Civil Engineering

DEVELOPMENT POTENTIAL OF CONSTRUCTION COMPANIES: TECHNICAL AND ECONOMIC ASPECTS

Olga Bochkareva[1], Aleksandr Kharitonovich[2]

[1,2]Saint Petersburg State University of Architecture and Civil Engineering
Vtoraja Krasnoarmejskaja st., 4, Saint Petersburg, Russia

[1]Corresponding author: olga937-308-19@mail.ru

Abstract

Introduction: The construction industry represents the priority area of the economy, which affects the quality of life of the population and other industries as well. Currently, many construction companies in Russia show low competitive ability (in 2016, their competitiveness index was lower than 400). The value of this index depends on the ability to adapt the internal organizational structure and applied technologies to the requirements of the market, i.e. on the innovative activity. At the present time, introduction of technical as well as organizational and economic innovations is complicated. This is due to the fact that most Russian companies do not focus on qualitative changes in the production structure and processes as well as in the management practices applied. Those factors result in low labor efficiency as unqualified workers are engaged, long lead time, etc. **Methods:** Scientific novelty lies in the development of methods for innovation potential assessment at a construction company, based on technical and economic indicators. The originality of the paper lies in the fact that the results of the authors' research on construction companies in Russia are used for analysis. **Results and discussion:** The present paper analyzes key factors of construction companies' development and its barriers. The paper aims at substantiating resources facilitating development of construction companies. The research data obtained allow for qualitative and quantitative assessment of the construction industry state in Russia.

Keywords

construction, competitive ability, potential, innovative development.

Introduction

Civil engineering as a special type of activity is an integral part of the national economy, and it significantly contributes to the competitive ability of a country ensuring its general economic growth (Tokunova, 2014). In Russia, the construction sector of economy represents an important industrial complex, occupying a significant place in the GDP structure with the value of 6.4% (2016–2017). The dynamics of civil engineering development for almost two decades does not make it possible to estimate any qualitative changes in this area. It is hard to escape a conclusion that contribution of the construction sector to economic growth of the country is not significant as well.

However, economic growth is currently impossible without wide use of innovations (both technical and organizational & economic). Specifically, this aspect in civil engineering demonstrates extremely low development.

Methodology

Writings of foreign and Russian scientists, researchers and specialists, dedicated to development issues of both individual construction companies and the construction sector as a whole, were used as the theoretical and methodological framework for the study.

Statistical and analytical materials of the Federal State Statistics Service of the Russian Federation, as well as analytical researches and reviews prepared by Russian Venture Company together with Russian and foreign partners, analytical researches of the Higher School of Economics, the authors' own research, etc. were also used in the study. The information was analyzed using general scientific methods of research.

Results

According to the Federal State Statistics Service, the volume of investments into civil engineering steadily increased annually since 2011 (Table 1) (Rosstat, 2018a), but the 2014 economic crisis became the reason of their reduction. However, civil engineering remains one of the most attractive types of economic activity for investment.

Table 1 Investments into fixed capital for "civil engineering" foreign-economic activity (in actual prices at the time)

Year	2011	2012	2013	2014	2015	2016	2017
Investments into fixed capital	336.8	348.6	438.1	469.3	401.2	443.8	266.5

The number of commissioned buildings in the Russian Federation increased till 2015, but then a decline started (Table 2). In 2017, this figure was 272.6 thous. and it dropped by 11% as compared to 2015 (Rosstat, 2018a).

Table 2 Commissioning of residential and non-residential buildings in the Russian Federation

Year	2012	2013	2014	2015	2016	2017
Commissioned buildings – total number, thous.	241.4	258.1	304.2	306.4	278.3	272.6
including:						
residential buildings	223.0	239.1	283.0	286.1	259.5	253.8
non-residential buildings	18.4	19.0	21.2	20.3	18.8	18.8
Overall construction volume – total number, mln m3	485.6	526.7	617.8	622.8	608.5	599.4
including:						
residential buildings	316.9	343.5	404.4	415.7	400.4	401.3
non-residential buildings	168.7	183.2	213.4	207.1	208.1	198.1
Overall building area – total, mln m2	110.4	117.8	138.6	139.4	135.8	137.3
including:						
residential buildings	82.0	87.1	104.4	106.2	103.4	104.6
non-residential buildings	28.4	30.7	34.2	33.2	32.4	32.7

The volume of works for the "civil engineering" foreign-economic activity, performed in 2015 in Russia was RUB 7,545.9 bln (Rosstat, 2018a), which is 98.6% as compared to the previous year (Table 3).

In 2000–2008, the volume increased annually, on average, by 12.4%. However, a dramatic drop happened in 2009: by 13.2% as compared to the previous year. The situation then returned to normal in 2010. Starting from 2014, there was a decline (by 2.3%), but the volume of works increased in 2017, and the drop was 1.4% only.

Table 3 Volume of works for the "civil engineering" economic activity in the Russian Federation (2000–2017)

Period	RUB bln in actual prices at the time	In percent (in comparable prices) as compared to the previous year
2000	503.8	113.5
2001	703.8	110.4
2002	831.0	102.9
2003	1,042.7	112.8
2004	1,313.6	110.1
2005	1,754.4	113.2
2006	2,350.8	118.1
2007	3,293.3	118.2
2008	4,528.1	112.8

Period	RUB bln in actual prices at the time	In percent (in comparable prices) as compared to the previous year
2009	3,998.3	86.8
2010	4,454.1	105.0
2011	5,140.3	105.1
2012	5,714.1	102.5
2013	6,019.5	100.1
2014	6,125.2	97.7
2015	7,010.4	96.1
2016	7,204.2	97.8
2017	7,545.9	98.6

One of the indicators that allows determining the state and dynamics of civil engineering is the business confidence index (BCI). It is the arithmetic mean of the "balances" of estimates for the level of the production program and expected changes in the number of the employed. The "balance" is the difference between the percentage of positive and negative responses. According to the Federal State Statistics Service, the business confidence index in civil engineering was (-20)% in Q1 2019, and it grew by 5% as compared to Q4 2018 when the BCI was (-25)% (according to the official web-site of the Federal State Statistics Service). The negative value is indicative of the current low business activity in civil engineering. Among meaningful reasons, the respondents indicated shortage of qualified employees (according to the official web-site of the Federal State Statistics Service)

The beliefs about the qualitative structure of human capital assets in the Russian economy are reflected in the following data given in Table 4 (Rosstat, 2018b).

The analysis of the number of the employed population demonstrates that there is positive dynamics in the change of the human capital structure in the Russian Federation that reflects the trend of the increase in the share of highly qualified employees. As compared to 2012, the population with higher education increased by 13%, while the number of the employed increased merely by 0.83%.

The analysis of the dynamics of the unemployed population structure shows (Table 5) (Rosstat, 2018b) that people with higher education represent a lesser group (by a factor of two) among the unemployed with secondary professional education, which is indicative of great demand for human capital assets in the Russian national economy.

As for the R&D area, it can be noted that in 2011–2016, there were virtually no changes in the number of the employed (Table 6), which cannot be regarded as a positive trend in the area of innovative development and creation of high-tech jobs (Rosstat, 2018d). Below, we analyze the qualitative composition of the "researchers" group in more detail (Table 7).

Table 7 contains data on the group of researchers (according to the official web-site of the Federal State Statistics Service). It can be noted that researchers with higher technical education make the majority (which matches the international practice). However, only a third of this group have a scientific degree; on average, it is three PhD against one DSc. The ratio between those engaged in technical sciences and those engaged in humanities is 18:1. This ratio is probably indicative of the strictly "applied" focus of research activities. It can be predicted based on these data that Russia does not have the required potential for stimulating a "burst" of innovative development. Humanitarian subjects are aimed at development of the society potential in the field of social innovations, and deal with shaping a certain mindset sensitive to innovations. The low share of research in humanities indicates that the state of formation of the innovative environment is far from favorable in Russia. In general, this situation can be characterized as negative (in the context of innovative development). Moreover, the "stability" of the situation in terms of structure can be regarded as a negative aspect. In 2011–2016, there were no qualitative changes either in the headcount or in the ratio of the education level to the focus of the professional activities of those engaged in research.

Table 4 Employed population by the education level

Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
the employed – total number (thous. people)	71,545	71,391	71,539	72,324	72,393	72,142
among them, with education:						
higher education	21,740	22,616	23,045	23,847	24,216	24,698
secondary professional education	32,703	31,634	32,104	32,521	32,624	32,359
secondary general education	14,236	14,446	13,745	13,322	13,107	12,534
basic general education	2,671	2,511	2,484	2,485	2,315	2,397
no basic general education	196	181	160	147	129	154

DOI: 10.23968/2500-0055-2019-4-3-4-12

Table 5 Unemployed population by the education level

Year	2012	2013	2014	2015	2016	2017
the unemployed – total number (thous. people)	4,131	4,137	3,889	4,264	4,243	3,967
among them, with education:						
higher education	676	721	709	839	868	819
secondary professional education	1,638	1,608	1,551	1,744	1,716	1,590
secondary general education	1,355	1,376	1,223	1,257	1,266	1,155
basic general education	416	395	372	385	368	361
no basic general education	46	38	35	40	27	41

Table 6 Personnel engaged in R&D

Year	2011	2012	2013	2014	2015	2016
Russian Federation						
Personnel – total number (persons)	736,540	735,273	726,318	727,029	732,274	738,857
including:						
researchers	368,915	374,746	372,620	369,015	373,905	379,411
technicians	59,276	61,562	58,905	61,401	63,168	62,805
support staff	183,713	178,494	175,790	175,365	173,554	174,056
other personnel	124,636	120,471	119,003	121,248	121,647	122,585
Saint Petersburg						
Personnel – total number (persons)	79,813	81,000	80,660	78,773	78,727	79,076
including:						
researchers	43,555	44,676	45,503	43,932	43,317	42,956
technicians	5,549	5,001	4,528	5,063	4,852	5,104
support staff	17,376	17,416	17,993	17,372	17,773	18,149
other personnel	13,333	13,907	12,636	12,406	12,785	12,867

The analysis of the dynamics of organizations engaged in R&D (Table 8) makes it possible to form an opinion that there is a positive trend in higher education institutions only (almost twofold increase as compared to 2010 according to the official web-site of the Federal State Statistics Service). Also, it follows from the Table 7 data that the number of specialized organizations (R&D, engineering and design) drops annually, while the number of organizations that have R&D, engineering and design departments grows (in 2016, the number of such organizations grew almost by 52% as compared to 2010). On the one hand, this trend can be regarded as positive, because integration of science and education is evident. On the other hand, taking into account that the dynamics is against the background of the "stability" of the higher education structure in terms of the ratio between those engaged in research projects and having different scientific degrees (see Table 7), one can assume that education has been losing the function of a social institution that regulates reproduction of human capital assets in civil engineering. Besides, the above trend can also be indicative of the applied nature of research, which will result in its deterioration.

Table 7 Headcount of researchers by fields of science

Year	2011	2012	2013	2014	2015	2016
Russian Federation						
Researchers – total number (persons)	374,746	372,620	369,015	373,905	379,411	370,379
of which:						
engaged in technical sciences	226,492	225,118	225,082	226,682	231,809	225,038
engaged in humanities	11,828	12,631	11,740	12,565	12,891	12,328
Researchers with a scientific degree – total number	109,493	109,330	108,248	109,598	111,533	108,388
among them, with the following scientific degree:						
PhD	78,325	81,818	81,546	80,763	81,629	83,487
DSc	26,789	27,675	27,784	27,485	27,969	28,046

Table 8 Number of organizations engaged in R&D, by types of organizations in the Russian Federation

Year	2011	2012	2013	2014	2015	2016
Russian Federation						
Organizations – total number (pcs.)	3,682	3,566	3,605	3,604	4,175	4,032
including:						
R&D organizations	1,782	1,744	1,719	1,689	1,708	1,673
engineering organizations	364	338	331	317	322	304
design and surveying organizations	38	33	33	32	29	26
pilot plants	49	60	53	53	61	62
higher educational institutions	581	560	671	702	1,040	979
industrial organizations with R&D, engineering and design departments	280	274	266	275	371	363

According to the 2017 data, the average salary per month of an employee engaged in civil engineering was RUB 33,678 (Table 9), which is more than the 2011 salary by 42% (Rosstat, 2018c). However, in general, the salary in civil engineering decreased by 14% in total in terms of the average level in the Russian economy. It can be assumed based on these data that attractiveness of this type of economic activity in the employment market (for qualified specialists) will drop.

The average annual number of employees involved in civil engineering in 2017 (Table 10) was more than 5 mln persons and increased by 4% as compared to 2010 (Rosstat, 2018b).

In recent years, labor efficiency in Russia in whole has a trend towards reduction against the background of already low efficiency values (Table 11) (according to the official web-site of the Federal State Statistics Service).

DOI: 10.23968/2500-0055-2019-4-3-4-12

Table 9 Average monthly nominal salary of employees

Year	2011	2012	2013	2014	2015	2016	2017
Total in the economy (RUB)	23,369	26,629	29,792	32,495	34,030	36,709	39,144
civil engineering	23,682	25,951	27,701	29,354	29,960	32,322	33,678

Table 10 Average annual number of employees engaged in civil engineering

Year	2011	2012	2013	2014	2015	2016	2017
the employed – total number (thous. people)	70,857	71,545	71,391	71,539	72,324	72,393	72,142
civil engineering	5,106	5,320	5,392	5,419	5,475	5,201	5,258

Table 11 Labor efficiency index in Russia in whole and in the civil engineering sector of the Russian Federation (in percent as compared to the previous year)

Year	In economy in whole	In the civil engineering sector
2010	103.2	99.6
2011	103.8	105.2
2012	103.2	101.6
2013	101.8	99.8
2014	100.7	98.4
2015	98.9	100.8
2016	100.2	102.3
2017	101.9	97.6

Also, the share of migrant workers in civil engineering who compensate a significant part of labor resources deficit in the sector should be taken into account. As of the end of 2012, the share of migrant workers with an effective work permit who were engaged in the economy of Saint Petersburg and the Leningrad Region was 12.9% and 3.0% of the total number of all migrant workers in Russia with a work permit, respectively (Shcherbakova, 2013). Besides, only 96,000 migrants working in the civil engineering sector in the Saint Petersburg agglomeration out of 296,000 people had a work permit in 2011 (Vedomosti, 2017). In H1 2013, according to the Directorate of the Federal Migration Service, only 100,000 people out of almost 800,000 migrants (with only 352 persons being highly qualified specialists) received a work permit (Sadkova, 2013). As of the beginning of 2016, there were 400,000–450,000 migrant workers in the city (Saint Petersburg Vedomosti, 2016). According to Petrostat, for this period in 2017, the number of migrants (including those who migrated from other Russian regions and non-CIS countries) grew by 15% (Vedomosti, 2017). However, only 132,000 migrants received a work permit in H1 2017.

The following conclusions can be made on the basis of the analysis of the civil engineering sector state:

- poor qualification of workers engaged in civil engineering, and, as a consequence, low labor efficiency, which is in many aspects caused by obsolete management and production technologies (Faltinsky, Tokunova, 2018);
- low level of the innovations used, which does not ensure economic growth of the construction sector;
- no comprehensive approach to management of the organization's resource portfolio that would take into account rapid development factors.

Thus, intensification of civil engineering production requires initiation and implementation of innovative processes, structural reorganization for creation and development of the most innovative activity both on a scale of the organization, sector and on a scale of the state as a whole. Integrated programs for planning and development of innovative activities, that can provide coordination of works performed, shall serve as a basis for activities on reorganization of the civil engineering sector.

We believe that to develop an integrated method for assessment of the resource portfolio and innovation environment of a construction organization, it is reasonable to use as a basis the assessment method proposed by Goran Roos. According to Roos, there is an individual set of resources in every organization, and these sets of resources affect the results of activities. However, since there is no clarity concerning the reasons for success or failure, it is hard to establish the contribution of an individual resource to the success without taking into account the interdependence with other resources.

Management of material and immaterial resources of an organization is aimed at the growth of the organization's market value (creation of the organization's value). The essence of the immaterial resources' management technique lies in transformation of the resource portfolio and search for its most preferable configuration. It is therefore necessary to use not only business processes' management tools, but also the organization's resource portfolio when elaborating a technique to create and manage development of the organization's innovation environment.

Civil engineering as a type of activity has a significant influence both on the organizational structure and the structure of the resource portfolio of a construction organization. As opposed to industrial organizations, in the civil engineering sector, the design and development stage (usually connected with innovative activity as the greater share of R&D in the industry occurs during this stage) is externalized and represents an independent professional activity. Therefore, various organizations performing design, construction, implementation and operation can be engaged in implementation of a single civil engineering project for fulfillment of its individual stages.

Thus, an integrated method of resource portfolio estimation in civil engineering should be structured on the basis of the project life cycle stages. They are described in more detail below.

During the pre-investment phase, the organization faces the need to solve non-standard, unique tasks, to make managerial decisions c and within limited timeframe. Therefore, the main focus should be on solving a unique problem of a client. The efficiency of organization activity lies not only in the solution (a result (innovative concept)) but also in individuals who suggested the given solution and in the way it was conceived (innovation environment). Operations performed during this stage are consistent and cycled. Capability for permanent re-configuration of the existing resource portfolio for resolving non-standard problems is required, thus, the organization acts as per the "economy of scope" logics. Organization's activity is estimated based on its efficiency (it does not mean that it is efficient; it means that the most attention is paid to efficiency), consequently, main efforts of the management are aimed at reduction of coordination costs that define organization's activity efficiency. Thus, the main resource of a construction organization at the pre-investment stage is human assets in the form of skills, knowledge, expertise and competences of personnel involved in the production process. Therefore, the education and qualification level of personnel (estimation of the human assets' level) significantly identifies the volume of the civil engineering organization innovative potential.

During the investment phase of the life cycle of a construction project, two scenarios are implemented: preparing design and estimate documentation (DED) and performing construction works. Conclusion of an agreement with a General Contractor, works acceptance and acquisition of a permit for civil engineering activities are performed during the documentation preparation stage. The production logics is similar to the previous (pre-investment) stage, thus, resource transformation technologies represent the most important management tools.

The leading resource at these two stages is human assets facilitating the accomplishment of organization's goals and increasing the organization's activity efficiency level.

An agreement with a General Contractor for fulfillment of construction and installation works with subsequent works acceptance is concluded at the construction stage. Operations performed at this stage are consistent and linear. Efficiency of organization's activity at the construction stage is defined by standardization and formalization of production processes, repetition (economy through training) and mass production (economy through scale). Commitment to economic efficiency is naturally created in the logics of the construction stage (the main criterion for estimation of production activity that is in constant focus of managerial attention). Therefore, main efforts are aimed to reduce transaction costs (related to efficiency). The concept of decrease in labor intensity of production processes shall be applied in accordance with the logics of this stage, and, therefore, innovative development shall be arranged at the expense of implementation of the corresponding technologies that minimize labor of workers and replace them by robots and equipment. For example, more than 550 various automation and robotization systems for civil engineering works and unattended civil engineering technologies were developed and implemented in Japan within the last two decades (Vin'kov et al., 2007).

A facility is commissioned at the post-investment stage of the civil engineering project life cycle.

In summary, it can be said that the specifics of civil engineering activity has a direct impact on innovative development of civil engineering organizations. In the context of development and implementation of an innovative idea, there is a pronounced difference in the structure and the size of the resource portfolio. Based on the above, we determine the weights of resources in the resource portfolio structure (Figs. 1, 2).

All resources 100%				
Immaterial resources 75%			Traditional economic resources 25%	
Organizational resources (25%)	**Human resources (30%)**	**Relationship resources (20%)**	**Monetary resources (15%)**	**Material resources (10%)**
Public image (25%)	Competences (18%)	Subcontractors (10%)	Cash (35%)	Raw materials (18%)
Business processes (40%)	Attitudes (11%): - behavior (28%) - motivation (40%) - traits (32%)	Suppliers (10%)	Investments (45%): - attraction of investors / lending activities (49%) - proceeds from owners/shareholders (51%)	Land (28%)
Intellectual property (35%): - patents (31%) - regulations (18%) - projects (26%) - quality standards (25%)	Personal relations (10%)	Clients (13%)	Guarantees (20%)	Structures (30%)
	Knowledge (18%)	Customers (12%)	Subsidies (51%)	Equipment (24%)
	Skills (18%)	Owners/shareholders (12%)	Public funding (49%)	
	Intellectual flexibility (25%): - innovations (45%) - problem statement (25%) - problem solution (30%)	Competitors (11%)		
		Financial institutions (12%)		
		State (15%)		
		Local communities (5%)		

Fig. 1. Determining the weights for the resource portfolio of a construction organization during life cycle stages of a construction project (pre-investment, preparation of design and estimate documentation)

DOI: 10.23968/2500-0055-2019-4-3-4-12

All resources 100%				
Immaterial resources 75%			Traditional economic resources 25%	
Organizational resources (25%)	**Human resources (30%)**	**Relationship resources (20%)**	**Monetary resources (15%)**	**Material resources (10%)**
Public image (25%)	Competences (18%)	Subcontractors (10%)	Cash (35%)	Raw materials (18%)
Business processes (40%)	Attitudes (11%): - behavior (28%) - motivation (40%) - traits (32%)	Suppliers (10%)	Investments (45%): - attraction of investors / lending activities (49%) - proceeds from owners/shareholders (51%)	Land (28%)
Intellectual property (35%): - patents (31%) - regulations (18%) - projects (26%) - quality standards (25%)	Personal relations (10%)	Clients (13%)	Guarantees (20%)	Structures (30%)
	Knowledge (18%)	Customers (12%)	Subsidies (51%)	Equipment (24%)
	Skills (18%)	Owners/shareholders (12%)	Public funding (49%)	
	Intellectual flexibility (25%): - innovations (45%) - problem statement (25%) - problem solution (30%)	Competitors (11%)		
		Financial institutions (12%)		
		State (15%)		
		Local communities (5%)		

Fig. 2. Determining the weights for the resource portfolio of a construction organization during life cycle stages of a construction project (investment, construction)

Conclusion

In the course of this study, the analysis of the construction sector was conducted, and the extremely low level of innovative activity in construction organizations was identified (among other things, due to the conservative nature of civil engineering as a type of economic activity). However, at the current stage of the society development, it is innovations that are the driving force behind the economic growth both at the level of the organization and the economy as a whole. The nature and areas of use of the innovative component radically differ from the implementation stage of a construction project. In the context of the work done, the difference in the structure and size of the resource portfolio with the weight for each resource was given. This approach should be included in the integrated method of assessment of the resource portfolio and innovative environment of a construction organization.

References

Faltinsky, R., Tokunova, G. (2018). Information technologies and construction sector: Why construction loses competition for innovations to other industries? In: *SHS Web of Conferences* (2018) CC-TESC 2018, 44, p. 00033 DOI: 10.1051/shsconf/20184400033.

Federal State Statistics Service (Rosstat) (2018a). *Civil engineering in Russia.* 2018. Rosstat, Moscow.

Federal State Statistics Service (Rosstat) (2018b). *Labor force, employment and unemployment in Russia (based on the results of sample studies of labor force).* 2018. Rosstat, Moscow.

Federal State Statistics Service (Rosstat) (2018c). *Russia in figures.* 2018. Rosstat, Moscow.

Federal State Statistics Service (Rosstat) (2018d). *Russian regions. Main characteristics of Russian constituent entities.* 2018. Rosstat, Moscow.

Vedomosti (2017). 50% more migrants from CIS countries came to Saint Petersburg. Available at: https://www.vedomosti.ru/management/articles/2017/09/05/732346-migrantov-sng (accessed on: 15.04.2019).

Vinogradova, A.V. (2012). *Macroeconomics. Study guide.* Nizhny Novgorod: Nizhny Novgorod State University, 85 p.

Roos, G., Pike, S., Fernström, L. (2010), *Intellectual capital: management approach.* Saint Petersburg: Higher School of Management, 436 p.

Sadkova, E. (2013). Out of 100,000 migrants having a work permit, only 352 persons are qualified specialists. Available at: https://ok-inform.ru/obshchestvo/3702-v-peterburg-chashche-vsego-priezzhayut-uzbeki.html (accessed on: 15.04.2019).

Saint Petersburg Vedomosti (2016). Saint Petersburg is a city of migrants. Available at: https://spbvedomosti.ru/news/obshchestvo/peterburg_gorod_nbsp_migrantov_/ (accessed on: 15.04.2019).

Shcherbakova, E. (2013). As of the end of 2012, 1,149 thous. foreign citizens had a permit to work in Russia. Available at: http://www.demoscope.ru/weekly/2013/0545/barom05.php (accessed on: 15.04.2019).

Tokunova, G.F. (2014). Construction cluster: trends and prospects. *Advanced Materials Research,* 1020, pp. 849–853. DOI: 10.4028/www.scientific.net/AMR.1020.849.

Vin'kov, A., Imamutdinov, I., Medovnikov, D., Oganesyan, T., Rozmirovich, S., Hazbiev, A., Shchukin, A. (2007). Innovations in construction cluster: obstacles and prospects. RAEX Analytics (International group of rating agencies). Available at: https://raex-a.ru/researches/city/inno_r_db (accessed on: 15.04.2019).