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Research on the Influencing Factors of ESG Performance in Construction Enterprises

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Abstract: Improving ESG performance is not only a national policy requirement, but also an inherent need for the long-term development of construction enterprises. Focusing on construction enterprises, this study sorts out relevant research on corporate ESG performance from the theoretical perspective of the strategic triangle view and summarizes 18 influencing factors. Combining principal component analysis and regression analysis, this paper quantitatively analyzes 18 factors affecting the ESG performance of construction enterprises using objective data of all A-share listed construction enterprises from 2019 to 2023, extracts 6 key influencing factors, and analyzes their influence degrees. Finally, relevant suggestions are put forward based on the analysis results.

Keywords: Construction enterprises; ESG performance; Principal component analysis; Regression analysis; Strategic triangle view

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1. Introduction

ESG (Environment, Social, Governance) is an evaluation system that measures enterprises' sustainable development capabilities and economic and social values from three dimensions: Environment, Social Responsibility, and Corporate Governance, and has attracted increasing attention in the investment field [1]. However, the problems exposed by the construction industry under the traditional development model have become increasingly prominent, such as excessive resource consumption, serious environmental pollution, and relatively low production efficiency, which have affected the sustainable development of the construction industry. Therefore, as a pillar industry in China, the construction industry's active improvement of its ESG performance plays a key role in the smooth implementation of the national sustainable development strategy [2,3]. However, in sharp contrast to its important status, in-depth discussions specifically targeting construction enterprises in existing ESG-related research are extremely scarce, and most focus on single-factor research, showing an obvious lag.

2. Extraction of influencing factors of ESG performance in construction enterprises

Using the literature research method, this paper conducts an extended Chinese and English searches in databases such as CNKI and Web of Science with the theme words “ESG performance” and “influencing factors” according to the three dimensions of the institutional level, enterprise level, and industry level of the strategic triangle view. After excluding literature irrelevant to this study, 48 papers are finally obtained, and 18 influencing factors are summarized, as shown in **Table 1**.

Table 1. Influencing factors of corporate ESG performance

Target Layer	Criterion Layer	Factor Layer	Target Layer	Criterion Layer	Factor Layer
Institutional End	Regulatory Institutions	Environmental Regulation Intensity (X1)	Enterprise End	Tangible Resources	Enterprise Scale (X9)
	Normative Institutions	Government Subsidies (X2)			R&D Innovation (X10)
		Media Attention (X3)			Profitability (X11)
		Analyst Attention (X4)			Financing Constraints (X12)
	Cultural-Cognitive	Corporate Cooperation Culture (X5)			Institutional Investor Shareholding Ratio (X13)
Industry End	Industry Market Structure and Industry Market Behavior	Market Concentration (X6)		Intangible Resources	Resource Allocation Capability (X14)
		Inter-enterprise Competition (X7)			Digital Transformation Degree (X15)
					Equity Balance Degree (X16)
		Supplier Concentration (X8)			Proportion of Female Managers (X17)
					Management Quality (X18)

3. Variable description

This paper selects all A-share listed construction companies from 2019 to 2023 as the research sample. The data are obtained from the CSMAR database, manually sorted media reports, and corporate annual reports. Samples with abnormal trading status (ST or *ST) and serious missing data are excluded. A small amount of missing data is supplemented by interpolation, and winsorization is performed at the top and bottom 1%. Finally, 77 companies with a total of 385 data points were obtained.

3.1. Dependent variable

ESG performance score of construction enterprises. The dependent variable in this paper is the ESG performance of construction enterprises, measured by the ESG score from the Wind database.

3.2. Independent variables

3.2.1. Institutional end

The details are as follows:

(1) Environmental Regulation Intensity: Referring to the research of He *et al.*, the specific calculation formula is: Environmental Regulation Intensity = (Completed Investment in Industrial Pollution Control / Industrial

Added Value) × 1000 [4];

(2) Government Subsidies: Measured by taking the natural logarithm of the total government subsidies;

(3) Media Attention: Adopting the measurement method used by Wang *et al*, the calculation formula is: natural logarithm of (number of media reports in one year + 1), where the "number of media reports" refers to the sum of the total number of news with the company's name in online news headlines and newspaper headlines [5];

(4) Analyst Attention: Referring to the method of Liu *et al*, expressed as the natural logarithm of (number of analysts (teams) tracking the enterprise in one year + 1) [6];

(5) Corporate Cooperation Culture: Adopting the method used by Pan *et al*., counting the total frequency of 15 words such as "co-organize" in the enterprise's annual report according to the lexicon established by Fiordelisi *et al.,* and taking the logarithm of (frequency + 1) [7,8].

3.2.2. Industry end

The details are as follows:

(1) Market Concentration: Referring to the research of Yuan *et al*, the Herfindahl-Hirschman Index (HHI) is used as the proxy variable for market concentration. The calculation formula is: $HHI = sum[(Xi/X)^2]$, where Xi represents the operating income of a single company, and X is the total operating income of all listed construction enterprises [9];

(2) Supplier Concentration: Adopting the measurement method of Zhang *et al*., the calculation formula is: the sum of the squares of the proportion of procurement volume from the top five suppliers to the total procurement volume of listed companies [10];

(3) Inter-enterprise Competition: Using spatial location competition intensity as the proxy variable for enterprise competition.

3.2.3. Enterprise end

The details are as follows:

(1) Enterprise Scale: Represented by the natural logarithm of the enterprise's total assets at the end of the period [11];

(2) R&D Innovation: This study measures enterprise R&D innovation from two dimensions: input and output. R&D innovation intensity (RD) is measured by the ratio of R&D investment to operating income, and R&D innovation output (Patent) is measured by the natural logarithm of (total number of enterprise patents + 1). Finally, the entropy weight method is used to obtain the final variable value [12];

(3) Profitability: Using return on total assets as the proxy variable [11]. The calculation formula is: (Total Profit + Financial Expenses) / Average Total Assets, where Average Total Assets = Ending Balance of Total Assets;

(4) Financing Constraints: Using the SA index as the measurement indicator, and following the calculation method of Li [13]. The SA index is composed of enterprise age (Age) and enterprise scale (Size), and the calculation formula is: $SA = -0.737 \times Size + 0.043 \times Size^2 - 0.04 \times Age$;

(5) Institutional Investor Shareholding Ratio: The calculation formula is: the proportion of the total number of shares held by institutional investors to the total shares of the listed company;

(6) Resource Allocation Capability: This paper divides enterprise resources into four dimensions: physical,

financial, human, and data resources [14–18]. Among them, physical resources are characterized by the net value of fixed assets, financial resources and human resources adopt the measurement methods of cash flow and number of employees respectively, and data resources are comprehensively reflected by standardizing and averaging digital fixed assets and digital intangible assets [16–18]. Further referring to the method of Tian *et al.*, the entropy weight method is used to construct a comprehensive enterprise resource allocation (Rst) indicator [15];

(7) Digital Transformation Degree: Referring to the research of Wu *et al.*, measured by the natural logarithm of (total frequency of 78 related words appearing in the enterprise's annual report + 1) [19];

(8) Equity Balance Degree: The calculation formula is: (Shareholding Ratio of the 2nd to 5th Largest Shareholders) / (Shareholding Ratio of the Largest Shareholder);

(9) Proportion of Female Managers: Obtained by the proportion of females among directors, supervisors, and senior management;

(10) Management Quality: Following the measurement method of Zhou *et al*., using whether the management has an academic background as the measurement indicator, where "Yes" = "1" and "No" = "0" [20].

4. Principal component analysis of influencing factors of ESG performance in construction enterprises

4.1. Suitability test

This study uses KMO sampling suitability test and Bartlett's spherical test to judge the suitability of the data. The KMO value ranges from 0 to 1, and a larger value indicates that the sample data is more suitable for principal component analysis. The specific results are shown in **Table 2**.

Table 2. KMO and Bartlett's spherical test

KMO Sampling Suitability Measure		0.855
Bartlett's Spherical Test	Approx. Chi-Square	4197.558
	Degrees of Freedom	153
	Significance	0.000

The KMO value of the data in this study is 0.855, verifying the suitability of principal component analysis. Sig. = 0.000 < 0.001, indicating that there are significant correlations between variables.

4.2. Extraction of principal components

SPSS Statistics 23.0 is used for principal component analysis of the 18 influencing factors, and the total variance explanation table of original variables and the eigenvalues of principal components are obtained. The specific results are shown in **Table 3**.

Table 3. Eigenvalues and cumulative contribution rates

Component	Initial Eigenvalues			Extracted Squared Loadings			Rotated Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.263	34.795	34.795	6.263	34.795	34.795	5.135	28.530	28.530

2	1.652	9.177	43.972	1.652	9.177	43.972	1.932	10.735	39.266
3	1.314	7.302	51.274	1.314	7.302	51.274	1.475	8.195	47.460
4	1.170	6.498	57.771	1.170	6.498	57.771	1.390	7.720	55.180
5	1.094	6.078	63.849	1.094	6.078	63.849	1.331	7.394	62.575
6	1.008	5.602	69.451	1.008	5.602	69.451	1.238	6.877	69.451
7	.877	4.873	74.324						
8	.808	4.490	78.814						
9	.738	4.097	82.911						
10	.681	3.783	86.694						
11	.489	2.717	89.411						
12	.454	2.523	91.934						
13	.428	2.375	94.309						
14	.403	2.238	96.548						
15	.329	1.828	98.375						
16	.170	.946	99.321						
17	.112	.625	99.946						
18	.010	.054	100.000						

The extraction results show that the cumulative variance contribution rate of these 6 principal components is 69.451%, indicating that the extracted 6 principal component factors capture most of the information of the original variables. Therefore, the first 6 are selected as principal components, named F1, F2, F3, F4, F5, and F6 respectively. To determine the key factors of each principal component, this paper further examines the principal component factor loading matrix, as shown in **Table 4**.

Table 4. Rotated factor loading matrix

Aspects	F1	F2	F3	F4	F5	F6
Environmental Regulation Intensity (X1)	0.029	0.096	-0.039	-0.063	0.829	0.028
Government Subsidies (X2)	0.858	0.234	0.166	-0.019	-0.024	0.089
Media Attention (X3)	0.243	0.006	0.488	0.313	0.515	0.018
Analyst Attention (X4)	0.620	0.366	0.356	-0.006	0.115	-0.038
Corporate Cooperation Culture (X5)	0.115	0.488	0.018	0.542	0.123	0.097
Market Concentration (X6)	-0.012	0.055	0.254	0.140	-0.238	-0.711
Inter-enterprise Competition (X7)	-0.336	-0.285	0.288	0.522	-0.382	0.246
Supplier Concentration (X8)	-0.826	-0.035	-0.015	0.075	0.004	0.003
Enterprise Scale (X9)	0.923	0.135	0.173	0.161	0.078	0.004
R&D Innovation (X10)	0.206	0.764	0.107	-0.009	0.156	0.016
Profitability (X11)	0.184	-0.067	0.633	-0.113	-0.172	-0.171
Financing Constraints (X12)	-0.911	-0.150	-0.174	-0.141	-0.109	-0.001
Institutional Investor Shareholding Ratio (X13)	0.659	0.038	0.111	0.322	-0.012	0.128
Resource Allocation Capability (X14)	0.851	0.274	0.137	0.038	0.132	-0.003
Digital Transformation Degree (X15)	0.117	0.213	0.175	0.050	-0.188	0.713
Equity Balance Degree (X16)	-0.270	0.059	0.170	-0.727	0.031	0.253
Proportion of Female Managers (X17)	0.297	0.153	0.606	0.004	0.138	0.146
Management Quality (X18)	0.235	0.795	-0.052	-0.025	-0.053	0.109

From **Table 4**, after rotation, the structure of the factor loading matrix is significantly optimized. Each principal component shows significantly high-loading variables, its factor meaning is clearly focused, and the definition of principal components is more accurate. In the first principal component F1, the absolute values of the coefficients of X9, X12, X2, X14, X8, X13, and X4 are relatively large, among which X9 is the primary influencing factor of this component; the second principal component F2 is composed of two original variables with relatively large absolute coefficients of X18 and X10, among which X18 is the primary influencing factor of this component; in the third principal component F3, the absolute values of the coefficients of two original variables X11 and X17 are relatively large, among which X11 is the primary influencing factor of this component; in the fourth principal component F4, the absolute values of the coefficients of X16, X5, and X7 are relatively large, among which X16 is the primary influencing factor of this component; in the fifth principal component F5, X1 and X3 have relatively high correlations, among which X1 is the primary influencing factor of this component; in the sixth principal component F6, X15 and X6 have relatively high correlations, among which X15 is the primary influencing factor of this component.

Based on the results of principal component analysis, six key influencing factors are extracted, namely Enterprise Scale (X9), Management Quality (X18), Profitability (X11), Equity Balance Degree (X16), Environmental Regulation Intensity (X1), and Digital Transformation Degree (X15).

5. Regression analysis

This study uses linear regression analysis to verify the impact of the six key influencing factors on the ESG performance of construction enterprises, and establishes a regression model as shown in Formula 5-1.

$$Y = C + \beta_1 X9 + \beta_2 X18 + \beta_3 X11 + \beta_4 X16 + \beta_5 X1 + \beta_6 X15 \quad (1)$$

The regression analysis results show that the overall goodness of fit R^2 of the model is 0.531, and the F value is 24.731, which is significant at the 1% level, indicating that the model has strong explanatory power; the VIF of each variable is less than 1.3, and there is no serious multicollinearity problem. The results are shown in **Table 5**.

Table 5. Regression analysis results

Aspects	Standard Error	Standardized Coefficient Beta	t	Significance	VIF
(Constant)	0.496		6.014	.000	
Enterprise Scale (X9)	0.021	0.292	5.946	.000	1.271
Management Quality (X18)	0.088	0.028	.611	.042	1.132
Profitability (X11)	0.626	0.165	3.679	.000	1.053
Equity Balance Degree (X16)	0.063	0.236	5.152	.000	1.103
Environmental Regulation Intensity (X1)	2.916	0.246	5.559	.000	1.028
Digital Transformation Degree (X15)	0.030	0.041	0.906	0.037	1.061
R^2			0.531		
F			24.791		
P			0.000		

Specifically, all six factors have a significant positive impact on ESG performance. Enterprise Scale (X9) has the highest standardized coefficient (0.292, $p < 0.01$), indicating that larger enterprises have more sufficient resources and higher attention, and are more capable of improving ESG performance. The coefficient of Environmental Regulation Intensity (X1) is 0.246 ($p < 0.01$), showing that external institutional pressure is an important driving force. The coefficient of Equity Balance Degree (X16) is 0.236 ($p < 0.01$), indicating that a reasonable equity structure can optimize internal governance and promote a long-term value orientation. The coefficient of Profitability (X11) is 0.165 ($p < 0.01$), providing financial guarantee for enterprises to practice ESG. The coefficients of Digital Transformation Degree (X15) and Management Quality (X18) are 0.041 and 0.028 respectively, both significant at the 5% level, indicating that technological empowerment and management vision also have a positive effect on ESG. In summary, the ESG performance of construction enterprises is the result of the synergistic effect of internal resource capabilities, governance mechanisms, and external regulatory pressure. The regression equation is shown in **Equation (2)**.

$$Y = 0.496 + 0.292X9 + 0.028X18 + 0.165X11 + 0.236X16 + 0.246X1 + 0.041X15 \tag{2}$$

6. Conclusion

Based on the above conclusions, the following suggestions are put forward:

(1) Implement classified policies and give play to the demonstration role of large-scale enterprises: Support large state-owned enterprises to establish high-standard ESG systems, and provide technical consulting and green credit support for small and medium-sized enterprises to reduce their improvement thresholds;

(2) Strengthen environmental regulation and optimize policy design;: Improve laws and regulations on environmental protection and safety, increase law enforcement efforts, explore green building standards and carbon trading mechanisms, and internalize external pressure into enterprise motivation;

(3) Improve internal governance: Guide enterprises to optimize their equity structure, introduce strategic investors to form checks and balances; incorporate ESG indicators into senior management assessment and compensation systems to enhance management's sense of responsibility;

(4) Empower ESG practices with digital transformation: Encourage enterprises to apply technologies such as BIM and the Internet of Things to achieve refined management, and the government can set up special funds to support digital transformation;

(5) Build a multi-party collaborative mechanism: Industry associations formulate evaluation standards, investors incorporate ESG into decision-making, and the public strengthens supervision to jointly promote the continuous improvement of ESG performance in the construction industry.

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