BIM use while architects are the primary adopters of BIM and many BIM practices are limited to the design stage (Bernstein et al., 2010). It would be interesting issue to investigate the stages of a construction project life cycle with BIM technologies application by AEC companies in Russia and to compare the results with the international trends.

The benefits BIM usage include close collaboration between the different project participants throughout the project life cycle and value provided for client by reducing of defects and mistakes in design as well as decrease time for correction (Bynum, Issa and Olbina, 2013).

The researchers and practitioners note the improvement of quality of design documentation in the following:

- decrease in mistakes due to better coordination between design documents (Cheng B., Wang Y., 2010);

- automatic generation of documentation with additional information (Cheng B., Wang Y., 2010);
- increase in efficiency (Xin Q., 2011).

The interest of the research is to analyse the first results of BIM application by Russian AEC companies and to define observed benefits getting through BIM.

Research methodology

The aim of this paper is to analyse BIM application by different AEC companies in Russian construction industry during a project life cycle and evaluate its first evident results.

The research pursues to consider existing knowledge and practices of BIM implementation in the leading countries and proposes an approach to further distribution and successful integration of BIM in construction project management processes.

A case study approach was used to gather qualitative and quantitative data about the real status of BIM implementation in the Russian construction sector. 12 case studies of projects with BIM application and BIM implementation in AEC companies (see Table 1) were examined in order to identify the peculiarities of BIM extension in Russia and to reveal the impact of BIM on the construction project sustainability and value provided for client. The case studies were chosen from Autodesk Section «Experience of effective application of BIM» (Autodesk, 2015), from official web-sites of companies, which projects were included in the governmental list of pilot projects. The selection of the case studies was justified by the following criteria: the detailed description of the project aims, problems and the ways of BIM usage as well as the availability of information about the achieved results of BIM implementation or application;

The road map analysis was conducted to investigate of the governmental support of BIM implementation in the Russian construction area. A comparative interpretation and diagnosis of BIM implementation roadmaps with other countries were carried out with the aim to reveal necessary actions, possible omissions, problems and mistakes. These findings provide the opportunity to propose the enhanced roadmap for BIM implementation in Russia.

Table 1

List of case studies

Case	Project description	Project stage with BIM
Case study 1 (Spectrum,2013)	A New terminal of international airport with the total area 41 700 sq.m. A complicated architectural and engineering project.	Design documentation, Tender documentation
Case study 2 (Sodis, 2013)	Olympic objects- (Fisht Olympic Stadium;Iceberg skating Palace). The aim of the project is to develop a system for monitoring the structure elements and engineering systems during maintenance of the buildings. Structural Health Monitoring system; Building services monitoring system	Monitoring of structures
Case study 3 (Spbgipro, 2013)	A concentrating factory. A pilot project of BIM implementation in company.	Design documentation
Case study 4 (Werfau Medical Engineering,2013)	State clinic with the total area 150 000 sq.m. The requirement for BIM from the client.	Design documentation
Case study 5	Reconstruction of shopping center.	Working

(Sibtechproekt, 2013)		documentation
Case study 6 (EtalonGroup, 2015)	Residential complex (Etalon)	Design documentation, Construction monitoring and control
Case study 7 (Morton, 2013)	School for 500 pupils. A typical project without controversial elements with the aim to reveal the pros and cons of BIM platform.	Design documentation
Case study 8 (Mushits, 2013)	Reconstruction of clinic	Design documentation
Case study 9 (SpbRenovaciya, 2014)	Residential building	Design documentation
Case study 10 (Akademstroyproekt, 2013)	BIM implementation in design company A.	Design documentation
Case study 11 (Barnaulgrazhdanproekt, 2013)	BIM implementation in design company B. The specialization of company are typical panel residential buildings	Design documentation
Case study 12 (Kb vips,2013)	BIM implementation in design company C.	Design documentation

Source: Author construction

Status of BIM implementation in Russia

Governmental BIM Policy

In March 2015 The Working Group of BIM implementation was established by Ministry of Construction Industry, Housing and Utilities Sector (Minstroy, 2015). The major target of the Working Group is support of the realization of governmental phased plan of Building Information Modelling implementation in civil and industrial construction design field (Minstroy, 2014).

Main players

In the process of BIM implementation involved several significant players:

- *Ministry of Construction Industry, Housing and Utilities Sector (Minstroy)* performs development and realization of governmental policy and norms and law regulation in the field of construction, architecture, urban development and housing and utilities sector, performs state services and manage the governmental property in this sphere.
- *The Working Group of BIM implementation* is aimed at solving the issues related to the performance of the plan for BIM implementation in Russian Federation;
- *Federal Agency on Technical Regulating and Metrology* is rendering state services in the sphere of standardization, technical regulation and metrology. Due to this function The *Agency* is developing national standards regarding BIM application during the whole project life cycle in civil and industrial construction field;
- *Autodesk* is promoting BIM through a regular BIM-breakfasts and master classes to present AEC companies the opportunities and advantages of BIM.

Governmental road-map of BIM implementation

In *December 2014*Ministry of Construction Industry, Housing and Utilities Sector issued a decree “About the approval of phased plan of Building Information Modelling implementation in civil and industrial construction design field”(Minstroy, 2014). (see Table 2)

Table 2

Phased plan of Building Information Modelling implementation in civil and industrial construction design field

Date	**March 2015**	**April-November 2015**	**December 2015**	**December 2016**	**January 2017**	**December 2017**
Task	Selecting of pilot projects designed with BIM application and its transfer to the Expert Organization	State expertise and obtain its favorable opinion of pilot projects designed with BIM application	Analysing BIM pilot project results and identifying the list of regulatory and normative-technical acts, educational standards	Making amendments in the regulatory and normative-technical acts, educational standards	A part of public projects should be carried out with BIM technologies application	Providing training for industrial and civil construction specialists and experts
Status	Done	Done	Done	**First drafts of standards are available for professional discussion to approve till the end of the year**	In progress	In progress

Source: Author construction

24 December 2014 The first project with BIM model accepted and approved by the state expert organization was a clinic for 550 persons in New Vatutinki district, Moscow (See Figure 1). The design documentation was developed by GRADPROEKT Company.

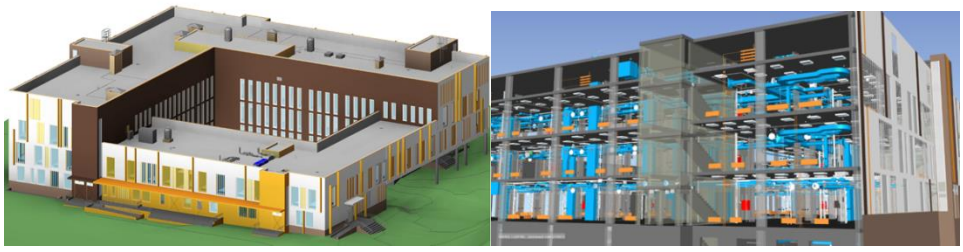

Fig. 1. **A first project with BIM in expert organization**

In *March 2015* Minstroy and the Working group announced the criteria for the pilot project selection:

- company experience in project design based on BIM technologies. At least 2 projects designed with BIM;

- availability of BIM-technologies specialists;
- internal regulation standards for application building information modelling;
- usage of unified information model of main project components (architecture, structure, budget, etc.) by specialists of design company (minimum 3 components);
- availability of valid 3D-environment with the enclosed data and tools for coordinated consolidation of the project.

On 22nd April 2015 the list of pilot projects for getting approval of State Expert Organization with BIM model was determined. The list includes 22 projects: reconstruction projects – 6, new construction - 16. The functionality and the size of the projects are different. There are residential projects, medical centers, schools, shopping centers, sports buildings (stadiums, swimming pool), and industrial plants.

According to Russian norms and regulations the design documentation is to be submitted to the expert organization only in the traditional 2D paper format. Nowadays there is a gap in law and requirements for submitting design documentation in information model format. For the pilot projects was taken an exception.

The expert of pilot projects reveals the existing problems of BIM applications by AEC companies (Mosgosexpertiza, 2015):

- the base of pilot project was reduced due to economic uncertainty;
- design companies manually refined the design documentation to the traditional layout without providing informational model;
- not all expert organizations are ready to perform appraisal at of the pilot projects;
- major AEC companies and construction sector stakeholders were out of the process at this stage.

Now the results of the expertise with BIM model are available and from the governmental point of view (Mosgosexpertiza, 2015, Stroyorbita, 2015) the benefits of BIM implementation in construction sector are as follows:

- increase in the efficiency and accuracy of construction project cost estimation and the effectiveness of public budget resources expenditure;
- optimization of construction process due to the quality of project planning and management;
- decrease in the time of construction
- optimization of the object maintenance.

BIM technology provides:

- creation of unitary data base with the information about the city (electronic data base of urban development plans, project documentation about the buildings, surveys data, repair works);
- multi-scenario modelling of urban development and visual representation for its evaluation; increase in the design quality due to the complex approach to the city development;
- increase in the cost transparency of public budgets during the whole project life cycle.

5.1. Development of BIM standards

On 19th January 2016 first drafts of national standards regarding BIM application during the whole project life cycle in civil and industrial construction field were introduced for public discussion and further improvement with the aim to approve of the final versions till the end of 2016.

Data analysis

This section presents and interprets the findings obtained from the case studies of BIM application in Russian AEC companies in a qualitative manner. Each case study was analysed in several ways:

1) project stage of BIM application;
2) project components used in BIM;
3) faced problems;
4) noted benefits.

BIM application in Russian construction field

The examined cases demonstrate the domination of BIM application by architecture and design companies for the preparation of design documentation, working documentation and tender documentation. (Table 3)

Table 3

Project stages and components with BIM application

Case study	Project life cycle stages						Project components			
	Concept Design	Design Documentation	Working Documentation	Tender Documentation	Construction Planning &Monitoring	Facility Management	Architecture	Structure	MEP	Cost estimation
Case study 1	-	+	-	+	-	-	+	+	+	-
Case study 2	-	-	-	-	-	+	-	+	+	-
Case study 3	-	+	-	-	-	-	+	+	+	-
Case study 4	-	+	-	-	-	-	+	+	+	+
Case study 5	-	-	+	-	-	-	+	+	+	+
Case study 6	-	+	+	-	+	-	+	+	+	+
Case study 7	-	+	-	-	-	-	+	+	+	-
Case study 8	-	+	-	-	-	-	+	+	-	-
Case study 9	-	+	+	+	+	-	+	+	+	+
Case study 10	-	+	-	-	-	-	+	+	+	+
Case study 11	-	+	-	-	-	-	+	+	-	-
Case study 12	-	+	+	-	-	-	+	+	+	-

Source: Author construction

Only in 2 cases from 12 the companies use BIM for the whole project life cycle. It confirms the problems of the other companies revealed from the survey. The key one is that there is a small number of AEC companies on construction market using BIM, that hinders the use of the model in full capacity at all stages of a project life cycle.

Most of the companies carry out all project components in the model such as architecture, structure and MEP systems. But unfortunately it is necessary to note that some of them use

design architectural and structure components in model applying 2D for MEP systems. Moreover only 4 companies make cost estimation with BIM technologies.

A small number of AEC players using BIM for construction planning and control shows the lack of understanding of BIM value for construction cost and time reduction.

In Russia design companies with governmental support become drivers of BIM spread. The BIM technologies application allows them to get a competitive advantage in comparison with 2D designers. The first noted benefits of BIM application are described in Table 4.

The following challenges of implementation BIM in the Russian construction practice were identified:

- overcoming the staff resistance to changes in the existing practice and spreading the understanding of BIM potential and value ;
- adapting the existing business processes to BIM;
- training people in BIM, recruiting the employees understanding BIM
- providing a more close collaboration and integration between architect, structural and MEP engineers;
- clear understanding of different stakeholders' responsibilities in the new process by all participants, including construction lawyers and insurers

Table 2

Problems and benefits of BIM application

Case study	Revealed problems	Noted benefits
Case study 1	▪ lack of BIM educated specialists ▪ fragmentary (architecture, structure) use of BIM at the beginning of implementation	▪ decrease in the number of conflicts and mistakes in design ▪ interconnection with interrelated components ▪ availability of wide data required by client ▪ accuracy of material and equipment calculations ▪ concurrent transfer of changes in all drawings ▪ significant time-saving tender documentation preparation ▪ decrease in the time for the design stage in 1.5-2 times (3 months saved at the design documentation stage, 2 months- at the tender documentation stage)
Case study 2	▪ necessity to create a model based on 2D drawings	▪ better coordination and development management ▪ material management, planning and optimization ▪ clash detection between different components ▪ interconnection between different design disciplines ▪ direct link between 3D models and 2D plans ▪ visualization and rendering ▪ complex geometry design & manufacturing ▪ automatic schedule generation
Case study	▪ inertness ▪ mistakes in resource download; ▪ insufficient knowledge ▪ BIM perception by specialists	▪ significant improvement of design process due to quick clash checking ▪ simplified process of approval by client ▪ quick modification
Case study	▪ resistance of construction companies ▪ usage of model for inner tasks ▪ small number of companies using BIM throughout the project life cycle and value provided for client	▪ 20 % design time-saving ▪ 6 times decrease in the time for checking model, revealing the mistakes and their correction numerous data base of equipment allowing to avoid the preparation of items ▪ more user-friendly intellectual models of equipment . ▪ 25-30% labor productivity increase
Case study	▪ creation of model on the basis of 2D pdf files ▪ organization of effective collaboration between architects, structure and MEP engineers ▪ creation of elements data base ▪ lack of models from equipment manufacturers ▪ difficulties with isometric schemes and sections during file printing from Revit.	▪ more quality design documentation ▪ accurate cost estimation documentation ▪ opportunity of quick changing of working documentation

	▪ using Excel for the creation of schedule of materials and equipment to decrease time	
Case study 6	not described	▪ decrease in mistakes in construction budget planning to 5-7% instead of 20% which is usual for the design stage ▪ using BIM as an argument for getting bank project financing due to the transparency of construction status control
Case study 7	▪ changes in norms and regulations related to design	▪ decrease in time for model modification caused by the changes in norms and regulations ▪ 10 times Decrease in time for the preparation of schedules of materials and equipment in ▪ decision to implement BIM at all stages of building life cycle including the operation and utilization ones
Case study 8	▪ use of Autocad at the beginning of BIM implementation	▪ decrease in time for the preparation of schedules of materials and equipment ▪ increase in the accuracy of calculations due to automated preparation of structure schedules for demolition
Case study 9	not described	▪ opportunity to get construction budget at the beginning of design stage ▪ accurate schedule calculations ▪ accurate estimation of equipment ▪ project schedule control for management approval ▪ control *as built* ▪ automatic generation of apartment area and mix schedule
Case study 10	▪ use of 2d design in 50% of components during the first years of BIM application ▪ nowadays time spent on BIM and 2D design is equal, but the outcome differs in terms of volume delivery	▪ faster decision making ▪ improved design quality due to the decrease in mistakes ▪ 10-30% decrease in project budget at the construction stage ▪ 40-70% decrease in change cost in comparison with 2D design ▪ existing opportunity to decrease design time
Case study 11	▪ different model for architect and for structure engineer ▪ need to draw walls for architect ▪ creation of element data base	▪ 30 mistakes were revealed in structure elements detail ▪ 1,5-2 weeks for preparation drawings per section (include several blocks) what early was needed per block ▪ 5 times time increase in layout changes in ▪ the quality control of schedules of materials doesn't require. Early it took 1 day.
Case study 12	not described	▪ increase in the efficiency and accuracy of design documentation ▪ decrease in the number of mistakes and clashes ▪ decrease in time for correction

Source: Author construction

Conclusions

Based on 12 case studies of BIM application by AEC companies this article provides an overview of current BIM practices in construction project management in Russia. The governmental contribution and its significance in BIM technologies universal distribution are described. The study confirmed the important role of state support in development of new technologies in industries. The research is limited by the number of cases but allows making the following conclusions:

1. The predominate area of BIM application by AEC companies in Russia is design stage- design documentation, working documentation and tender documentation. It correlates with the international tendencies of BIM implementation.
2. The noted time saving of BIM use in the cases reaches 1.5-2 times in comparison with the traditional design. It also includes a shorter time for the correction of mistakes and clashes easily identified with BIM technologies and increased labor productivity because of more efficient collaboration of all involved participants.
3. The accuracy of design, working and tender documentation is increased what allows to decrease the mistakes in construction budget planning to 5-7% and to cut project budget at the construction stage by 10-30%.
4. The requirement to submit 2D design documentation for expert approvals needs extra work from designer to generate 2D drawing therefore it is still difficult for software to do it automatically in accordance with the local normative and regulatory acts.
5. There is a need to deal with local legal norms and regulations that should be adopted to use BIM for the state approvals, design and construction contracts.
6. Research results show that faced problems of BIM implementation and application roots to the lack of trained specialists as well as lack of unified library of elements and BIM standards.

There is a great potential of getting benefits through BIM use over the whole construction life cycle by all project participants.

Further investigation of BIM use by AEC participants at each stage of a project life cycle needs to follow this work. Moreover it is important to scrutinize the feedback from experts of design documentation for a better analysis of changes in the expertise process and achieved improvements.

References

Akademstroyproekt, 2013, *Tochnaya smeta dlya stroitel'stva na osnove BIM modeli.*[Online] Available at: http://images.autodesk.com/emea_apac_main/files/akademstroy_web.pdf [Accessed 20 December 2015]

Autodesk, 2015. [Online] Available at: *http://www.autodesk.ru/suites/building-design-suite/case-studies*[Accessed 20 December 2015]

Azhar S., 2011, *Building information modeling (BIM): trends, benefits, risks, and challenges for the AEC industry*, Leadership and Management in Engineering, pp. 241–252.

Azhar S., Khalfan M., Maqsood T., 2012, *Building information modelling (BIM): now and beyond*, Australasian Journal of Construction Economics and Building, 12 (4), pp.15–28

Azhar S., Brown J., 2009, *BIM for sustainability analyses*, International Journal of Construction Education and Research 5 (4), pp. 276–292.

Azhar S., Hein M., Sketo B., 2008, *Building information modeling (BIM): benefits, risks and challenges*, [on-line] Available at http://ascpro.ascweb.org/chair/paper/CPGT182002008.pdf (Accessed 20 December 2015).

Barnaulgrazhdanproekt, 2013, *Autodesk Revit v krupnopanel'nom domostroenii*. [Online] Available at: http://images.autodesk.com/emea_apac_main/files/barnaul_web.pdf [Accessed 20 December 2015]

Bernstein H.M., Jones S.A., Gudgel J.E., et al., 2010, *The Business Value of BIM in Europe: Getting Building Information Modeling to the Bottom Line in the United Kingdom, France and Germany*, McGraw Hill Construction, Bedford, MA.

Bynum P., Issa R.R.A., Olbina S., 2013. *Building information modeling in support of sustainable design and construction*, Journal of Construction Engineering and Management. ASCE 139 (1), pp. 24–34

Cheung F., Rihan J., Tah J., Duce D., Kurul E., 2012, *Early stage multi-level cost estimation for schematic BIM models*, Automation in Construction, 27 , pp. 67–77.

Cheng B., Wang Y., 2010. *BIM's content and its application in contemporary architectural design*, International Conference on Management and Service Science, pp. 1–4.

Eastman C., 1976, *General purpose building description systems*, Computer-Aided Design8 (1), pp. 17–26

EtalonGroup, 2015, *Upravlenie stroitel'numi proektami s pomoschiu BIM.* [Online] Available at: http://autodeskforum.ru/upload/iblock/832/2015_06_24_pulatova.pdf [Accessed 20 December 2015]

Giel B., Issa R.R.A., Olbina S., 2010, *Return on Investment Analysis of Building Information Modelling in Construction*, Nottingham University Press, Nottingham

Grilo A., Jardim-Goncalves R., 2010, *Value proposition on interoperability of BIM and collaborative working environments*, Automation in Construction, 19 (5), pp. 522–530.

Ham N., Kyung-Min M., Ju-Hyung K., Yoon-Sun L., Jae-Jun K., 2008, *A study on application of bim (building information modeling) to pre-design in construction project*, Proceedings of Third International Conference on Convergence and Hybrid Information Technology. ICCIT'08, vol. 1, IEEE, 2008, pp. 42–49.

Hardin B., 2009, *BIM and Construction Management*, 1st ed. Wiley Publishing Ltd., Indiana, USA.

Ibrahim M., Krawczyk R., Schipporeit G., 2004,*Two approaches to BIM: a comparative study*, Proceedings of Education and Research in computer aided architectural design in Europe, ECAADe, 2004, vol. 22, pp. 610–616.

Kb vips, 2013, *Mnogofunkcional'nij vusotnuj complex Morskie Bashni Sankt Peterburga*. [Online] Available at: http://images.autodesk.com/emea_apac_main/files/ success_story_kb_vips_web0.pdf [Accessed 20 December 2015]

Minstroy, 2015, *№182-pr from 17.03.2015 O sozdanii rabochey gryppu po rassmotriniu voprosov, voznikayuschikh pri realizacii plana poetapnogo vnedreniya technologij informacionnogo modelirovaniya v oblasti promushlennogo i grazhdanskogo stroitel'stva* [Online] Available at: http://www.minstroyrf.ru/upload/iblock/ebb/prikaz-182pr.pdf [Accessed 20 December 2015]

Minstroy, 2014, *№926-pr from 29.12.2014 Ob ytverzhdenii plana poetapnogo vnedreniya technologij informacionnogo modelirovaniya v oblasti promushlennogo i grazhdanskogo stroitel'stva.* [Online] Available at: http://www.minstroyrf.ru/upload/iblock/383/prikaz-926pr.pdf [Accessed 20 December 2015]

Morton, 2013, *BIM technologii dlya massovogo stroitel'stva.* [Online] Available at: http://images.autodesk.com/emea_apac_main/files/13_morton_web.pdf [Accessed 20 December 2015]

Mushits, 2013, *BIM dlya slozhnuch rekonstrukcii zdanij.* [Online] Available at: http://images.autodesk.com/emea_apac_main/files/Mushits.pdf [Accessed 20 December 2015]

Sibtechproekt, 2013, *Masshtabnaya reconstrukciya po BIM technologii.*[Online] Available at: http://images.autodesk.com/emea_apac_main/files/sibtehproject_web.pdf [Accessed 20 December 2015]

Sodis, 2013, *BIM dlya system monitoring a controlya olympijskich ob'ectov.*[Online] Available at: http://images.autodesk.com/emea_apac_main/files/sodis_success_story.pdf [Accessed 20 December 2015]

Spb-Giproshacht, 2013, *BIM proektirovanie ob'ektov gornodobuvauschey promushlennocti*, [Online] Available at: http://images.autodesk.com/emea_apac_main/files/spg_web_1.pdf [Accessed 20 December 2015]

SpbRenovaciya, 2014, *Upravlenie krupnum investicionnum proektom razvitiya gorodskoy territorii na osnove BIM technologii.*[Online] Available at: http://www.agpmeridian.ru/image_content/presentation_2014/17-20_17-40-Manin.pdf [Accessed 20 December 2015]

Spectrum. Group of companies,2013.*Mezhdunarodnuj aeroport po BIM technologii.*[Online]Available at: http://images.autodesk.com/emea_apac_main/files/Spectrum_web.pdf [Accessed 20 December 2015]

Smart Market Report, 2012, *The Business Value of BIM in North America: Multi-Year Trend Analysis and User Ratings (2007–2012)*

TEKES, 2008, *Sara – Value Networks in Construction 2003–2007*, Technology Programme Report 2/2008, Helsinki, ISBN 978-952-457-392-4.

Werfau Medical Engineering,2013, *BIM dlya medicinskich ob'ektov.*[Online] Available at: http://static-dc.autodesk.net/content/dam/autodesk/www/suites/autodesk-building-design-suite/docs/pdf/werfau_web.pdf [Accessed 20 December 2015]

Wong A.K.D., Wong F.K.W., Nadeem A., 2010, *Attributes of Building Information Modelling Implementations in various countries.* Architectural Engineering and Design Management Volume 6, Issue 4 pp.288-302

Yan H., Damian P., 2008, *Benefits and barriers of Building Information Modelling*, 12th International Conference on Computing in Civil and Building Engineering. [Online] Available at: http://homepages.lboro.ac.uk/~cvpd2/PDFs/294_Benefits%20and%20Barriers%20of%20Building%20Information%20Modelling.pdf

Mosgosexpertiza, 2015 [Online] Available at: *http://stroi.mos.ru/uploads/user_files/files/presentations/bim.pdf* [Accessed 20 December 2015]

Stroyorbita, 2015. [Online] Available at: *http://www.stroyorbita.ru/index.php/item/4337-bim-tehnologii-proektirovanie-ekspertiza-ekspluatatsiya* [Accessed 20 December 2015]

Xin Q., 2011. *Building information modelling (BIM) adoption of construction project management based on Hubei Jingzhou bus terminal case,* International Conference on Business Computing and Global Informatization, pp. 282–284.