



Research on the Path of High-Quality Development of Shenyang City Driven by Digitalization

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Abstract. Based on the technology-organization-environment (TOE) framework, combined with SEM and fsQCA, this study takes Shenyang as an example to explore the path mechanism of digitally driving the high-quality development of old industrial cities. By constructing an evaluation system covering three dimensions of economy, society and environment, the high-quality development level of Shenyang from 2016 to 2023 was evaluated. . The study found that the overall level of high-quality development in Shenyang is on the rise, but it fluctuates around 2020 due to the impact of the epidemic. A single variable does not constitute a necessary condition for high-quality development. During the 13 th Five-Year Plan period, three AI empowerment paths were identified: technology-capability-policy type, technology-innovation-environment type and application-organization-environment type ; during the "14th Five-Year Plan" period, it converged into an application-ability-policy path. This change shows that Shenyang has gradually shifted from an exogenous drive of policy and technology to a new stage of high-quality development(HQD) with organizational capacity as the core.

Keywords: High-quality urban development; technology-organization-environment (TOE) framework; configuration path, digital empowerment

1 Introduction

Urban high-quality development is the urban scene practice of the five development concepts of "innovation, coordination, green, openness and sharing." It is the core standard to measure the comprehensive strength and competitiveness of the city.

The evaluation of urban high-quality development level is the key to effectiveness measurement. The existing research constructs the index system from the three dimensions of economy, society and environment, but there are limitations such as heavy economy, static and unified standards. Digital technology provides a new idea for evaluation through big data and intelligent algorithms.

Digital empowerment has a significant role in promoting high-quality urban development[1]. Optimize resource allocation and improve production and governance efficiency at the technical level ; at the institutional level, relying on policy and governance innovation to reduce transaction costs and enlarge technological dividends, especially when technology and policy break through simultaneously, it can produce multiplier

effect and help urban development and transformation. The existing research on the high-quality development of digitally empowered cities has three main limitations: single perspective, traditional methods, and sample bias. A more systematic and targeted framework is urgently needed.

In order to make up for these shortcomings, this paper evaluates the high-quality development level of Shenyang from three aspects of economy, society and environment through the cross-sectional data of Shenyang from 2016 to 2023. Combined with the technology-organization-environment (TOE) framework, the structural equation model and fuzzy set qualitative comparative analysis (fsQCA) are used to explore the path of high-quality development of digitally enabled cities.

2 Research Background and Hypothesis

Digitalization drives high-quality urban development through three levels : technology, organization and environment[2]. At the technical level, digital infrastructure is the ' physical basis ' of data circulation and application[3], and digital technology application is the ' practical carrier ' to improve efficiency and quality[4]. At the organizational level, organizational innovation breaks data barriers through process reengineering, and organizational capabilities rely on data applications and talents to achieve technological docking. At the environmental level, government policies provide institutional incentives, and digital finance helps technology land through capital and risk control[5]. Based on the driving mechanism of digitization in technology, organization and environment, this paper puts forward a series of hypotheses that digital infrastructure, digital technology application, digital organization innovation, digital organization ability, government digital policy and regional digital finance have a significant impact on urban high-quality development.

3 The High-Quality Development Level of Shenyang City

3.1 Research Design and Data Sources

This study uses the entropy weight method to evaluate the level of high-quality urban development, and based on the TOE framework, combined with multiple linear regression and fuzzy set qualitative comparative analysis, explores the correlation and empowerment path between digitization and high-quality urban development. The research takes Shenyang as a sample, and has significant representativeness in industrial structure, economic level and digital transformation practice. The data are derived from various authoritative statistical data such as the " China Statistical Yearbook " Shenyang Statistical Yearbook " from 2016 to 2023 to ensure the scientificity and reliability of the research.

3.2 Variable Measure

Based on the five dimensions of innovation, coordination, green, openness and sharing, this study constructs an evaluation index system of high-quality development level in Shenyang, covering specific indicators such as GDP growth rate, R & D investment intensity, industrial structure, unit output emissions, foreign trade dependence and residents' income growth elasticity, and uses the entropy weight method to calculate the corresponding weights. At the same time, according to the TOE framework, the digital empowerment factors are summarized as infrastructure and application at the technical level, innovation and capability at the organizational level, and policy and digital finance at the environmental level, forming a research system composed of multi-dimensional indicators and multi-level elements, which provides systematic support for subsequent empirical analysis.

3.3 High Quality Development Level of Shenyang

Through the above selected indicators and determined weights, the high-quality development level of Shenyang City in 2016-2023 is calculated. Shenyang's high-quality development is on the rise but with stages: it rose steadily from 2016 to 2019, peaked in 2019, declined in 2020, and gradually rebounded after 2021, vulnerable to external environmental fluctuations. The growth from 2016 to 2019 is due to the optimization of industrial structure, the upgrading of equipment manufacturing industry and the growth of new energy and other emerging industries. In 2020, due to the impact of the epidemic, consumption is shrinking, the industrial chain is blocked, and the service industry and foreign trade are frustrated, resulting in a decline in development; after 2021, with the normalization of epidemic prevention and control, the effective policy of stable growth, the resumption of projects, the integration of data and reality and the promotion of regional coordination strategy, the level of development has gradually recovered.

3.4 Regression Analysis of the Influencing Factors of High-Quality Development

The linear regression analysis of each variable of Shenyang's high-quality development under digital empowerment is shown in Table 1.

It can be seen from Table 1 that the P values of digital infrastructure, digital organization ability and government digital policy are all less than 0.05, and the P values of digital technology application, digital organization innovation and regional digital finance are between 0.05 and 0.1, which are significant with the high-quality development level of Shenyang. Therefore, it is assumed that H1-H6 are verified. The P values of the six variables are all less than 0.1, and there is no need to eliminate the variables. So they are retained for subsequent fsQCA analysis.

Table 1. Model regression results

	_cons	Digital in- frastuc- ture	Application of digital technology	Digital Or- ganization Innovation	Digital or- ganization ability	Govern- ment digi- tal policy	Regional digital fi- nance
Coeffi- cients	.53376	-.01819	.00059	.07500	-.31226	1.1467	-.83912
Standard error	.02983	.00668	.00412	4.18e-07	.08221	.35057	.34617
tStat	17.89	-2.7	1.44	1.80	-3.80	3.27	-2.42
P-value	0.257	0.014	0.068	0.089	0.019	0.031	0.072
Lower95 %	.45093	-.03223	-.00027	-1.28e-07	-.54052	.17342	-1.80027
Up- per95%	.61659	-.00415	.00145	1.63e-06	-.08001	2.1201	.12202

4 Research on the Configuration Path of Digitally Empowering High-Quality Development in Shenyang

4.1 Data Calibration

Based on the existing relevant research experience, combined with the actual situation and data characteristics of Shenyang City, the antecedent conditions and outcome variables are calibrated. The quantiles of the anchor points are determined to be 95 %, 50 %, and 5 %, respectively, corresponding to complete membership, intersection, and complete non-membership. In order to avoid the loss of the same value as the anchor point in the truth table, the relevant variable values are uniformly added with 0.001 for preprocessing.

4.2 Necessity Analysis of a Single Condition

According to the necessary condition criterion proposed by Fiss, this paper argues that the condition is a necessary condition when the consistency threshold of the antecedent condition is higher than 0.9. The fsQCA software was used to test the necessity of the six antecedent conditions. During the "135" period, the government digital policy and regional digital finance were the necessary conditions to drive the high-quality development of Shenyang city. Through the x-y scatter plot test, this study found that most of the years were distributed near the right x-axis, which indicated that even if the government digital policy and regional digital finance had passed the consistency test, they were not the necessary conditions for Shenyang to achieve high-quality urban development. During the "145" period, there was no condition to promote Shenyang to achieve high-quality development. Therefore, the high-quality development of Shenyang needs to comprehensively consider the synergistic effect of multiple conditions.

4.3 Adequacy Analysis

The sufficiency analysis aims to reveal the configuration path of high-quality development in Shenyang. The configuration path consistency threshold is set to 0.8, the PRI threshold is set to 0.7, and the case frequency is set to 1. The configuration path that drives the high-quality development of Shenyang during the "135" and "145" periods is determined. The results are shown in Table 2.

Table 2. Analysis of multi-period regional high-quality development configuration path.

Time	135			145
Variable	P1	P2	P3	P1
Digital infrastructure	·	·	×	×
Application of digital technology	·	·	·	·
Digital Organization Innovation	×	·	·	×
Digital organization ability	·	×	·	·
Government digital policy	·	·	·	·
Regional digital finance	×	·	·	·
Raw coverage	0.184502	0.428044	0.343173	0.760976
Unique coverage	0.107011	0.332103	0.23569852	0.595122
Consistency	0.846971	0.793481	0.821934	0.785134
Solution coverage		0.782288		0.765854
Solution consistency		0.749117		0.640816

4.4 Analysis on the Path of Digital Enabling High-quality Development

According to the results of fsQCA analysis, Shenyang shows different high-quality development paths of digital empowerment during the "13th Five-Year Plan" and "14th Five-Year Plan".

Three driving paths are identified in the 13 th Five-Year Plan period : P1 (technology-ability-policy) emphasizes the core of digital infrastructure, technology application and organizational capabilities, and promotes the upgrading of traditional industries under the guidance of policies ; p2 (Technology-Innovation-Environment) integrates technology, organizational innovation, policy and digital finance to achieve multi-factor coordinated development ; p3 (Application-Organization-Environmental) relies on technology application, organizational capabilities and digital finance to form an effective supplement in the case of imperfect infrastructure.

Entering the "14th Five-Year Plan" stage, the path converges to a single application-ability-policy-finance type, which takes technology application, organizational ability, government policy and digital finance as the core conditions.

Shenyang 's HQD has shifted from "multiple exogenous driving" to "connotation endogenous driving" : its "13 th Five-Year Plan" relies on external promotion of policies and technologies ; the "14th Five-Year Plan" is a dual-core power with endogenous organizational capabilities and digital finance, entering a high-quality stage, providing a reference for the transformation of similar old industrial cities.

5 Summary and Prospect

Based on the TOE framework, this study uses structural equation model and fuzzy set qualitative comparative analysis method to analyze the high-quality development level and digital empowerment path of Shenyang from 2016 to 2023. The study found that the overall high-quality development of Shenyang City during this period was on the rise, but there were fluctuations due to external factors such as the epidemic situation ; its driving path is from the technology-capability-policy type, technology-innovation-environment type and other paths during the "13 th Five-Year Plan" period to the "application-capability-policy-finance type" path with digital technology application, organizational capacity, policy support and digital finance as the core during the "14 th Five-Year Plan" period, showing an evolution trend from " multiple exogenous driving " to " connotation endogenous driving ". It is suggested to implement differentiated regional development strategies, strengthen the coordination of digital infrastructure and government affairs, improve the digital financial ecology and innovation platform, and build a closed-loop mechanism of "R & D-application-feedback-reinnovation", so as to provide a path reference for the digital transformation and HQD of Shenyang and other old industrial cities.

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