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ESG PRINCIPLES IN QUALITY AND PROFITABILITY MANAGEMENT OF CONSTRUCTION COMPANIES OF KAZAKHSTAN

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Abstract. As the global shift toward sustainable development accelerates, applying ESG principles (environmental, social, and governance) has become increasingly important for construction companies. In Kazakhstan, ESG integration in the construction sector remains limited, highlighting the relevance of this study. The research aims to evaluate how ESG factors influence quality management and profitability in Kazakhstani construction firms and their role in enhancing competitiveness and business resilience. The methodology includes a comparative analysis of ESG practices in six countries (USA, Germany, China, Brazil, the UK, and Kazakhstan) and quantitative analysis using regression and clustering techniques. The empirical base comprises data from 23 construction companies in Kazakhstan for 2023. Key variables in the model include economic efficiency of quality management systems (EEQMS), quality management costs (QMC), overall profitability (OCP), customer satisfaction (CSL), and company age (PO). Regression results show that EEQMS, QMC, and OCP significantly and positively affect sales volume (SV), with a high explanatory power ($R^2 = 0.98$). Cluster analysis grouped companies based on ESG-related performance, identifying both high-performing and at-risk segments. The practical contribution of this research is the formulation

of recommendations for incorporating ESG principles into strategic planning within Kazakhstan's construction industry. These insights can guide managers, investors, and policymakers in fostering sustainable and competitive development. By aligning management practices with ESG standards, construction firms may improve operational performance, stakeholder trust, and long-term market success.

Keywords: ESG, quality management system, profitability, regression analysis, corporate governance.

© Ж. Жұман¹, М.А. Еজেбеков², А.А. Чейрханова^{3*}, 2025.

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ҚАЗАҚСТАННЫҢ ҚҰРЫЛЫС КОМПАНИЯЛАРЫНЫҢ САПАСЫ МЕН РЕНТАБЕЛЬДІЛІГІН БАСҚАРУДАҒЫ ESG-ҚАҒИДАТТАР

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Аннотация. Бұл мақалада Қазақстанның құрылыс компанияларының сапасы мен рентабельділігін басқарудағы ESG-қағидаттарының (Environmental, Social, Governance) рөлі зерттеледі. Жаһандық тұрақты даму үрдісі жағдайында ESG қағидаттарын (экологиялық, әлеуметтік және корпоративтік басқару) қолдану құрылыс компаниялары үшін аса өзекті мәселеге айналууда. ESG қағидаттары компанияның ұзақ мерзімді тиімділігі мен нарықтағы орнығуына тікелей әсер етеді. Қазақстанда ESG стандарттарын құрылыс саласына ендіру процесі бастапқы сатыда ғана, бұл осы зерттеудің маңыздылығын арттырады. Зерттеудің мақсаты – ESG факторларының сапа менеджменті мен компания рентабельдігіне ықпалын анықтап, олардың бәсекеге қабілеттілік пен іскерлік тұрақтылықты арттырудағы рөлін бағалау. Зерттеу әдістемесіне АҚШ, Германия, Қытай, Бразилия, Ұлыбритания және Қазақстан елдеріндегі ESG тәжірибелеріне салыстырмалы шолу, сондай-ақ 2023 жылғы Қазақстандағы 23 құрылыс компаниясының мәліметтері негізінде регрессиялық және кластерлік талдау кіреді. Модельде келесі айнымалылар қарастырылды: сапа менеджменті жүйесінің экономикалық тиімділігі (EEQMS), сапаны басқару шығындары (QMC), жалпы рентабельдік (OCP), тұтынушы қанағаттанушылығы (CSL)

және компанияның нарықтағы қызмет ету ұзақтығы (PO). Нәтижелер EEQMS, QMC және OCP айнымалыларының сатылым көлеміне (SV) айтарлықтай оң әсер ететінін көрсетті, модельдің түсіндірмелігі жоғары ($R^2 = 0.98$). Кластерлік талдау ESG көрсеткіштері бойынша компанияларды жіктеп, орнықты және тәуекелге бейім топтарды анықтауға мүмкіндік берді. Сонымен қатар, ESG қағидаттарын енгізу компаниялардың ішкі процестерін оңтайландырып, тұтынушы сенімін арттыруға және инвестициялық тартымдылығын күшейтуге ықпал етеді. Зерттеудің практикалық мәні – Қазақстандағы құрылыс компанияларына ESG қағидаттарын стратегиялық басқаруға енгізу бойынша нақты ұсыныстар беру. Бұл ұсыныстар сала басшыларына, инвесторларға және мемлекеттік органдарға пайдалы бола алады.

Түйін сөздер: ESG, сапа менеджменті жүйесі, рентабельділік, регрессиялық талдау, корпоративтік басқару.

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ESG-ПРИНЦИПЫ В УПРАВЛЕНИИ КАЧЕСТВОМ И РЕНТАБЕЛЬНОСТЬЮ СТРОИТЕЛЬНЫХ КОМПАНИЙ КАЗАХСТАНА

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Аннотация. В условиях глобального перехода к устойчивому развитию применение ESG-принципов (экологических, социальных и управленческих) становится критически важным для строительных компаний. В Казахстане интеграция ESG в строительную сферу пока находится на начальном этапе, что определяет высокую актуальность данного исследования. Цель исследования – определить влияние ESG-факторов на управление качеством и рентабельностью строительных компаний Казахстана, а также оценить их вклад в повышение конкурентоспособности и устойчивости бизнеса. Методологическая база включает сравнительный анализ международных практик внедрения ESG в строительной отрасли шести стран (США, Германия, Китай, Бразилия, Великобритания, Казахстан), а также регрессионный и

кластерный анализ данных 23 строительных компаний Казахстана за 2023 год. В модели использовались такие показатели, как экономическая эффективность системы менеджмента качества (EEQMS), затраты на управление качеством (QMC), общая рентабельность (ОСР), удовлетворенность клиентов (CSL) и срок функционирования компании (РО). Результаты анализа показали, что EEQMS, QMC и ОСР оказывают статистически значимое положительное влияние на объемы продаж (SV), при этом модель обладает высокой объяснительной способностью ($R^2 = 0.98$). Кластерный анализ позволил классифицировать компании по уровням ESG-показателей, выявив устойчивые и уязвимые группы. Практическая значимость исследования заключается в разработке научно обоснованных рекомендаций по интеграции ESG-принципов в стратегическое управление строительными компаниями Казахстана. Полученные результаты могут быть полезны для руководителей предприятий, инвесторов, аналитиков и государственных органов, формирующих политику устойчивого развития строительного сектора.

Ключевые слова: ESG, система менеджмента качества, рентабельность, регрессионный анализ, корпоративное управление

Introduction. In modern conditions, construction companies are increasingly faced with the need to implement ESG standards-principles (environmental, social, and managerial) that define standards for environmental sustainability, social responsibility, and corporate governance. International practice shows that integration in the field of ESG factors not only improves the reputation of companies, but also contributes to the growth of their financial stability and profitability. This approach is especially relevant for the construction sector, where quality management, energy efficiency and social aspects have a significant impact on the competitiveness of companies.

Despite the active development of ESM initiatives in developed countries, this process is at an early stage in Kazakhstan, which creates both challenges and growth opportunities for construction companies implementing sustainable management strategies.

Literature review. The authors (Bezerra et al., 2024:1) analyzed the problems of implementing ESG standards in the Brazilian construction industry, highlighting key obstacles such as the lack of standardized performance indicators and insufficient transparency of non-financial reporting. It is not necessary for the authors to develop clear instructions and stands for the successful integration of ESG practices into the construction sector. Author (Isaac Akomae-Frimpong, 2023:5) conducted a systematic review of writers, which made it possible to identify key ESG analysts in the state. Its results show that at the project level, factors such as climate sustainability and green construction are important, while at the company level, active interaction with stakeholders and effective project management are important. At the national level, compliance with environmental and social standards is an important factor. The author notes that he is constantly monitoring the changes and emphasizes that there is no need for further use of the ESG identifier in the strategic area.

His paper (Yu Wang et al., 2023:52), published in the *Journal of Cleaner Production*, analyzes new trends in the implementation of ESG in the construction sector. The authors note that companies face challenges such as the need for significant financial investments and the difficulty of coordinating between different stakeholders. However, the authors emphasize that the implementation of ESG standards helps to increase energy efficiency, reduce operating costs, and improve the company's reputation. Conducted a study on the relationship between ESG and innovation in the construction industry. The authors (Pedro et al., 2023:28) emphasize that companies integrating ESG principles in the field are more likely to develop innovative solutions that enhance long-term sustainability and financial stability. The authors (Xin Lei et al., 2024:56) examined the ESG indicators of construction companies in China and their impact on financial performance. The study found that companies with high ESG scores demonstrate higher profitability and stable growth. The authors also emphasize the importance of integrating ESG strategies into corporate governance to ensure long-term success. Thus, international experience shows that integrating ESG principles into the strategy of construction companies is not only ethically justified but also an economically sound practice. Companies implementing ESG face certain challenges, but overcoming them contributes to increased competitiveness and business sustainability.

Materials and methods of research. For the comparative analysis of international ESG implementation practices in the construction sector, six countries were selected: the United States, Germany, China, Brazil, the United Kingdom, and Kazakhstan. This selection was based on differences in the development levels of ESG standards, which allowed for identifying best practices, key barriers, and opportunities for further ESG integration into the construction industry.

The United States is a leader in green construction and corporate governance due to the implementation of the LEED certification system, developed by the U.S. Green Building Council (USGBC) in 1998. LEED has become a global standard for evaluating energy efficiency and environmental performance of buildings. Washington, D.C., was the first city in the world to receive LEED Platinum status, confirming the country's commitment to high environmental standards. In addition, American companies actively promote corporate social responsibility (CSR) and apply international reporting standards such as GRI and CDP, which enhance transparency in sustainability practices. These factors confirm the US's leading role in the development and implementation of ESG standards in the construction sector.

Germany is a recognized leader in energy efficiency and sustainable construction through the adoption of the Passivhaus standard, developed in the early 1990s in Darmstadt. This standard sets strict requirements for building energy use, limiting heating energy consumption to 15 kWh/m² per year—about 90% less than conventional buildings. Germany also actively promotes ESG reporting systems, integrating environmental, social, and governance aspects into corporate practices. The country applies a combination of mandatory regulations and voluntary governance codes to increase business transparency and resilience. For example, companies such as

Deutsche Bank regularly publish non-financial reports that address ESG topics, underscoring their commitment to sustainable development.

China is the world's largest producer of construction materials and leads in construction volume. In 2022, the total value of completed construction works reached 29.87 trillion yuan, while the area of newly completed buildings totaled 15.75 billion square meters. China is also actively implementing ESG standards, aiming to peak carbon emissions by 2030 and achieve carbon neutrality by 2060. However, the country faces challenges related to high emission levels and difficulties in regulating corporate governance. In 2021, the goals for carbon reduction were included in the Government Work Report, indicating China's serious intentions toward sustainable development. Brazil represents a developing ESG market, where significant barriers persist, including limited transparency and weak protection of workers' rights.

The United Kingdom is one of the ESG leaders in Europe, with government programs that promote sustainable construction and legal requirements for mandatory ESG reporting by large companies. Kazakhstan, as an emerging economy, is just beginning to actively implement ESG standards in the construction sector, making it an important case for studying the challenges and prospects of ESG adoption. This matrix presents a comparative study of six countries – USA, Germany, China, Brazil, the United Kingdom, and Kazakhstan – across three core ESG aspects: environmental (E), social (S), and governance (G). The environmental section analyzes the implementation of green standards, energy-efficient technologies, and sustainable building materials. The USA and Germany are leading countries in this area, while Kazakhstan and Brazil are in the early stages of developing environmental standards. The social aspect covers workers' rights protection, labor conditions, and stakeholder engagement. The United Kingdom and Germany exhibit the most developed social practices, while China and Brazil face challenges related to transparency and labor rights protection. The governance section in Table 1 reflects the level of corporate governance, transparency of ESG reporting, and government regulation. The UK and the USA have established high standards for corporate reporting, while Kazakhstan and Brazil are still in the process of forming their regulatory frameworks.

Thus, Table 1 provides a comparative analysis that highlights international best practices in ESG for the construction sector and identifies key barriers and future opportunities for countries that are only beginning to integrate ESG standards.

Table 1. Comparative analysis of international ESG implementation practices in the construction sector

Country	Environmental Aspect (E)	Social Aspect (S)	Governance Aspect (G)
USA	Developed LEED standards, active use of renewable energy	High occupational safety standards, consideration of local community interests	Transparent reporting, ESG filters in investment decisions
Germany	High energy efficiency requirements for buildings, strict environmental regulations	Strong labor rights protection, high standards of social responsibility	Strong corporate governance standards, high level of reporting

China	Active development of green construction, but high carbon footprint	Government initiatives to improve labor conditions, but limited transparency	Growth in corporate governance, but significant state influence on business
Brazil	Limited environmental initiatives, high dependence on traditional materials	Weak labor rights protection, insufficient attention to social aspects	Low reporting transparency, weak enforcement of standards
United Kingdom	Promotion of environmentally sustainable construction through government programs	Well-developed corporate social responsibility programs	Mandatory ESG reporting for large companies
Kazakhstan	Early stage of green standard adoption, slow regulatory development	Initial implementation of social standards, high inconsistency in compliance	Lack of clear ESG reporting, low motivation among companies for compliance

The analysis of financial and economic indicators of construction companies requires not only the examination of individual values but also their statistical interpretation, which allows identifying key trends, data variability, and potential growth points. The graphs presented in Figure 1 demonstrate the main statistical characteristics – mean values, standard deviation, range (minimum and maximum values), and quartile distribution – which provide an opportunity to assess the stability of indicators, identify market leaders and laggards, and determine strategic directions for improving efficiency. This approach helps companies optimize resource management, assess the impact of various factors on profitability and sales volume, and make informed strategic decisions to enhance competitiveness in the construction sector.

The mean value histogram by parameters shows the average for each key indicator (PO – company age, SV – sales volume, EEQMS – economic efficiency of the quality management system, QMC – quality management costs, etc.).

Mean values allow for determining the overall level of company characteristics, which is especially important when comparing them to benchmark values or industry averages. Such analysis helps identify major trends and typical levels of costs, profitability, and quality management efficiency, which can be used for forecasting financial results and strategic planning. The standard deviation histogram by parameters illustrates the spread of data relative to the mean, showing how much companies in the sample differ for each indicator. A high standard deviation, for example in QMC (quality management costs), may indicate varying quality management strategies among companies – from minimal to significant investments in these processes.

The level of data variability helps assess risk and uncertainty when making management decisions. If the profitability indicator (OCP) has a high standard deviation, it suggests the presence of both highly efficient and less efficient companies, which may form the basis for competitive advantage analysis. The range of values diagram (Min/Max) reflects the minimum and maximum values for each indicator, allowing for an understanding of the boundaries within which the financial

and economic characteristics of construction companies vary. For instance, if the range of sales volume (SV) is too wide, this may indicate significant differences in the scale of companies' operations.

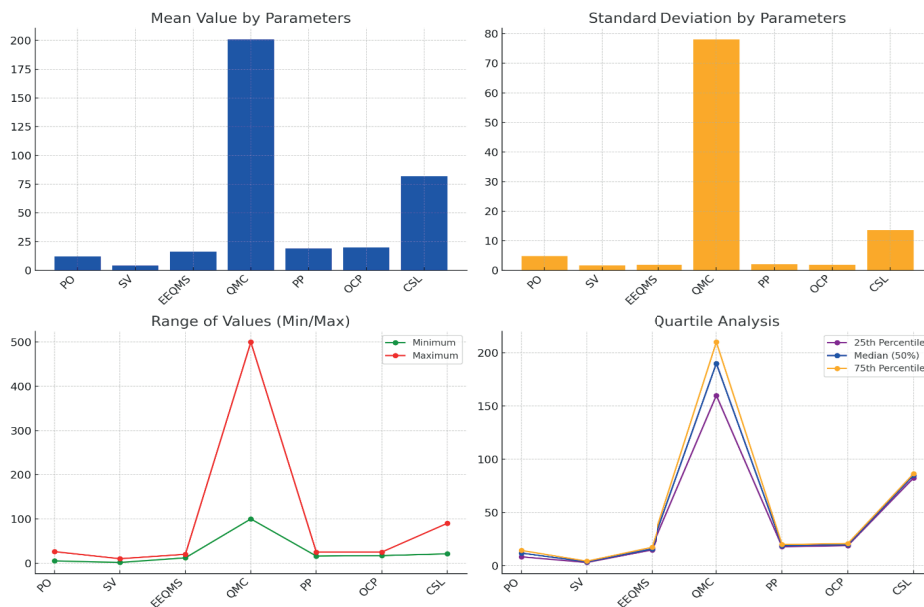


Figure 1 – Statistical analysis of financial and economic indicators of 23 construction companies in Kazakhstan

Note: Compiled by the authors.

The analysis of value ranges allows for identifying market leaders and lagging companies, as well as determining which factors may contribute to high or low levels of efficiency. Companies in the upper profitability range can serve as benchmarks for developing strategies to increase profitability within the industry. Quartile analysis (25th, 50th, 75th percentile) shows the distribution of data by highlighting the 25th, 50th (median), and 75th percentiles for each indicator. For example, if the median profitability value (OCP) is significantly lower than the 75th percentile, it may indicate that only the top quartile of companies demonstrate truly high performance, while most of the market operates at lower profitability levels.

This analysis is essential for developing company segmentation strategies and identifying potential growth areas. Companies below the median can adjust their business strategies by targeting the performance of top market players. The analysis and interpretation of the charts enable construction companies to optimize their management decisions, while helping investors and analysts assess the financial stability and competitive positions of firms in the market. For instance, analyzing mean values and standard deviations helps to understand the overall stability of the industry, while the value range reveals the boundaries of possible growth or stagnation risks.

Quartile analysis makes it possible to segment the market, define strategic groups of companies, and identify the most successful management models. Together, these visual tools provide valuable insights for strategic planning and enhancing the competitiveness of construction companies. The statistical chart analysis helped identify key patterns in the financial and economic indicators of construction firms, including average levels, variability, and the possible range of fluctuations.

Results and discussion. The obtained results demonstrate significant variability in sales volumes, quality management costs, and profitability, indicating differences in strategies and management effectiveness among companies.

At the same time, quartile analysis revealed that only a limited group of companies achieves high financial results, while the majority of the market remains at medium or low performance levels.

The findings highlight the need for conducting regression analysis to determine the influence of various factors on sales volumes and to identify the most significant determinants of success. This, in turn, will help companies develop effective growth strategies and improve their competitiveness.

In this regard, regression analysis becomes necessary to quantitatively assess the impact of various factors on the sales volumes (SV) of construction companies.

The preliminary stage of regression analysis involves identifying key indicators to be used in the model for evaluating the effect of different factors on the target variable. It is important to define the dependent and independent variables that will be examined to assess their influence on the company's performance indicators.

In this case, sales volume (SV) is considered the dependent variable, which means identifying which factors affect changes in the sales volumes of construction firms.

The independent variables include:

- Economic efficiency of the quality management system (EEQMS);
- Quality management costs (QMC);
- Product profitability (PP);
- Overall company profitability (OCP);
- Customer satisfaction level (CSL);
- Company age (PO).

EEQMS and QMC are among the key factors that may influence sales volume. For the regression analysis, data from 23 construction companies in Kazakhstan for the year 2023 were collected and used. These companies represent various segments of the construction market, including residential, commercial, and industrial construction.

The analysis focused on financial indicators such as sales volume (SV), quality management costs (QMC), product profitability (PP), overall company profitability (OCP), as well as non-financial indicators such as EEQMS and CSL.

This dataset enabled the formation of a quality sample capable of providing deep insights into the relationships between management decisions and company performance.

Using data for a full calendar year ensures an accurate reflection of current market

conditions, including macroeconomic factors such as inflation, shifts in demand for construction services, and price dynamics of construction materials.

Thus, this dataset allows not only for identifying general patterns in the influence of quality management systems on key company indicators but also for accounting for the specific characteristics of construction firms operating in Kazakhstan.

The implementation of effective quality management processes helps reduce product defects and improve overall business operations, which can directly lead to an increase in sales volumes. However, in the short term, quality management costs may negatively affect financial results if they do not lead to improved product quality.

In such cases, regression analysis helps determine the balance between quality costs and their actual impact on sales volumes.

Other important independent variables such as product profitability (PP), overall company profitability (OCP), and customer satisfaction (CSL) play a critical role in shaping sales volumes. Product and overall profitability reflect how effectively a company utilizes its resources to generate profit. Customer satisfaction is a key indicator of long-term business sustainability and client loyalty, which can increase repeat purchases and, therefore, sales volumes.

Including a factor such as company age (PO) helps account for a firm's market experience and longevity, which may also influence its ability to grow sales.

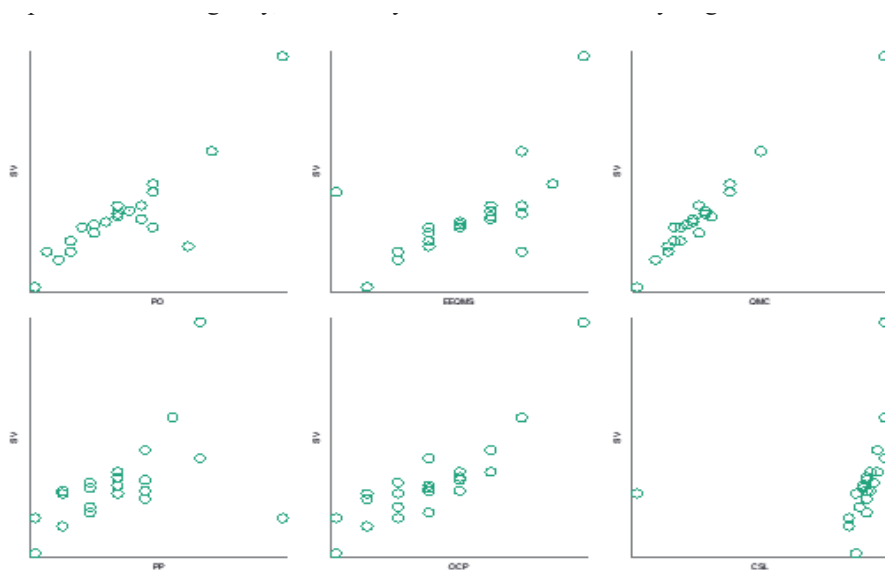


Figure 2. Correlation matrix of variables

Note: Compiled by the authors.

Figure 2 shows a positive correlation between the company's years of operation and sales volume (PO – Period of Operation).

There is a weak positive correlation suggesting that the economic efficiency of the quality management system contributes to increased sales volume (EEQMS –

Economic Efficiency of the Quality Management System). A noticeable positive relationship is observed, indicating that higher quality management costs correlate with higher sales volumes (QMC – Quality Management Costs).

The correlation is weaker for product profitability (PP), but still shows a positive trend.

A clear positive correlation is evident, pointing to the strong influence of overall company profitability on sales volume (OCP – Overall Company Profitability).

Table 2 shows the strongest correlation among all variables: a high level of customer satisfaction is directly associated with increased sales volume (CSL – Customer Satisfaction Level).

The Table 2 also reveals the interrelationships between variables, which can be used to build the regression model in the study.

Table 2 - Model 1: OLS, using observations 1-23
Dependent variable: SV

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	-2.85727	0.729466	-3.917	0.0009	***
QMC	0.0172551	0.00110741	15.58	<0.0001	***
OCP	0.173853	0.0450511	3.859	0.0010	***

Mean dependent var	4.078261	S.D. dependent var	1.646196
Sum squared resid	1.076154	S.E. of regression	0.231965
R-squared	0.981950	Adjusted R-squared	0.980144
F(2, 20)	544.0018	P-value(F)	3.67e-18
Log-likelihood	2.578570	Akaike criterion	0.842861
Schwarz criterion	4.249343	Hannan-Quinn	1.699581

White's test for heteroskedasticity -

Null hypothesis: heteroskedasticity not present

Test statistic: LM = 2.96435

with p-value = $P(\text{Chi-square}(5) > 2.96435) = 0.705483$

Test for normality of residual -

Null hypothesis: error is normally distributed

Test statistic: Chi-square(2) = 6.00192

with p-value = 0.0497393

Chow test for structural break at observation 12 -

Null hypothesis: no structural break

Test statistic: $F(3, 17) = 1.66062$

with p-value = $P(F(3, 17) > 1.66062) = 0.213026$

Constant (const): The coefficient of -2.85727 with a p-value of 0.0009 indicates that this variable is statistically significant in the model.

QMC (Quality Management Costs): The coefficient of 0.0172551 with a p-value < 0.0001 suggests a strong positive relationship between quality management costs and

sales volume. Each unit increase in QMC is associated with a 0.017 increase in SV.

OCP (Overall Company Profitability): The coefficient of 0.173853 with a p-value of 0.0010 shows that an increase in overall profitability also has a significant positive impact on sales volume. Each unit increase in OCP leads to a 0.174 increase in SV.

Model Summary:

R-squared: 0.981950. The model explains 98.2% of the variation in the dependent variable (SV), indicating high explanatory power.

Adjusted R-squared: 0.980144. The adjusted value also confirms the model's strong quality, considering the number of predictors.

F-statistic: 544.0018 with a p-value of $3.67e-18$, indicating the model is statistically significant overall.

White's Test for Heteroskedasticity: p-value = 0.705483. Since the p-value is greater than 0.05, we conclude that heteroskedasticity is not present, meaning the variance of the residuals is constant.

White's Test for Normality of Residuals: p-value = 0.0497393. The value is close to the 0.05 threshold, which may suggest a slight deviation from normality.

Chow Test for Structural Break (at observation 12): p-value = 0.213026. No significant structural break was found at the 12th observation, indicating the stability of the model.

The model demonstrates high explanatory power, and both predictors (QMC and OCP) have a statistically significant positive effect on sales volume. The diagnostic tests confirm the absence of heteroskedasticity and structural breaks.

In Figure 3, most of the points are located close to the line, which indicates that the residuals follow a normal distribution for the majority of the sample. However, there is an outlier on the right-hand side of the graph, which may suggest a slight deviation from normality in the tail.

The main portion of the residuals follows a normal distribution, although a minor deviation is observed in the upper-right corner, indicating a potential outlier.

This is consistent with the result of the normality test (p-value ≈ 0.049), which suggests a possible slight departure from normality.

Table 3 – 95% Confidence Intervals for OLS Model Coefficients ($t(20, 0.025) = 2.086$)

	coefficient	95 confidence interval
const	-2.85727	[-4.37891, -1.33563]
QMC	0.0172551	[0.0149451, 0.0195651]
OCP	0.173853	[0.0798783, 0.267828]

Forecast Accuracy Evaluation Based on 23 Observations

Forecast evaluation statistics using 23 observations

Mean Error	-8.5922e-016
Root Mean Squared Error	0.21631
Mean Absolute Error	0.16375
Mean Percentage Error	-0.76392
Mean Absolute Percentage Error	4.8736

Theil's U1	0.024682
Bias proportion, UM	1.686e-029
Regression proportion, UR	5.1001e-028
Disturbance proportion, UD	1

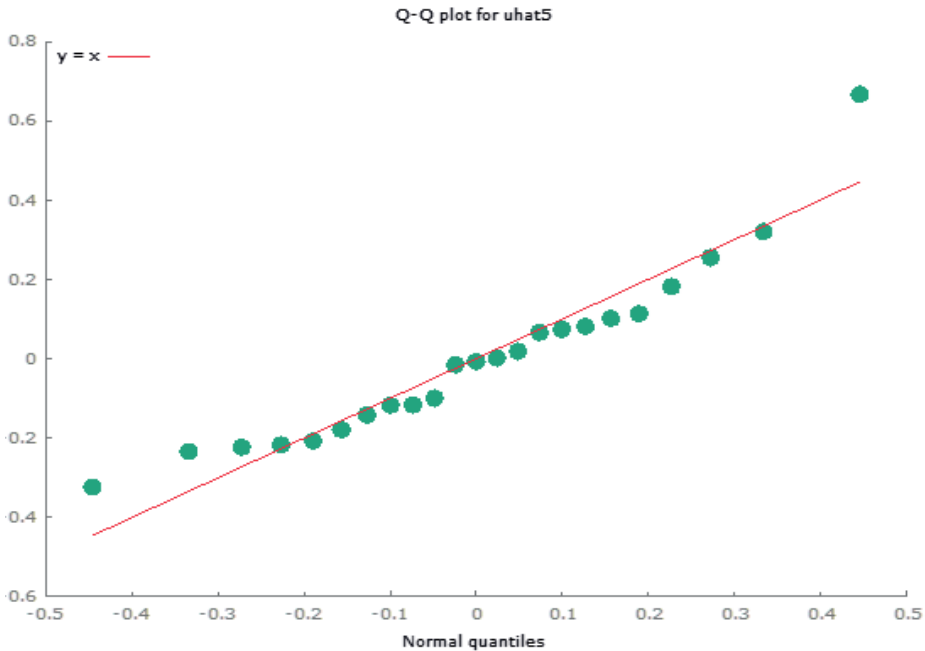


Figure 3 – Q-Q Plot for Testing the Normality of Residuals (uhat5)

Statistical indicators are used to evaluate the forecasting accuracy of the model based on 23 observations. They help assess how accurately the model predicts the values of the dependent variable compared to the actual data.

- **Mean Error:** $-8.5922e-016$. The mean error is nearly zero, indicating no forecasting bias; in other words, the model does not systematically overestimate or underestimate the predicted values.

- **Root Mean Squared Error (RMSE):** 0.21631. This value indicates high model accuracy, with relatively small deviations between actual and predicted values.

- **Mean Absolute Error (MAE):** 0.16375. The value of 0.16375 reflects low deviations and good predictive ability of the model.

- **Mean Percentage Error (MPE):** -0.76392 . The negative value suggests a slight systematic underestimation of predicted values compared to actual ones.

- **Mean Absolute Percentage Error (MAPE):** 4.8736%. Indicates high forecast accuracy, with an average error of approximately 4.87%.

- **Theil's U1 Index:** 0.024682. A low value indicating that the model outperforms a naïve forecast and is highly accurate.

- **Bias Proportion (UM):** $1.686e-0291$. An extremely small value, showing that the model has almost no systematic bias.

- **Regression Proportion (UR):** $5.1001e-0285$. A very low value indicating strong alignment between the forecast and the actual trend.

- **Disturbance Proportion (UD):** 1. Indicates that the forecast errors are entirely due to unexplained random factors rather than systematic issues in the model.

The model demonstrates high forecasting accuracy with minimal systematic deviations. The values of MAPE, RMSE, and Theil's U1 confirm a good fit between the model and the actual data.

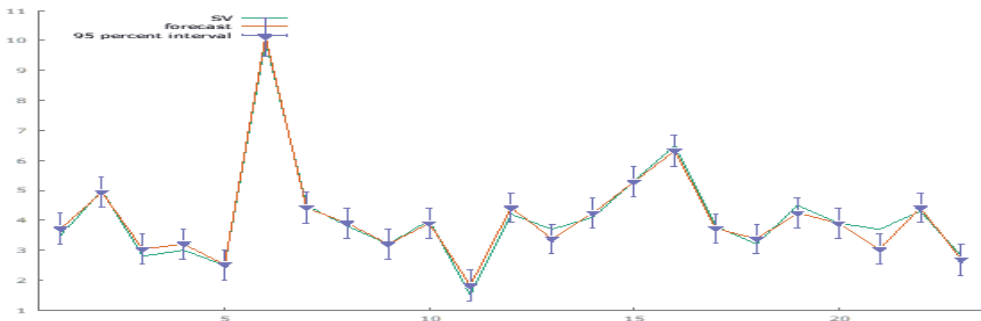


Figure 4. Forecast and actual sales volumes (SV) with 95% confidence interval

Note: Compiled by the authors.

Figure 4 clearly illustrates that the model demonstrates consistency between the predicted and actual sales volumes. Most of the forecasted values are close to the actual ones, and the confidence intervals are relatively narrow, confirming the model's high accuracy.

The results of the regression analysis indicate that the constructed model has strong explanatory power and is statistically significant for forecasting sales volumes of construction companies.

The coefficients for quality management costs (QMC) and overall company profitability (OCP) are statistically significant at the 95% confidence level, as indicated by low p-values (less than 0.001).

The R-squared and adjusted R-squared values (0.981950 and 0.980144, respectively) suggest that the model explains 98% of the variation in the dependent variable, demonstrating high model effectiveness.

Low values of root mean squared error (RMSE = 0.21631) and mean absolute percentage error (MAPE = 4.87%) confirm that the model provides accurate forecasts.

Additionally, diagnostic tests such as White's test for heteroskedasticity (p-value = 0.705483) and the Chow test for structural breaks (p-value = 0.213026) indicate that the model is not affected by heteroskedasticity or structural instability, which makes it reliable for analytical use.

Minor deviations from normality in the residuals (p-value for the normality test = 0.0497393) do not significantly affect the overall accuracy of the model.

Taken together, the model shows a high level of predictive ability and stability,

confirming its suitability for analyzing the dependence of sales volumes on quality management and profitability in construction companies.

Following the regression analysis, which identified significant factors influencing sales volumes and company profitability, the next step of the study involved segmenting companies using cluster analysis. While regression analysis focused on the quantitative relationships between variables, cluster analysis allows classification of companies based on the similarity of their characteristics, providing a deeper understanding of group differences.

The following key factors were selected for cluster analysis: overall company profitability (OCP), customer satisfaction level (CSL), economic efficiency of the quality management system (EEQMS), and company age (PO). These variables reflect both the financial performance of a company and its ability to meet customer needs and implement effective management processes.

Conclusion. This study examined the role of ESG principles in managing quality and profitability in construction companies in Kazakhstan. The analysis of international practices showed that the successful integration of ESG factors contributes to business resilience, risk reduction, and improved financial performance. A comparative analysis of six countries (USA, Germany, China, Brazil, the United Kingdom, and Kazakhstan) made it possible to identify global best practices and key barriers faced by construction companies at different stages of ESG implementation. Specifically, Kazakhstan is at the early stage of ESG standard development, which presents both challenges and opportunities for companies aiming to enhance their competitiveness through sustainable development.

The regression analysis based on data from 23 construction companies in Kazakhstan revealed that economic efficiency of the quality management system (EEQMS), quality management costs (QMC), and overall profitability (OCP) are significant factors influencing sales volumes.

The identified relationships confirm that effective quality management and the adoption of ESG principles can enhance companies' financial performance and increase customer satisfaction (CSL), ultimately leading to more repeat orders in the long run.

The results obtained can be useful for managers, investors, and government bodies in designing strategies to support the sustainable development of the construction sector.

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