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Integral multi-criteria evaluation of construction sector competitiveness

Abstract. The absence of both a unified approach to the integral evaluation of the construction sector competitiveness and adequate economic and mathematical models to measure the level of competitiveness were the cause of criteria complementing and supplementing, and development of a technique, which makes it possible to integrate all the indicators into a single system to determine region's ranking according to the level of competitiveness and further development strategy. The approach has been tested on the six chosen Russian regions: Belgorod, Voronezh, Kursk, Smolensk, Orel, and Bryansk regions.
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Інтегральна багатофакторна оцінка конкурентоздатності будівельного сектору
Анотація. У статті обґрунтовано необхідність розробки інтегральної багатофакторної методики оцінки конкурентоздатності будівельного сектору, що дозволяє групувати всі показники в єдину оцінку, визначати рейтинг регіону за рівнем конкурентоспроможності для подальшого цільового розвитку. Методику апробовано на ряді російських регіонів.
Ключові слова: конкурентоздатність; інтегральна оцінка; будівельний сектор.

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Аннотация. В статье обоснована необходимость разработки интегральной многофакторной методики оценки конкурентоспособности строительного сектора, позволяющая группировать все показатели в единую оценку, определять рейтинг региона по уровню конкурентоспособности для дальнейшего целевого развития. Методика апробирована на ряде российских регионов.
Ключевые слова: конкурентоспособность; интегральная оценка; строительный сектор.

1. Introduction. Increasing the competitiveness of the construction sector of the economy is of paramount importance. The effective functioning of this sector can create new jobs and improve the development of the related sectors of the economy. In this regard, a need to determine an integral objective criterion to evaluate competitiveness and indicators of its evaluation for effective managerial decisions aimed at increasing the level of regional development arises.

2. Brief literature review. The main framework of the study is based on the works of the leading Russian scientists and experts in theoretical foundations of the concept of competitiveness, such as G. L. Azoev (1996) [1], M. I. Gelvanovsky (1998) [2], R. A. Fatkhutdinov (2000) [3], etc.; and in the research of the construction sector development and management, such as Yu. V. Vertakova (2005) [4], V. A. Voronin, (2006) [5], I. V. Milgunova (2008) [6], V. Z. Chernyak (2003) [7], etc.

The works of the foreign scientists, who made a significant contribution to the development of the theory of competition and competitiveness, are also used in the study. They include the works of I. H. Ansoff (1989) [8], P. F. Druker, (2009) [9], F. Gouillart and J. Kelly (2000) [10], S. V. Krivenko (2014) [11], K. Lewin (1951) [12] M. E. Porter (1985) [13], T. L. Saaty (1989) [14], I. I. Cherlenyak (2014) [15], etc.

The analysis of the works on the problem under study led to the following conclusions:

1) the analysis of the works of the authors mentioned above has shown that there is still a narrow disciplinary approach to the problem of construction sector competitiveness;

2) a unified approach to the systematization of the criteria of the analysis and evaluation of the level of the construction sector competitiveness has not been defined;

3) the techniques proposed by the authors are not fully adjusted to the construction sector competitiveness evaluation as a whole, and mainly assess the competitiveness of individual businesses.

3. The purpose of the article is to develop a technique for integral multi-criteria evaluation of the construction sector competitiveness.

4. Results. The analysis of the competitiveness evaluation issues allowed substantiating the multivariance of the indicators and conditions of competitiveness, relativity of this category which, consequently, leads to the complexity of its definitions. In our opinion, there is no single and universal concept of «competitiveness». That is why, it is necessary to use a combination of quantitative analysis and competitiveness evaluation techniques.

There is a need for competitiveness evaluation techniques at meso-level (sectors, complexes) in terms of determining the relationships of individual structural elements of the construction sector, in which each next level is based on the grounds of the previous one, and, in addition, has its own elements and characteristic features and provides the grounds for a higher level.

Typically, competitiveness is evaluated using four calculation methods: 1) based on the comparison of the quality and the price of an object; 2) a differential method; 3) an integrated method; 4) a mixed method.

The above-noted methods do not allow determining the level of competitiveness with absolute accuracy and do not take into account its changes; they are not adapted to the requirements of today's market relations, which can change the conditions of objects' competition, including geographic market fractions, advertising companies, etc.

We offer an aggregate (integral) technique of evaluating the construction sector competitiveness, based on the theory of effective competitiveness. In accordance with this technique, the

most competitive is that construction industry complex, in which the work of all the interrelated economic entities and their units (construction companies and enterprises producing construction materials) is organized in the best possible way. Many external and internal factors influence the effectiveness of their activities; that is why a multi-criteria evaluation of the resource efficiency is required.

It is necessary to group the criteria (indicators) of competitiveness. Then, it is reasonable to divide them into four groups according to performance, economic entity financial status, effectiveness of final product sales, competitiveness indicators.

These groups include the following criteria:

Group 1: production cost figures, return on assets, construction works effectiveness, and labour productivity;

Group 2: financial stability criteria, turnover figures;

Group 3: profitability criteria, utilization rate, the coefficient of final product merchandising;

Group 4: quality indicators and pricing policy analysis.

Formally, meso-entities' competitiveness can be represented as follows:

$$KC_{meso.s} = F(y_s) + KC_{m/prod.i_s}, \quad (1)$$

where $KC_{meso.s}$ is meso-entities' competitiveness, $F(y_s)$ are the parameters characterizing the construction sector at the meso-level (meso-entity), $KC_{m/prod.i_s}$ is the indicator of the competitiveness of the i-th mini-entities (enterprises producing construction materials, construction companies, etc.), which are parts of the s-th meso-entity.

A large number of indicators are involved in the calculations, and they have different dimensions. These criteria are reduced to uniform characteristics in order to adequately involve them in the process of analyzing and construct the aggregate indicator. These factors can act as stimulants and destimulants.

Taking into account the above-said, a technique similar to the one used to calculate Human Development Index in the United Nations can be applied to transit to uniform characteristics.

The maximum and minimum values of the j-th criterion, respectively, based on the values of this indicator for 6 years in 6 regions of Russia are used in this paper to exemplify the technique as $X\,max\,j$ and $X\,min\,j$, i.e. $X\,max\,j$ = max (Xij for 6 years), $X\,min\,j$ = min (Xij for 6 years).

Criteria scaled values are calculated and adjusted for weight coefficients according to formulas (2) and (3).

$$Xmij = \frac{Xij - X\min j}{X\max j - X\min j} \quad \text{- for stimulants,} \quad (2)$$

$$Xmij = \frac{X\max j - Xij}{X\max j - X\min j} \quad \text{- for destimulants,} \quad (3)$$

where $Xmij$ is the scaled value of the j-th indicator for the i-th region in n year;

Xij is the actual value of the j-th indicator for the i-th region in n year;

$X\ min\ j$ is the minimum value of the j-th indicator for n years for i regions;

$X\ max\ j$ is the maximum value of the j-th indicator for n years for i regions.

Further, we propose to use an aggregate criterion, which allows comparing the activities of all economic entities of the complex simultaneously to determine the level of competitiveness of the building complex.

The model, which is used in the technique procedure, is based on a comparison of planned (target) and actual indicators. The contents of this model are as follows. The set of indicators C form each object. The distinction of an object occurs when at least one Pi^{th} indicator from the set of C^a describing the object «a», is numerically different from Pi^{th} indicator from the set C^b describing the object «b». In other words, if $C^a = \{P^a{}_1, P^a{}_2, \ldots, P^a{}_n\}$ and $C^b = \{P^b{}_1, P^b{}_2, \ldots, P^b{}_n\}$ are the images of two objects, $C^a \neq C^b$; if at least one of the indicators $P^a{}_i \neq P^b{}_i$. All the indicators of the reference C^a are assigned maximum values. The calculations start with determining the difference between the actual indicators of the studied object *(Pfi)* and the target indicators *(Pei)*. The degree of similarity of an actual image and a target one is calculated by the formula:

$$Yi = 1 - \frac{dio}{Co}, \quad (4)$$

where

$$dio = \sqrt{\sum_{j=1}^{n}(xij - xoj)^2}, \quad Co = \bar{x} + 2Sd,$$

$$\bar{x} = \frac{1}{t}\sum_{i=1}^{t} dio, \quad Sd = \sqrt{\frac{1}{t}\sum_{i=1}^{t}(dio - \bar{x})^2},$$

xij is the implementation of the j-th property in the i-th object *(Pf)*;

xoj is the implementation of the j-th property in the target object *(Pe)*.

The proposed technique allows taking into account the distance between the objects under study, considering their competitiveness in terms of time, examining regression relations of independent and resulting indicators.

Using the proposed technique the construction sector competitiveness of six regions was calculated for 2009-2014 period of time. They include Belgorod, Voronezh, Kursk, Smolensk, Orel, and Bryansk regions.

With regard to the construction sector, all the competitiveness criteria can be grouped according to investments, the amount of work performed at construction sites, the beginning of capacity utilization.

Evaluation includes the following stages: criteria determination, calculation of their weighting; adjustment of indicators determining their weighting; the formation of an aggregate indicator for each group of criteria and their adjustment determining their weighting (Figure 1).

Thus, on the whole, the grading of competitiveness criteria consists of three levels. Hierarchy analysis method was used as the basis of determining the coefficients' weighting of the indicators. Judgment matrices for each group of criteria were filled using professional judgments. At the final stage, an aggregate indicator of the construction sector competitiveness was calculated. Indicators for six years (2009-2014) were estimated to track the dynamics of the construction sector competitiveness in the regions. Ranking results are given in the Table 1.

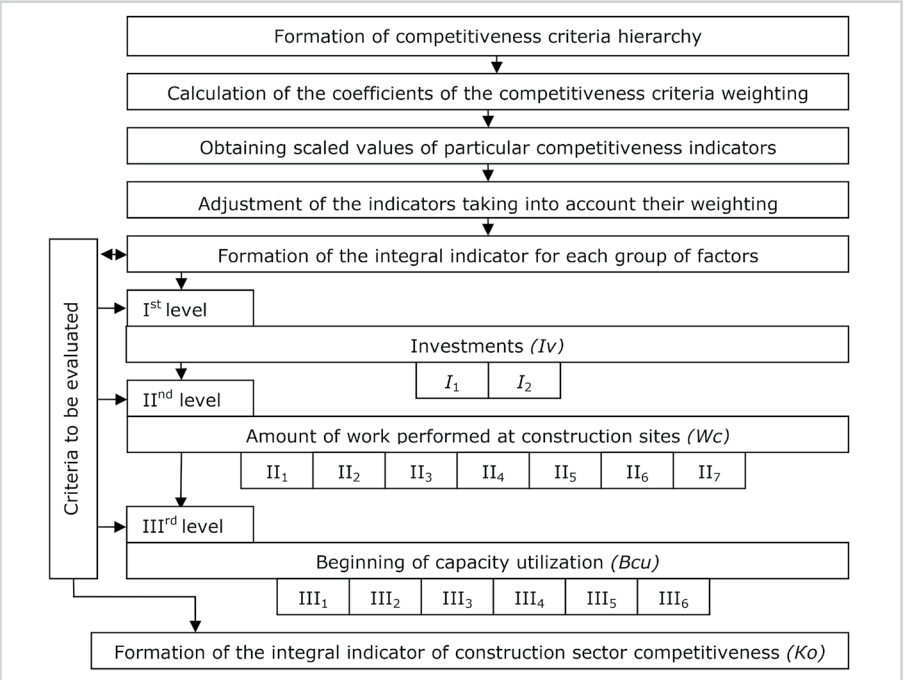
The obtained results indicate that Voronezh and Belgorod regions are the most competitive ones according to the used ranking technique. It can also be concluded that Kursk region is in the need of transforming the development of raw material areas of the industry, and production facilities reconstruction and technical revamping. Due to these, it is necessary to create organizational framework for all the stages of the technological cycle of construction works at the regional level.

Thus, the proposed technique makes it possible to integrate all the indicators into a single evaluation of construction sector competitiveness, rank the regions in terms of their competitiveness, and identify a strategy for the further development tending to the reference value.

5. Conclusion. Previously used techniques are not adapted to evaluate the construction sector competitiveness as a whole; they evaluate mainly the competitiveness of separate business entities.

A technique for integral multi-criteria evaluation of the construction sector competitiveness has been developed to solve this problem. In the developed technique the factors influencing the construction sector competitiveness have been identified, the specified indicators have been grouped, and the mechanism for calculating the integrated indicator has been defined.

Practical approval of the developed technique allowed ranking the six studied regions in terms of construction sector competitiveness level and making effective managerial decisions for the regional development of this sector.



Note: Ko is the sector competitiveness; Iv is the investments; I1 is the investments for the development of physical facilities of construction organization; I2 is the investments in fixed assets; Wc is the amount of work performed at construction sites; II1 is the number of organizations; II2 is the amount of work performed under construction contracts; II3 is the average annual number of employees in the construction sector organizations; II4 is the average employees' salary; II5 is the construction of residential buildings; II6 is the number of buildings commissioned for operation; II7 is the cost of work in progress; Bcu is the beginning of capacity utilization; III1 is the is the beginning of capacity utilization of all construction objects; III2 is the is the beginning of capacity utilization of residential buildings; III3 is the beginning of capacity utilization of flats per 1,000 of working-age population; III4 is the beginning of capacity utilization of gas transmission networks; III5 is the average prices at the primary market of residential buildings; III6 is the average prices at the secondary market of residential buildings.

Fig. 1: **Algorithm of integral multi-criteria evaluation of construction sector competitiveness**
Source: Authors' elaboration

Tab. 1: **Ranking of the regions' construction sector indicators of the competitiveness level**

Regions	Competitiveness						
	2009	2010	2011	2012	2013	2014	Rank
Kursk	0.2439	0.335017	0.535818	0.586063	0.779003	0.697645	4
Belgorod	0.342701	0.461012	0.527071	0.635234	0.825453	0.721539	2
Voronezh	0.347973	0.451420	0.568878	0.652425	0.771594	0.841305	1
Orel	0.253369	0.366148	0.436646	0.453394	0.700964	0.647631	5
Smolensk	0.317055	0.449471	0.54616	0.550073	0.823862	0.742895	3
Bryansk	0.197735	0.305465	0.375352	0.496534	0.644297	0.632971	6

Source: Source: Authors' own calculations

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