

# Research on the Measurement Index System for the High-Quality Development Level of Urban Gas Enterprises

Ke Yan, Qiao Yang, and Liu Yang\*

School of Southwest Petroleum University, Chengdu 610500, China

\*Corresponding Author

## Abstract

**This study developed a systematic measurement framework to evaluate the high-quality development of urban gas enterprises. Drawing on the current status of China's gas industry and guided by five development principles-innovation-driven, coordinated, green, open, and inclusive development-a comprehensive and multi-dimensional indicator system is constructed. The CRITIC-entropy combined weighting method is employed to determine indicator weights objectively, and the TOPSIS model is used to assess the overall development level of enterprises. The results indicate a steady upward trend in development quality across sectors. Through obstacle degree analysis, this study further identifies the main factors constraining progress, offering theoretical and empirical references for decision-making and performance improvement in urban gas enterprises.**

## Keywords

**Urban Gas; High-quality Development; Evaluation System; Obstacle Factors.**

## 1. Introduction

Since the 19th National Congress of the Communist Party of China (CPC), the nation's economic growth model has shifted from rapid expansion to a focus on high-quality development. The 20th CPC National Congress further defined high-quality development as the primary goal of China's modernization. President Xi Jinping emphasized the need to fully implement a new development philosophy based on innovation, coordination, greenness, openness, and sharing, highlighting that energy security underpins the overall stability of national economic and social progress. As a core component of clean and low-carbon energy, natural gas serves as both the foundation and lifeblood of urban energy systems in China. Its development directly influences the achievement of carbon neutrality goals, urban safety, and citizen well-being. Therefore, assessing the quality of development of urban gas enterprises through a scientific framework is essential to guide progress, enhance competitiveness, and promote sustainable growth. With the integration of emerging technologies, such as the Internet of Things (IoT), big data analytics, and artificial intelligence, the operational models, management approaches, and service delivery mechanisms of gas enterprises are undergoing fundamental transformations. Simultaneously, national policies have emphasized safety supervision, service quality, and environmental standards [1] Against this backdrop, it is crucial to establish a rigorous, systematic, and practical measurement framework for evaluating the high-quality development of urban gas enterprises. Such a framework can not only help companies identify strategic priorities and improvement areas, but also provide government agencies with theoretical support for evidence-based policymaking and targeted regulation [2].

This study aims to establish a comprehensive measurement framework for assessing the high-quality development level of urban gas enterprises. The framework serves as a practical tool that enables enterprises to conduct self-evaluation and pursue continuous improvement, while

also providing government authorities with a theoretical foundation for policy formulation and precise regulatory supervision. By systematically examining the design of the indicator system, this study contributes to advancing urban gas enterprises across multiple dimensions, including economic efficiency, social contribution, environmental performance, technological innovation, and sustainable development, thereby supporting the healthy, stable, and high-quality growth of the entire industry.

## 2. Current Situation of Urban Gas Enterprise Development

In recent years, China's urban gas industry has expanded rapidly: infrastructure coverage has grown, the service population has increased, and penetration rates have increased significantly. According to the *China Energy Data Report (2025)* published by the National Energy Research Institute, the national urban gas penetration rate reached 98.10% in 2024, up 0.1% from the previous year, and the pipeline gas penetration rate reached 79.84%, an increase of 2.0 percentage points. In the same year, the nationwide supply of manufactured coal gas to cities totaled 1.87 billion cubic meters, representing a year-on-year decline of 19.1%. The marked improvement in urban gas coverage has not only raised residents' living standards but also created a broad market for the gas sector. The policy environment has also continued to improve: the government has successively issued the *Regulations on Urban Gas Management*, "Several Opinions on Accelerating the Development of Natural Gas", and "2025 Energy Work Guidance", thereby providing a clearer roadmap and a regulatory framework for the industry. Under the twin drivers of dual-carbon targets and high-quality development, natural gas has been identified as a clean, low-carbon bridge for energy transition. Regulatory authorities have stepped up the monitoring and follow-up of gas turbine innovation pilot projects and launched the fifth round of assessments for first-of-a-kind major technological equipment in the energy sector, with an emphasis on closing key gaps. Simultaneously, the applications of the Internet of Things (IoT), big data, and artificial intelligence (AI) are accelerating the intelligent transformation of the urban gas industry faces multiple challenges.

Nevertheless, the industry faces multiple challenges. Market concentration remains low, and regional fragmentation is evident; scale and integration levels are insufficient. Safety management capabilities vary across firms, and the task of renovating aging pipeline networks is formidable. As competition intensifies, newcomers that leverage technological and institutional advantages are increasingly encroaching on traditional market positions. Customer expectations are also rising, demanding faster response times and more effective problem resolution, putting pressure on conventional operating models[3]. A review of the literature reveals several limitations in existing research on the high-quality development of urban gas enterprises. First, much of the prior work focuses on regional economies or the energy sector as a whole; there is comparatively little research treating individual urban gas enterprises as independent evaluation units. Second, although some studies address dimensions such as green development or safety assurance, they tend to examine single aspects in isolation and do not systematically analyze the interrelations among the five development principles. To address these gaps, this study surveys the status of domestic urban gas enterprises over 2019-2023, adopts the five-principle framework, constructs a comprehensive evaluation index system, determines indicator weights using a CRITIC-entropy combined weighting method, and applies TOPSIS for integrated assessment, thereby providing more targeted theoretical and practical guidance for both government and industry.

## 3. Construction of the High-quality Development Index System

High-quality development for urban gas enterprises is achieved by first ensuring safe and stable operations, and then primarily through pathways including technological innovation,

management optimization, service upgrades, and green development to enhance operational efficiency, service quality, and emission reduction performance, ultimately realizing long-term coordination between enterprise and societal development. Guided by forward-looking principles, a problem-oriented approach, and scientific rigor, while considering data availability and comparability, this study draws on prior research and the new development philosophy to construct an indicator system. This system is organized around five primary dimensions: innovation-driven, coordinated, green, open, and shared development. Each primary dimension is further decomposed into secondary indicators that are quantifiable and classified as either positive or negative indicators, so that direct comparisons of values can serve as evaluation standards[4]. The chosen evaluation procedures allow the transformation from multi-level indicator values into a composite index representing the enterprises' high-quality development level.

**Table 1.** Evaluation Indicator System for High-Quality Development Level of Urban Gas Enterprises

Dimension (Primary)	Secondary Indicator	Note	Attribute
Innovation-driven	R&D Investment /10 thousand yuan	X <sub>1</sub>	Positive
	Number of R&D personnel/persons	X <sub>2</sub>	Positive
	Talent training (proportion of master's degree and above)/%	X <sub>3</sub>	Positive
	Senior management awareness of high-quality development /times	X <sub>4</sub>	Positive
Coordinated development	Total asset turnover/times	X <sub>5</sub>	Positive
	Sales profit margin/%	X <sub>6</sub>	Positive
	Profitability/%	X <sub>7</sub>	Positive
	Asset-liability ratio/%	X <sub>8</sub>	Negative
	Current ratio/%	X <sub>9</sub>	Positive
	Cash flow ratio /%	X <sub>10</sub>	Positive
	Fixed asset share/%	X <sub>11</sub>	Negative
Green development	Safety production expenditure/10 thousand yuan	X <sub>12</sub>	Positive
	Cost-and-expense utilization rate/%	X <sub>13</sub>	Positive
	Return on net assets/%	X <sub>14</sub>	Positive
	Social welfare investment/yuan	X <sub>15</sub>	Positive
Openness	Purchased gas expenditure/yuan	X <sub>16</sub>	Positive
	Gas revenue/100 million yuan	X <sub>17</sub>	Positive
Shared development	Employee salary growth rate/%	X <sub>18</sub>	Positive
	Employee number growth rate/%	X <sub>19</sub>	Positive
	Total dividends/10 thousand yuan	X <sub>20</sub>	Positive
	Basic earnings per share/yuan	X <sub>21</sub>	Positive

### (1) Innovation-driven Dimension

Innovation is the core driver of high-quality development, covering R&D investment, talent endowment, and leadership's strategic awareness. This study selects four indicators: R&D investment, number of R&D personnel, talent training (proportion of master's degree and above) and senior management's awareness of high-quality development. R&D investment reflects the financial intensity supporting technological breakthroughs; R&D personnel count measures the scale of innovation teams; talent training indicates improvements in talent structure; and senior management's recognition of high-quality development is quantified using text-mining techniques applied to management statements and strategic reports.

### (2) Coordinated Development Dimension

Coordinated development emphasizes the balance between operational efficiency and risk control. Seven indicators were set: total asset turnover, sales profit margin, profitability, asset-liability ratio, current ratio, cash flow ratio, and fixed asset share. The total asset turnover reveals how efficiently management uses assets to generate revenue; the sales profit margin reflects market competitiveness; the asset-liability and current ratios jointly assess long-term solvency and short-term liquidity risk; the cash flow ratio provides insight into cash generation capacity; and the fixed asset share indicates capital rigidity associated with heavy-asset operations.

### (3) Green Development Dimension

Green development focuses on safety, environmental protection, and corporate social responsibility. Four indicators were selected: safety production expenditure, cost-and-expense utilization rate, return on net assets, and social welfare investment. Safety expenditure directly indicates a firm's investment intensity in operational safety. The cost and expense utilization rate measures efficiency during the green transition. Return on net assets gauges financial returns relative to equity. Finally, social welfare investment, collected from CSR disclosures, quantifies contributions to social welfare.

### (4) Openness Dimension

Openness reflects resource integration and market expansion capabilities. Two indicators, purchased gas expenditure and gas revenue, were chosen. Purchased gas expenditure shows how firms secure supplies to meet demand and may reflect market integration or external procurement strategies. Gas revenue measures the market share and scale of operations. Together, these indicators assess an enterprise's capacity to allocate resources under policies promoting a "national unified gas network."

### (5) Shared Development Dimension

Shared development emphasizes stakeholder value sharing. Four indicators are included: employee salary growth rate, employee number growth rate, total dividends, and basic earnings per share. Salary and employment growth rates reflect the degree to which human capital is shared. Total dividends and earnings per share quantify the returns to shareholders and indicate a firm's ability to balance stakeholder interests.

## 4. Research Methods and Models

### 4.1. Method Selection

#### 4.1.1. Selection of Indicator Weighting Method

Based on the evaluation system for high-quality development of urban gas enterprises, it is essential to assign weights to each indicator in a scientific and reasonable manner and select an appropriate evaluation method. This ensures the reliability and validity of the entire evaluation framework, directly affecting the credibility and practical value of the results. By introducing the concept of information entropy from the entropy weight method into the CRITIC method

and combining it with standard deviation, the approach effectively avoids the limitations of the entropy weight method, which insufficiently considers the characteristics of indicators, and the CRITIC method, which inadequately accounts for indicator dispersion [5]. This hybrid approach yields more scientific and reasonable composite weights. Therefore, this paper adopts the CRITIC–Entropy Weight combined weighting method, integrating it with standard deviation to enhance the scientificity and credibility of the evaluation results.

**4.1.2. Selection of Comprehensive Evaluation Method**

A comprehensive evaluation method is a systematic approach for evaluating multiple objects based on a multi-indicator system. Table 2 presents a comparison of commonly used comprehensive evaluation methods.

**Table 2.** Comparison of Common Comprehensive Evaluation Methods

Method	Description	Advantages	Disadvantages
Fuzzy Comprehensive Evaluation	Quantifies complex indicators using fuzzy mathematics for systematic evaluation.	Effectively handles ambiguity in evaluation; simple and intuitive model.	Cannot eliminate redundancy caused by indicator correlation; relatively subjective.
Grey Relational Analysis	Calculates the correlation degree between the standard value and evaluated items for ranking.	Reduces information asymmetry and workload.	Requires subjective determination of optimal indicator values.
Factor Analysis	Uses dimensionality reduction to convert multiple indicators into fewer composite ones while retaining information.	Comprehensive and comparable; objective and rational.	High data requirements.
DEA	Analyzes input–output data to compute and rank efficiency indicators.	Dynamic weight adjustment; low subjectivity; high effectiveness.	Reflects only relative development levels, not absolute performance.
TOPSIS	Ranks objects based on proximity to ideal solutions.	No strict requirements on data distribution or sample size; flexible and convenient.	Complex standardization and potential extreme cases.
BP Neural Network	Trains weights through comparison of outputs and expected results from samples.	Handles nonlinear relations; strong self-learning and fault-tolerance.	Requires large, accurate sample data; training may be computationally intensive.
Method	Description	Advantages	Disadvantages
Fuzzy Comprehensive Evaluation	Quantifies complex indicators using fuzzy mathematics for systematic evaluation.	Effectively handles ambiguity in evaluation; simple and intuitive model.	Cannot eliminate redundancy caused by indicator correlation; relatively subjective.

Based on the above comparison, the TOPSIS method demonstrates significant advantages in evaluating the high-quality development of urban gas enterprises. First, it measures the closeness between each evaluation object and the ideal solution, providing a simple and intuitive computation process that overcomes the limitations of traditional methods[6]. Second, TOPSIS imposes no strict requirements on the number of indicators, sample size, or data distribution, offering broad applicability. Third, it supports both single-layer and multi-level indicator evaluations, balancing overall and local perspectives. Thus, using TOPSIS not only

reveals individual enterprise progress but also objectively captures industry-wide development trends.

### 4.2. Barrier Degree Model

To accurately evaluate the contribution of each indicator to the high-quality development of urban gas enterprises and identify improvement priorities, this study employs the Barrier Degree Model to analyze key obstacle factors. The calculation steps are as follows:

Step 1: Calculate indicator deviation.

$$K_{ij} = 1 - Y_{ij} \tag{1}$$

Step 2: Calculate barrier degree.

$$\frac{F_i \times K_{ij}}{\sum_{i=1}^{23} F_i K_{ij}} \times 100\% \tag{2}$$

## 5. Results and Analysis

### 5.1. Systematic and Scientific Indicator Framework

The constructed indicator system, based on the 'innovation, coordination, green, openness, and sharing' development philosophy, covers multiple dimensions such as economic efficiency, social benefits, environmental performance, technological capability, and innovation. This system comprehensively reflects the connotation and performance of high-quality development in urban gas enterprises.

### 5.2. Overall Improvement in High-quality Development Levels

Using public information and corporate social responsibility reports, data from three urban gas enterprises (A, B, and C) from 2019–2023 were collected. The CRITIC–Entropy Weight method determined indicator weights across five dimensions, and TOPSIS was applied for comprehensive evaluation. The results are presented in **Table 3**.

**Table 3.** High-Quality Development Scores of Urban Gas Enterprises (2019–2023)

Enterprise	2019	2020	2021	2022	2023	Average
A	0.257	0.275	0.264	0.283	0.309	0.277
B	0.142	0.132	0.149	0.174	0.178	0.155
C	0.206	0.218	0.229	0.232	0.237	0.225

As shown in Table 3, Enterprise A consistently achieved the highest comprehensive score, with an average of 0.277, indicating strong overall capability and sustained improvement. Enterprise C ranked second (average 0.225) with a steady upward trend. Although Enterprise B’s average was lower, it demonstrated continuous improvement after 2020. Overall, the development levels of all three enterprises improved steadily from 2019 to 2023, reflecting the industry's progress in structural optimization, innovation, and green transformation.

### 5.3. Barrier Factor Diagnosis

A total of 21 indicators were analyzed, and the top five indicators with the highest barrier degrees were selected as the main obstacle factors for each enterprise (**Table 4**).

**Table 4.** Major Obstacle Factors Affecting High-Quality Development

Enterprise	1	2	3	4	5
	Obstacle Factor	Barrier Degree / %	Obstacle Factor	Barrier Degree / %	Obstacle Factor
A	X <sub>4</sub>	19.62	X <sub>15</sub>	7.77	X <sub>1</sub>
B	X <sub>15</sub>	18.75	X <sub>18</sub>	16.46	X <sub>4</sub>
C	X <sub>15</sub>	13.16	X <sub>4</sub>	11.31	X <sub>20</sub>

According to Table 4, senior management awareness of high-quality development and social responsibility investment are the common obstacle factors among all three enterprises. Other key barriers include R&D investment, current ratio, safety expenditure, and employee compensation growth rate. To overcome these, enterprises should optimize investment structures, strengthen safety mechanisms, enhance innovation capacity, and establish rational compensation systems. Tailored strategies balancing economic and social benefits are vital for sustained high-quality development.

## 6. Conclusion

This study constructs a 21-indicator evaluation system for urban gas enterprises based on the five-dimensional framework of 'innovation-coordination-green-openness-sharing'. Weights were determined through the CRITIC-Entropy Weight method, and development levels were assessed using TOPSIS combined with the Barrier Degree Model. The system integrates policy guidance and data objectivity, offering valuable references for enterprise self-assessment and government supervision. Findings indicate that addressing weak indicators such as managerial awareness and social responsibility investment helps enterprises balance profitability with sustainability. Future work may apply this framework to pilot benchmarking projects in key regions to guide safe, green, efficient, and inclusive industry advancement under the dual-carbon goal.

## References

- [1] Z. Xu, H. Du: Standardization Status and Development Prospects in the Urban Gas Field, Proc. 2024 China Urban Gas Association Standard Work Committee Annual Conference and Gas Safety Operation and Smart Construction Seminar (Tai'an, China, July 25, 2024), p.42.
- [2] B. Yu: Construction and Application of a High-Quality Development Evaluation System for Coal Enterprises (M.S., Inner Mongolia University, China 2022), p.1
- [3] Y. Gao: Exploration of New Business Models in the Gas Industry Under the "Dual Carbon" Background, Sales and Marketing, Vol. 50 (2025) No.12, p.127..
- [4] G.H. Chi, W.Y. Shao and S.F. Wang: Construction and Application of an Enterprise High-Quality Development Evaluation System Based on the New Development Philosophy, Financial Research, Vol. 2024 (2024) No.1, p.81.
- [5] Y.P. Li, X.M. Jiang, Y.Y. Hu, et al: Study on Differential Components of Actinolite from Different Habitats Before and After Processing Based on Principal Component Combined with Entropy Weight-TOPSIS Analysis, Lishizhen Medicine and Materia Medica Research, Vol. 36 (2025) No.16, p.3086.
- [6] Z.Q. Zhu: Research on Financial Risk Evaluation of China Power Construction Based on Combined Weighting TOPSIS Method, Modern Business Trade Industry, Vol. 36 (2025) No.20, p.146.