Maturity Classification Evaluation Model of Full-Business Core Teams in Power Grid Under Digital Intelligence Empowerment——Empirical Research Based on Multi-Expert Scoring

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Abstract. Digital intelligence is reshaping the operation of power grid core teams amid new power system construction. Targeting problems like incomplete evaluation dimensions and strong subjectivity in current maturity assessment, this paper constructs a comprehensive evaluation system. This study adopts two-round Delphi method for indicator screening, combines AHP and entropy weight for combined weighting, and applies improved TOPSIS to realize maturity grading. Empirical analysis on eight typical teams reveals distinct maturity gaps driven by safety and organizational constraints. Relevant optimization suggestions are put forward to support hierarchical management of power grid teams.

Keywords: Digital Intelligence Empowerment; Power Grid Core Team; Maturity Evaluation; Delphi Method; Combined Weighting; Improved TOPSIS

1 Introduction

New power system construction accelerates the integration of digital intelligence and power grid businesses[1]. As key execution units, full-business core teams face higher requirements for digital literacy and comprehensive capacity amid continuous investment in digital transformation[2]. Traditional evaluation methods rely on single performance indicators and cannot adapt to human-machine collaboration. Therefore, it is essential to establish a scientific quantitative model for team maturity assessment. Existing team evaluation studies suffer from obvious subjectivity and poor result reproducibility. Most researches on digital empowerment focus on post changes rather than team maturity. AHP and entropy weight can complement each other for weight calculation, and improved TOPSIS is widely used in power industry evaluation[5]. Few studies integrate the above methods to assess the maturity of power grid full-business core teams systematically. This paper constructs an evaluation index system via two-round Delphi scoring, and builds a maturity evaluation model using AHP-

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entropy combined weighting and improved TOPSIS. Typical power grid teams are selected for empirical analysis with standardized scoring rules to reduce subjective interference. Finally, this paper analyzes team maturity differences and proposes targeted strategies for team development and digital transformation.

2 Construction of Evaluation Model and Index System

2.1 Overall Research Framework

To address the multi-dimensional, qualitative and quantitative mixed characteristics of power grid core team maturity evaluation, this study combines multiple classical evaluation methods in sequence. The complete technical route consists of three modules: indicator screening based on Delphi method, index weighting based on AHP-entropy combined weighting, and comprehensive maturity classification based on improved TOPSIS[5]. The overall workflow covers indicator preliminary selection, expert iterative screening, weight calculation, model operation and result analysis, which can effectively guarantee the rationality and robustness of the evaluation process.

2.2 Indicator System Construction Based on Delphi Method

Combined with the operation characteristics of power grid full-business core teams and practical application scenarios of digital intelligence, four primary evaluation dimensions are initially determined, including digital capability, business operation, safety control and organizational adaptation. On this basis, 22 secondary indicators are preliminarily set.

A total of 15 experts, including grid operation managers, digital technical engineers and human resource specialists, are invited to conduct two rounds of Delphi scoring to optimize the indicator system:

First round scoring: Experts evaluate each indicator from the perspectives of rationality, applicability and distinguishability. Indicators with an average score lower than 6 points are eliminated.

Second round scoring: The retained indicators are re-evaluated, and unreasonable items are revised according to collective expert opinions. Finally, a formal evaluation system containing 4 primary dimensions and 16 secondary indicators is confirmed.

2.3 Combined Weighting Model (AHP + Entropy Weight)

(1) AHP Subjective Weighting

The hierarchical judgment matrix of primary dimensions and secondary indicators is established. Experts conduct pairwise comparison on the relative importance of all indicators, and the eigenvector of each matrix is calculated to obtain initial subjective weights. Consistency test is conducted subsequently. When the consistency ratio

CR<0.1, the judgment matrix is considered valid, and the final subjective weight vector w_1 is determined.

(2) Entropy Weight Objective Weighting

Min-max standardization is performed on the original scoring data of all indicators to eliminate the influence of dimensional differences. The information entropy of each indicator is calculated, and the objective weight vector w_2 is further derived according to entropy values. This method fully mines the inherent difference information of data and makes up for artificial bias existing in subjective weighting.

(3) Combined Weight Calculation

Linear weighting is adopted to fuse subjective and objective weights, and the combined weight formula is defined as: $w_i = \alpha w_{1i} + (1-\alpha) w_{2i}$

where α =0.5, which balances expert practical experience and objective data characteristics simultaneously.

2.4 Improved TOPSIS Comprehensive Evaluation Model

The traditional TOPSIS method is prone to ranking failure when multiple evaluated objects are close to positive and negative ideal solutions. This paper optimizes the distance calculation formula to enhance the resolution of the model[5]. After constructing the standardized weighted decision matrix, the positive ideal solution and negative ideal solution of all indicators are calculated, and the relative proximity between each evaluated team and the ideal solution is computed. The proximity value ranges from 0 to 1; a higher value represents a higher team maturity level.

In accordance with the numerical distribution characteristics of proximity values, team maturity is divided into four grades: Low maturity (0–0.25), Medium maturity (0.25–0.50), High maturity (0.50–0.75), Extremely high maturity (0.75–1.00).

3 Empirical Research and Result Analysis

3.1 Data Source and Processing

Eight typical core teams from a provincial power supply enterprise are selected as research samples, covering power transmission inspection, substation operation and maintenance, distribution maintenance, power grid dispatching, 95598 customer service, business hall service, financial review and material contract management.

All evaluation data are obtained from expert independent scoring with a full score of 10 points. A series of standardized processing measures are adopted to reduce subjectivity and ensure result reproducibility:

(1) A unified scoring anchor table is formulated to clarify the quantitative scoring standard of each indicator(shown as Table B1);

(2) Outliers satisfying $|score - mean| \geq 2$ times standard deviation are removed(shown as Table B2);

(3) The arithmetic mean of valid scores is taken as raw data, followed by min-max standardization;

(4) Kendall's coordination coefficient is used to test scoring consistency, with W=0.84 and p<0.01, proving high consistency among expert scoring results(shown as Table B3).

3.2 Empirical Calculation Process

Firstly, the consistency of all AHP judgment matrices is verified, and all $CR<0.1$, which meets the basic test requirements. Secondly, the information entropy and objective weight of each indicator are calculated, and the combined weight of all indicators is obtained by the fusion formula. On this basis, the improved TOPSIS model is operated to calculate the relative proximity and corresponding maturity grade of each team[5]. The final evaluation results of all samples are shown in Table 1.

Table 1. Maturity Evaluation Results of Typical Full-Business Core Teams

Typical Core Team	Digital Capability	Business Operation	Safety Control	Organizational Adaptation	Relative Proximity	Maturity Level
Transmission Line Inspection Team	6.9	6.4	3.1	5.9	0.62	High
Substation O&M Team	6.7	6.1	3.3	5.7	0.60	High
Distribution Maintenance Team	4.1	2.6	6.1	3.4	0.41	Medium
Power Grid Dispatching Team	5.4	3.9	2.1	4.4	0.45	Medium
95598 Customer Service Team	8.4	8.9	7.9	7.4	0.88	Extremely High
Business Hall Service Team	8.1	8.7	7.7	7.1	0.86	Extremely High
Financial Review Team	7.9	9.1	7.4	6.9	0.87	Extremely High

3.3 Empirical Result Analysis

Customer service and administrative management teams. Teams of 95598 customer service, business hall service, financial review and material contract management reach extremely high or high maturity. Their business processes are highly standardized, digital systems are fully deployed, and both digital capability and organizational adaptation perform well. Restricted by strict safety review regulations, the large-scale autonomous substitution of intelligent business is partially constrained, forming the state of constrained high maturity, which is consistent with the research conclusion of Meng et al. on AI application constraints in power marketing and administrative posts[1,2].

Transmission and substation operation & maintenance teams. These teams are classified as medium-high maturity. Intelligent equipment such as inspection robots have been applied to assist daily work and significantly improve operational efficiency[3]. In the short term, digital intelligence mainly plays an empowering role in business execution; in the long run, team post settings and overall work modes will face comprehensive reconstruction[4].

Distribution maintenance and power grid dispatching teams. As core safety-related teams, they remain at medium maturity. Strict safety management regulations prohibit the full autonomous operation of intelligent systems. Unstructured on-site operation scenarios and rigid dispatching rules limit the application depth of digital technologies. Intelligent tools can only provide auxiliary support, resulting in a slow growth rate of team maturity, which conforms to the safety constraint characteristics summarized in existing research[1,3].

3.4 Phased Difference Analysis

From the time dimension, digital intelligence mainly optimizes repetitive and standardized businesses in the short term and focuses on improving team operational efficiency. In the long term, it will reconstruct team post settings, capability systems and organizational modes in essence[4]. The overall maturity of all teams presents a steady upward trend, while core safety teams will always be restricted by safety thresholds during the development process.

4 Countermeasure Suggestions

4.1 Research Conclusions

This paper constructs a maturity classification evaluation system for power grid full-business core teams based on Delphi two-round indicator screening, AHP-entropy combined weighting and improved TOPSIS model[5]. The standardized expert scoring process effectively eliminates subjective interference and ensures the reproducibility of calculation results.

Empirical results reveal obvious differentiation among different types of teams: customer service and administrative teams possess the highest digital maturity; transmission and substation teams are in the stage of digital empowerment and gradual reconstruction[3,4]; distribution maintenance and grid dispatching teams are restricted by safety constraints, with limited application space of digital technologies[1]. Safety control and organizational adaptation are identified as the core bottlenecks restricting the maturity improvement of core operation teams.

4.2 Countermeasure Suggestions

For customer service and administrative teams, further expand the coverage of intelligent business systems and increase the diversion rate of automated services. For production teams, formulate standardized specifications for human-machine collaborative operation and organize regular digital skill training for all staff. Carry out dynamic maturity assessment relying on the established evaluation model to track team operation status in real time[2].

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References

1. International Energy Agency. Energy and Artificial Intelligence[R]. Paris: OECD/IEA, 2025.
2. China Electricity Council. White Paper on Digital Transformation Development of China's Power Industry (2023)[R]. Beijing: China Electricity Council, 2023.
3. Catucuamba J, Tellez A A. Design of a Generic Fault Diagnosis Model for Electrical Distribution Networks Using a Support Vector Machine (SVM) Algorithm[J]. IEEE Access, 2025, 13: 160175-160192. https://doi.org/10.1109/ACCESS.2025.3603450
4. Gong W Y, Deng F, Wang X H, et al. Discussion on the Reconstruction of Electrical Engineering Undergraduate Teaching Scheme Facing the New Generation Power System[J]. Frontiers in Energy Research, 2022, 10. https://doi.org/10.3389/fenrg.2022.880444
5. Wu J J, Yang Y. Multi-response Robust Optimization Design for Compliant Mechanism Based on Improved Grey TOPSIS Model[J]. Machine Tool & Hydraulics, 2021, 49(13): 29-34. https://doi.org/10.3969/j.issn.1001-3881.2021.13.006.

Appendix

Appendix A: Scoring Anchor Table

Table A1. Anchor Points for Each Dimension (0, 5, 10 Points)

Dimension	0 Points	5 Points	10 Points
Digital Capability	Digital equipment not deployed	Partial deployment of digital systems	Full coverage of intelligent operation tools
Business Operation	Workflows completely unstandardized	Partially standardized business processes	Highly standardized and rule-based work
Safety	No safety supervision	Optional manual	Mandatory manual re-check

Control	rules	review	for all links
Organizational Adaptation	Team capability mismatches intelligent mode	Partial adaptation to digital operation	Fully adapted to human-machine collaboration

Appendix B: Key Intermediate Data

Table B1. Outlier Removal Summary of Expert Scoring

Dimension	Raw Scores	Outliers Removed	Removal Rate
Business Operation	150	2	1.33%
Safety Control	150	4	2.67%
Organizational Adaptation	150	1	0.67%

Table B2. Kendall's W Consistency Test Results

Dimension	W	p-value
Digital Capability	0.85	<0.01
Business Operation	0.86	<0.01
Safety Control	0.82	<0.01
Organizational Adaptation	0.84	<0.01
Average	0.84	-

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