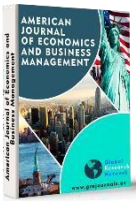

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Article

Methodology of Assessing the Prospects of Competitiveness in Construction Industry Companies

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Abstract: Assessing the competitiveness of construction industry enterprises at the national level is of great importance in developing a strategy for socio-economic development since construction is one of the driving industries of the economy, and positive changes in it are considered a growth factor in other industries. Research conducted by the author showed that improving quality is the central concept of competitiveness in the construction industry. The selected scientific assumption is based on the importance of attention to quality management in the modern construction market, the low efficiency of quality management systems in the industry, and the insufficient development of conceptual and methodological approaches to improving quality. In proving the scientific assumption, new, comprehensive scientific and methodological proposals were created at construction industry enterprises, reflecting the quality strategy, concept, organisational and economic models, mechanisms and methods. Implementing the methodology created requires a unique approach to determining the effect of continuous improvement on the quality of construction products. In this case, a method based on forecasting the indicators of the construction industry network and analysing the results according to a specific procedure is necessary. This article proposes a methodological approach to assessing the generalised indicator of the construction industry's competitiveness through mathematical modelling and clarifies the network's prospects.

Keywords: Construction Industry, Competitiveness, Quality Management, Forecasting, Mathematical Modelling, Quality Factor.

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1. Introduction

The competitiveness of construction industry enterprises holds critical importance for economic growth, as the industry acts as a primary driver within the economy, influencing developments in related sectors. Evaluating competitiveness at the national level informs socio-economic strategies that enhance industry performance and contribute to sustainable growth. Key indicators, such as investment levels, quality management, and output volume, form a framework that reflects the construction industry's health and potential for competitive advancement in the marketplace.

This research specifically examines quality management's impact on construction enterprises' competitiveness. The study's foundation is the hypothesis that improvements in quality directly correlate with enhanced competitive performance. A unique methodological framework integrates mathematical modeling and statistical analysis to quantify the influence of quality management on competitiveness. This approach isolates

quality as a distinct factor and evaluates its contribution relative to other traditional measures like capital investment and production output.

In the current literature, multiple studies highlight the role of quality management systems in enhancing enterprise competitiveness. For instance, prominent theories emphasize defect-free production and the integration of quality principles in construction processes. However, a knowledge gap exists regarding the specific economic impact of these quality improvements on industry competitiveness, particularly within Uzbekistan's construction sector. This study addresses this gap by modeling competitiveness with quality management as a core variable, offering a methodological advancement over traditional cost-based competitive assessments.

Our methodological approach utilizes regression analysis to forecast competitiveness indicators, relying on construction data from 2010-2023. By integrating factors such as fixed capital investment, material volumes, and GDP impact, the model predicts competitiveness metrics and highlights areas for quality enhancement. Expected outcomes include a quantitative evaluation of quality's role in competitive success, offering a predictive analysis for the construction industry through 2030.

The findings from this research are anticipated to demonstrate that systematic quality management improvements yield substantial benefits, not only in cost reduction but also in enhanced enterprise ratings and market position. As an implication, this study proposes a policy framework that promotes quality-driven competitiveness, with recommendations for stakeholders in construction and government policy bodies aiming to strengthen the national economy through targeted quality management initiatives.

Literature review

Problems of increasing competitiveness and quality management in construction industry enterprises and Organizations A.A. Thompson [1], K.R. McConnell [2], V.V. Asaul [3], M. Babarin [4], V. Buzyrev [5], N.G. Verstina [6], D.S. Voronov [7], A.A. Petrosyan [8], M.A. Shuvaev [9], etc., are widely covered in the researches of foreign scientists. In them, ways to increase the competitiveness of enterprises through the formation of the quality of construction products in the investment-construction process, the improvement of defect-free production mechanisms, and the introduction of quality management principles have been determined.

Issues of increasing competitiveness and quality management in construction industry enterprises in Uzbekistan: S.S. Gulomov [10], M.A. Ikramov [11], N.M. Makhmudov [12], B. Khodiev [13], G.J. Allaeva [14], A.N. Dzhabriev [15], R.I. Nurimbetov [16], M.R. Boltaboev [17], I.A. Usmanov [18] and others are widely covered in the author's research. In most of these scientific developments, the problems of evaluating the quality of construction products with the level of defects, studying the factors causing defects, analysing the costs of quality management, and quality competitiveness have been raised.

2. Materials and Methods

Summarising the opinions of scientists and experts and analyzing construction industry statistics in depth, we reached the following conclusion: The main general indicator of competitiveness in the construction industry is the volume of construction work. Factors affecting it include the volume of investments in fixed capital, the number of enterprises in the field, labour resources, the building materials industry, and the physical volume of some construction products.

As part of the goals and objectives of the research, we included the following factors in the regression equation to create a forecast of the volume of construction work (U1):

- the volume of investments in fixed capital, billion soums (X1)
- the volume of manufacturing industry, billion soums (X2)
- the volume of building materials, in the case of concrete, thousand tons (X3);
- the volume of investments in construction works, billion soums (X4)

- the total area of commissioned houses, thousand sq.m. (X5)
- gross domestic product in billion soums (X6).

3. Results and Discussion

Main body. To evaluate the influence of factors on the general indicator, we selected the database for the years 2010-2023 as a base point (Table 1)

Table 1, Table of factors for forecasting the volume of construction work

Year	Volume of construction works (billion soums)	Volume of investments in fixed capital (billion soums)	Manufacturing industry (billion sums)	Building materials (portland cement) (thousand tons)	The volume of investments in construction and assembly works in fixed capital investments (billion soums)	Total area of commissioned houses (thousand square meters)	Gross domestic product volume (by production method, billion soums)
2010	8245,8	16463,7	28742,8	5938,7	8001,4	8859,2	78936,6
2011	9504,8	19500	37295,3	6354,4	9126,0	9203,3	103232,6
2012	11753,9	24455,3	44347	6862,8	11909,7	10367,7	127590,2
2013	15219,3	30490,1	56068,7	7274,5	15153,6	10744,4	153311,3
2014	20060,4	37646,2	68225,7	7638,2	19387,8	11419,7	186829,5
2015	25423,1	44810,4	78492,3	8459,6	22853,3	12052,7	221350,9
2016	29413,9	51232	91483	8645,9	26640,6	11280	255421,9
2017	34698	72155,2	120687	9132,2	38530,9	11456,4	356453,8
2018	51129,3	124231,3	189643	9080,4	55407,2	13398,6	473652,8
2019	71156,5	195927,3	254861	10549,8	78762,8	15501,5	594659,6
2020	88130,3	210195,1	305929	11926,1	91224,7	12867,9	668038
2021	107492,7	239552,6	378186	13043,3	106600,9	14045,5	820536,6
2022	130790,9	266240	460492	13058,2	130990,1	14612,6	995573,1
2023	150792,6	356071,4	556382	14556	164148,9	14752,3	1192162,5

After applying economic-mathematical methods and carrying out appropriate calculations to check their validity, we decided to use the mathematical model of linear programming. We decided to show the final results, taking into account that the details of the tools and calculations used would take up a lot of space in the text of the study.

The regression equation is based on statistical data from 2010-2023 and includes the forecast period of 2024-2030. Based on the obtained results, the regression equation is as follows:

$$Y = -23136.0075 - 0.09093X_1 + 0.3447X_2 + 2.9934X_3 + 0.1307X_4 + 0.6909X_5 - 0.0491X_6.$$

Regarding the economic details of this model, an increase in the X1 factor by one unit leads to an average decrease in Y by 0.0909 units; by X2 factor - to increase by 0.345 units on average; by factor X3 - to increase by 2,993 units on average; by factor X4 - to increase by 0.131 units on average; by X5 factor - to increase by 0.691 units on average; According to the X6 factor - it leads to an average decrease of 0.0491 units. From the most significant amount of b-coefficient (b2=1.246), we conclude that the X2 factor has the most significant influence on the Y result.

The factor analysis allows us to predict the level of competitiveness through a forecast of construction works. Suppose we take into account the change of factors based on the determined regression equation. In that case, we will calculate the prospective

indicators of the volume of construction works in the republic until 2030 in the table below (Table 2).

Table 2, Forecast of construction work in the Republic of Uzbekistan for 2024-2030 based on the regression equation

T.p	Years	Volume of construction works, (billion soums)
1	2024	170795,14
2	2025	190797,68
3	2026	210800,21
4	2027	230802,75
5	2028	250805,29
6	2029	270807,83
7	2030	290810,36

These results are compiled based on factors that generally impact the construction industry; that is, the mechanisms of introducing quality management models and increasing competitiveness in enterprises are not reflected here. At the same time, as shown in the previous chapters, the proposed models of increasing competitiveness optimise quality costs, reduce losses and increase labour productivity. We believe the effectiveness of scientific research and proposals should be included in this forecast. Therefore, an element showing the effect of quality management systems should be included in addition to the existing regression model. Conducted personal research led to the conclusion that this element can be in the form of a correction coefficient, i.e.

$Y = K_{smt}*(-23136.0075-0.09093X_1 + 0.3447X_2 + 2.9934X_3 + 0.1307X_4 + 0.6909X_5-0.0491X_6)$.

Here, K_{smt} is a correction coefficient that considers reducing quality costs that result from improving quality management systems.

To calculate this coefficient, we decided to introduce a specific procedure.

By the end of 2023, 35,297 construction organisations were operating in the republic, of which 17,007 were included in the "Transparent Construction" system and 18,290 were not.

Our scientific hypothesis is:

1. To make quality costs comparable, we assume that the number of organisations is constant as a boundary condition. Then, as a result of improving quality management, enterprises and organisations carry out their actions within this complex.
2. If the "A" model of quality management is gradually implemented in O* category enterprises and organisations, 15% of them will become equal members of the "Transparent Construction" system per year; that is, they will be included in the D category of the electronic rating.
3. Implementing the "B" model of quality management step-by-step in contracting organisations in the D category will lead to at least 10% of them moving up one step in the electronic rating and to the "S" category.
4. Simultaneously, the gradual introduction of the "V" model of quality management in contracting organisations of the C category will cause at least 5% of them to rise one step in the electronic rating and move to the V category.
5. Finally, the gradual introduction of the "G" model of quality management in contracting organisations of the V category will cause at least 3% of them to rise one step in the electronic rating and move to the highest category A.

If this process is effectively implemented, the number of enterprises and organisations not included in the electronic rating will be reduced by tenfold by 2030.

Based on these scientific assumptions, we determined that the structure of contract construction organisations will change during the forecast period (Table 3).

Table 3, Changes in the composition of the rating of contract construction organisations during the improvement of quality management systems

Category		**Main (2024)**	**1st year (2025)**	**2nd year (2026)**	**3rd year (2027)**	**4th year (2028)**	**5th year (2029)**	**6th year (2030)**
A		6	40	78	123	175	236	308
B	**3%**	1123	1280	1483	1735	2041	2400	2814
C	**5%**	3809	4825	5945	7146	8412	9727	11077
D	**10%**	12069	13606	14989	16233	17353	18362	19269
O*	**15%**	18290	15546	12803	10059	7316	4572	1829
		35297	**35297**	**35297**	**35297**	**35297**	**35297**	**35297**

Note: O* - Construction enterprises that are operating today and are not included in the transparent system

The numbers in the table above are the result of the following calculations. According to the first year of the effectiveness of the models: Because 15% of enterprises in the O* category are transferred to the D category, their number is 15546 (18290 - 0.15*18290). The number of enterprises in the D category will be increased from below, and 10% of the existing enterprises will be transferred to the C category. Then their number will be as follows (12069 – 0.1*12069 + 0.15*18290);

In the same order, the number of C category enterprises is calculated, that is (3809 – 0.05*3809 + 0.1*12069);

- The number of category V enterprises is (1123 – 0.03*1123 + 0.05*3809)
- The number of enterprises included in category A will equal (6 + 0,03*1123).

Since improving quality management systems is a multi-stage continuous process, the structure of construction enterprises will shift towards higher-category enterprises in the following years.

As a result, in 2030, there will be 308 (0.87%) A-category enterprises, 2814 (7.97%) B-category enterprises, 11,077 (31.38%) C-category enterprises, 19,269 (54.59%) D-category enterprises, and those who have not entered the transparent system. Makes 1829 (5.18%).

As a result of the improvement of quality management systems, a step increase in the rating system of enterprises leads to a reduction of quality costs; that is, although the costs of quality management increase slightly, the losses related to defects are sharply reduced. (The composition of quality costs is shown in the previous chapters of the dissertation). In the process of expert surveys and as a result of studying foreign experience, we determined the probable level of expenses corresponding to the quality level of enterprises, that is, for enterprises of category A - 3 per cent, for enterprises of category B - 6 per cent, for enterprises of category C - 10 per cent, for enterprises of category D - 18 per cent. , for enterprises that have not reached the level of the "Transparent construction" system - 25 per cent.

Our calculations based on these data were based on the following results (Table 4) following the above scientific assumptions.

Table 4, Changes in the level of quality costs as a result of the implemented measures, %

Categories	**Quality expenditure, %**	**Fundamental (2024)**	**1-st year (2025)**	**2-nd year (2026)**	**3-rd year (2027)**	**4-th year (2028)**	**5-th year (2029)**	**6-th year (2030)**
A	**3**	0,2	1,2	2,3	3,7	5,2	7,1	9,2
B	**6**	67,4	76,8	89,0	104,1	122,4	144,0	168,9
C	**10**	380,9	482,5	594,5	714,6	841,2	972,7	1107,7
D	**18**	2172,4	2449,0	2697,9	2922,0	3123,6	3305,1	3468,4
O*	**25**	4572,5	3886,6	3200,8	2514,9	1829,0	1143,1	457,3

Total quality expenditure		7193,3	6896,1	6584,5	6259,3	5921,5	5572	5211,4
Degree of quality costs, %		20,38	19,55	18,65	17,73	16,78	15,79	14,76
Annual efficiency, %			**0,842**	**0,8831**	**0,9213**	**0,9569**	**0,9903**	**1,0215**
Total efficiency, %								**5,6151**

Note: O* - Construction enterprises that are operating today and are not included in the transparent systempи

Based on this, the reduction of quality costs in the first year is 0.842%, in the second year—0.8831%, in the third year—0.9213%, in the fourth year—0.9569%, in the fifth year—0.9903%, and in the sixth year—1.0215%. The total economic benefit obtained during the forecast period will equal 5.6151% of construction costs.

Since the volume of additional work performed expresses the impact of quality management systems on construction work, we suggest adding another element to this equation: the quality improvement coefficient. Practical studies and calculations show that this coefficient can vary from 1.008 to 1.012. If we take this coefficient to be equal to 1.01 on average, the adjusted volume of construction work for the forecast period will be as follows (Table 5).

Table 5, Forecast of construction works in the Republic of Uzbekistan for 2024-2030 as a result of improving quality management

No	Years	Volume of construction works, (billion soums)	Adjusted volume of construction works, (billion soums)
1	2024	170795,14	172503,09
2	2025	190797,68	192705,66
3	2026	210800,21	212908,21
4	2027	230802,75	233110,78
5	2028	250805,29	253313,34
6	2029	270807,83	273515,91
7	2030	290810,36	293718,46

So, suppose the development trend of the main factors is maintained and quality management systems are developed by 2030. In that case, the republic's construction work volume will be 293718.46 billion, which amounts to a sum.

Scientific research shows that the possibilities of increasing the competitiveness of individual enterprises in the construction industry are limited in many ways. Therefore, it is appropriate to discuss the competitiveness of the regional construction industry. In this case, quality competitiveness is based on connecting all construction industry enterprises to a unified quality management system.

4. Conclusion

The findings of this study underscore the significant role that quality management systems play in enhancing the competitiveness of construction industry enterprises. Through the application of mathematical modeling and regression analysis, it was demonstrated that improved quality management not only reduces defect-related costs but also positively impacts productivity, market position, and competitive sustainability. These outcomes suggest that prioritizing quality management within the construction sector can serve as a catalyst for broader economic growth, particularly by fostering industry-wide improvements that align with socio-economic development strategies. The proposed methodology offers a foundation for predictive models that could guide future policy and enterprise-level decisions aimed at enhancing competitive performance.

However, further research is necessary to refine these models, particularly in examining the long-term effects of quality management initiatives and their interaction with external market factors. Additionally, future studies should consider sector-specific adaptations to ensure the broader applicability of these findings across varying construction industry contexts.

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