

## **Research Article**

# **Performance Evaluation of Public Management in View of Fuzzy DEA Model**

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The research on management performance evaluation and governance countermeasures of public utilities, as an important entry point, focus, and flash point of the combination of management science, engineering research, and public management research, not only highlights the implementation and implementation of the scientific outlook on development and correct outlook on political performance, so that the topic has distinct theoretical frontier, practical perfinence, and practical guidance. It also highlights the intersection and integration of multiple disciplines, combines normative research with empirical research, qualitative research with quantitative research, macro research with micro research, and method and technology research with concept innovation and institutional arrangement research, and strives to realize the integration and complementarity of research methods of management science and engineering and public management. The research of public management broadens new horizons, expands new fields, and provides new paradigms, methods, and means. Based on the weight of public utilities management performance evaluation indicators and the selection of empirical samples, this paper studies the basic principles and comparative advantages of fuzzy comprehensive evaluation model and DEA model, makes an empirical evaluation of public utilities management performance, draws evaluation conclusions, and analyzes the key factors affecting and restricting the level of public utilities management performance. From the research level of evaluation technology and methods to the level of institutional arrangement, it is the only way to realize the scientific, standardized, and institutionalized performance evaluation of local government public utilities management. The basic procedures of performance evaluation and the performance evaluation mechanism are introduced, and the establishment and improvement of the information fidelity system and result application system of public utilities performance evaluation are studied. Based on the evaluation conclusion and empirical analysis of public utilities management performance, aiming at the key factors affecting the level of public utilities management performance, this paper puts forward the governance countermeasures of public utilities from the aspects of establishing scientific public utilities management performance concept, innovating public utilities management system, establishing and perfecting public utilities investment management mechanism, and so on.

## 1. Introduction

Performance evaluation of public utilities management is an internationally recognized problem. As a governance tool to evaluate and improve the performance of public utilities management, performance evaluation has attracted the general attention of governments all over the world. It has become a frontier topic in management science and engineering and modern public management research [1–8].

Over the past 20 years, Britain and the United States and other Western developed countries have paid special attention to "management issues" and have continuously deepened the administrative reform, with remarkable results. China's current administrative reform focuses more on the macro "system level" and "structure level," which is limited to the increase and decrease of the number of institutions and the adjustment and transformation of functions. The hot spots focus on the relationship between institutional reform and function transformation, and there is not enough direct attention and in-depth research on the "management problems" at the micro level. "Management problems" are not organically combined with system innovation, institutional reform, and function transformation. There is a lack of an effective method to evaluate the management level and effect after the reform, let alone improve and improve the management level. At the same time, the evaluation of local public utilities management performance is used in qualitative analysis and less quantitative analysis. In the specific evaluation process, not only the index system is unscientific, the evaluation information is insufficient and inaccurate, the water content is large, and there is a lack of effective evaluation methods and tools but also the social evaluation of public utilities management performance is quite weak. Therefore, strengthening the research on the evaluation of local public utilities is conducive to find an effective method to evaluate the management level and reform effect after the reform of public utilities and is conducive to the smooth implementation of deepening administrative reform measures [5, 6, 9–11].

E.S. Savas uses a large number of conclusive evidence to prove that contract contracting is the most efficient. Quamrul Alam and John Pacher studied the impact of mandatory competitive bidding system on local structure and performance in Victoria by means of empirical research. He believed that at present, private sector management practices are being introduced into the public sector all over the world. Adopting bidding system can improve efficiency, reduce operation costs, clarify operation objectives and better respond to "customers," and demand and improve the quality of public goods and services. Foreign scholars have made a detailed exposition on the position of public sector performance evaluation, performance management, and the joint participation of policy makers and citizens in the improvement of public sector performance. Although citizen participation usually produces effective policies and a satisfactory public sector, it is often considered to be burdensome, costly, and time-consuming. Thomas pointed out in public participation in public decision-making that public participation can increase the effectiveness of policies formulated by public managers. Sanderson studied the public sector reform of OECD member countries and found that these countries have constructed a new model of "public governance," in which the scale is more appropriate and performance management is particularly emphasized. Bernstein (David J. Bernstein) selected five places as research samples, which widely used performance measurement to support the supervision of public projects and improve service performance [12-21].

The public management performance evaluation is studied as a part of a complete and systematic management process. It is considered that the public management performance evaluation is the core link of the performance management process. The public management performance evaluation is combined with the research on the performance management process of the public management department, rather than the research on the public management performance evaluation, mainly based on the

research of specific problems and practical cases, mainly using empirical research methods, through the design of quantitative indicators to measure the performance of public management and the quality of public services. In terms of specific countermeasures and suggestions, it actively advocates the application of various advanced management methods and technologies of the private sector to its research, so as to form its distinctive research characteristics, which is related to the overall quality of life and common interests of all the public. Take the narrow social public affairs as the basic content and include the activities and results of necessary social public economic affairs. It mainly includes education, science and technology, culture, health, sports, infrastructure, social security, and environmental protection. Public goods belong to the category of public goods and quasipublic goods. Publicity is the essential characteristic of the public. Public management is a process in which the core public organization adjusts and controls the public according to law in order to promote the coordinated development of the overall interests of society.

The characteristics of public management are determined by the publicity. In essence, public management is the management of public goods and quasipublic goods. The purpose is to provide the public with sufficient and highquality public goods and quasipublic goods in time and effectively. Public management is to ensure and develop public interests. Its management performance should be evaluated and measured by indicators such as service quantity, quality, and the degree of meeting social needs, rather than simply using profit and efficiency as standards [22–30].

Public management performance evaluation evolved from enterprise performance evaluation, or government public management performance evaluation is the reference and development of enterprise performance evaluation in management. This kind of reference and development is determined by the identity between public management performance evaluation and enterprise performance evaluation. In essence, organization is an open social unit established to achieve certain goals. It includes four aspects: static organizational structure, dynamic organizational behavior, ecological organizational environment, and psychological organizational consciousness. This essential regulation of organization determines that public management performance evaluation and enterprise performance evaluation are the same as organizational performance evaluation. This identity is mainly reflected in that performance evaluation is based on organizational objectives, based on standardization and institutionalization, focusing on organizational analysis, based on relevant evaluation and conditional on the participation of organizational members. However, management and enterprise management are completely different management categories. Due to the publicity, service, and complexity of public management, it is impossible and impossible to simply apply the modes and methods of enterprise performance evaluation to the performance evaluation of government public management.

Performance evaluation is an important part of the systematic and periodic process of performance

management. Public sector performance management consists of a progressive process of environmental analysis, establishing mission and vision, setting objective system, formulating action plan for integrating various resources, evaluating and measuring performance, and implementing tracking and monitoring. Public management performance management is to establish a "result oriented" public service delivery system to implement responsibilities and improve management performance by integrating and improving the performance of all levels and fields of the public sector and maintaining coordination among them.

#### 2. Fuzzy DEA Model

The multi-index comprehensive evaluation method for complex objects has always been a research topic concerned by scholars. Each method has its own characteristics: value analysis, which is essentially based on the weight of each single evaluation index and the value of the system under the action of a single index, and then the comprehensive index is obtained by weighting. It is characterized by simplicity and convenient calculation. However, it is difficult to determine the value (effect) of the system, especially the weight of each index; and the data envelopment analysis. From the perspective of production function, it uses linear programming or its duality to estimate effective production frontier, which is used to study multiple production, especially multiple output departments, and is also effective for technology. "Scale efficiency" is an ideal and effective method, but it also has some limitations. The relative efficiency of the decisionmaking unit can only be measured by input or output, and the measurement results of the two angles are usually different, but cannot be measured by input and output at the same time. Whether the decision-making unit is relatively effective or not must be judged by introducing infinitesimal "e" into the corresponding mathematical programming, and the adaptability of this method needs to be further discussed. The first stage: traditional model; the second stage: removing the influence of environmental variables and random factors; the third stage: adjusted DEA.

In recent years, people have discussed the application of neural network in comprehensive evaluation according to the characteristics of neural network with strong pattern recognition ability. This method avoids the subjectivity in determining the index weight and obtains the experience, knowledge, subjective judgment, and the tendency to the importance of the target of the evaluation expert through the learning of the given sample mode. Its characteristics are as follows: considering the complexity of the internal relations of objective things and the fuzziness of the value system, but in the fuzzy comprehensive evaluation, the determination of fuzzy membership function and the fuzzification of index parameters will be mixed with human factors and lose useful information. Therefore, the selection of its operator is also very important as shown in Figure 1.

The fuzziness of public management performance brings difficulties to performance evaluation. How to solve the contradiction between the accuracy requirements of evaluation and the imprecision of performance itself is a key

problem in public management performance evaluation. The fuzziness of public management performance is determined by the following four characteristics of public management performance: first, the complexity of public management performance structure. The structural factors of government performance intersect and integrate with each other, and their measurement cannot be measured by unified standards and scales, which is extremely complex. Secondly, the nonmarketability of public management output. As a nonprofit organization engaged in the authoritative distribution of value within the political community, the state promotes economic and social development and public welfare by coordinating relations, ruling disputes, maintaining order, and providing support. The output of government public management cannot enter the market system like the output of enterprises to form money prices. The output of administrative institutions is different from that of enterprises, and its determination and measurement are very difficult. Thirdly, the nondiscreteness of public management performance. Public management performance does not exist discretely and cannot be measured by a single object. James Wilson believes that it is often difficult to measure the output of an organ, in fact, even a mere assumption of what is the output of national departments is enough to make people dizzy. Both administrative effect and administrative consumption are categories with vague connotation and drifting extension. At the same time, public management performance is the evaluation of the publicity. The prescriptive nature of the quantity of objects is often nonnumerical, such as the degree of social democratization, the improvement level of citizens' quality, the degree of social self-organization, etc., which cannot be measured on the spot like physical quantities. Finally, the uncertainty of public management performance boundary. Although the satisfaction degree of service objects has a great correlation with the administrative efforts of organs, in fact, it is not completely determined by the administrative efforts, but the result of the comprehensive action of many factors, among which the influence of social environmental factors on the satisfaction degree cannot be ignored. In the language of economics, there is externality in public management performance, that is, if part of public management performance is brought by the efforts of nonsubjects, then public management performance presents positive externality. At the same time, cost and public management performance are not in a strong linear relationship. Therefore, this paper must pay attention to the uncertainty of public management performance boundary when evaluating public management performance. Aiming at this characteristic of local public management performance, the fuzzy comprehensive model applies fuzzy mathematics tools to provide a broad space for the rational quantification of evaluation [31–35].

The performance evaluation of public management is a comprehensive evaluation of multiple indicators, which involves a wide range of indicators. There is no unified measurement standard among each indicator, so it is difficult to compare and choose. Therefore, before comprehensive evaluation, it is necessary to adopt a standard transformation method to uniformly transform the attribute

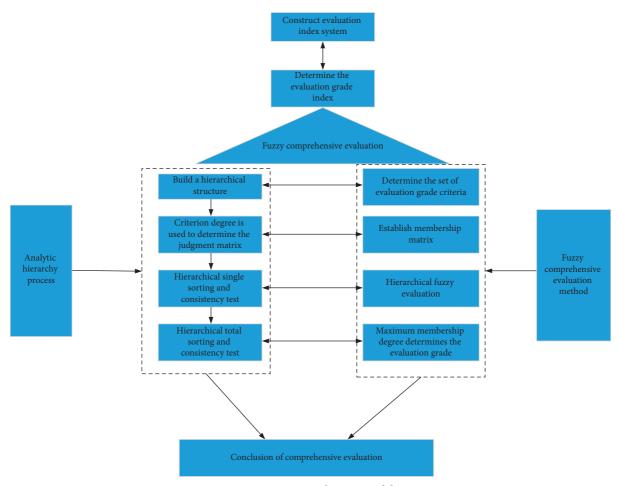


FIGURE 1: Fuzzy evaluation model.

values of all indicators to the range of [0,1], that is, to carry out dimensionless evaluation index attribute values. However, since the types of evaluation indicators are often different, each indicator is also different. There are also different ways of translating into appraisal value.

$$b_j = \bigvee_{k=1}^n * \left( w_k \wedge * r_{kj} \right), \tag{1}$$

where  $b_j$  is the operator,  $\lor$  is the fuzzy union, and  $\land$  is the fuzzy product, indicating the minimum value between comparison elements.

If different basic algorithms are adopted for fuzzy comprehensive evaluation model, the results may be different even for the same object, which is in line with the objective and practical law of understanding things.

The subset satisfies

$$u = \bigcup_{i=1}^{3} u_{i},$$

$$u_{r} \cap u_{s} = \phi,$$

$$r, s \in \{1, 2, 3\},$$

$$r_{i} = u_{d_{i}}(x_{i}),$$
(2)
(3)

The fuzzy mapping f is

$$f: U \longrightarrow F(U),$$
  
$$u_i \longrightarrow f(u_i) = (r_{i1}, r_{i2}, \dots r_{im}) \in F(V),$$
(4)

where  $u_i$  is to evaluate the attribute value of index,  $x_i$  must be dimensionless to give the standard function, that is, to calculate the specific membership degree of indicators, so as to carry out the relative comparison between attributes.

The weight vector shape and the fuzzy comprehensive evaluation matrix scale are synthesized as the fuzzy comprehensive evaluation result.

$$S = W * R \bigg( \Leftrightarrow u_j = \bigvee_{i=1}^n (w_i \wedge r_{ij}), \quad j = 1, 2, \dots, m \bigg).$$
(5)

Fuzzy relations are induced by mapping f

$$R_f \in F(U \times V), \tag{6}$$

$$R_{f}(u_{i}, v_{j}) = f(u_{i})(v_{j}) = r_{ij},$$
  
 $i = 1, 2, ..., n; \ j = 1, 2, ..., m.$ 
(7)

The optimization model is constructed as follows:

$$\left( C^{2}R - \overline{P} \right) \begin{cases} \max \quad h_{0} = \frac{u^{T}Y_{0}}{v^{T}X_{0}} = V_{\overline{P}}, \\ h_{j} = \frac{u^{T}Y_{0}}{v^{T}X_{0}} \le 1 \quad j = 1, 2, \dots, n, \\ \text{s.t.} \quad v \ge 0, \\ u \ge 0. \end{cases}$$

$$(8)$$

The linear programming model is a fractional model, which can be transformed into an equivalent linear programming model by Charnes-Cooper transformation. Make

$$t = \frac{1}{v^{T} X_{0}},$$

$$w = tv,$$

$$k = tu,$$

$$\left(C^{2}R - P\right) \begin{cases} \max & k^{T} Y_{0} = V_{P1}, \\ & w^{T} X_{j} - k^{T} Y_{j} \ge 0 \quad j = 1, 2, \dots, n, \\ & w^{T} X_{0} = 1, \\ & v \ge 0, \\ & u \ge 0, \end{cases}$$
(10)

$$(C^{2}R - D) \begin{cases} \min & \theta, \\ & \sum_{j=1}^{n} X_{j}\lambda_{j} + S^{-} = \theta X_{0}, \\ \text{s.t.} & \sum_{j=1}^{n} Y_{j}\lambda_{j} - S^{+} = Y_{0}, \\ \text{s.t.} & \lambda_{j} \ge 0 \quad j = 1, 2, \dots, n, \\ & S^{+} \ge 0, \\ & S^{-} \ge 0, \end{cases}$$
(11)

$$\left(C^{2}GS^{2}-D_{\varepsilon}\right)\left\{\begin{array}{ll}\min \quad \theta,\\ &\sum_{j=1}^{n}X_{j}\lambda_{j}+S^{-}=\theta X_{0},\\ &\sum_{j=1}^{n}Y_{j}\lambda_{j}+S^{+}=Y_{0},\\ \text{s.t.} \quad &\sum_{j=1}^{n}\lambda_{j}=1,\\ &\lambda_{j}\geq 0, \quad j=1,2,\ldots,n,\\ &S^{+}\geq 0,\\ &S^{-}\geq 0.\end{array}\right.$$

(12)

Each DSU has *m* types of "inputs" and *s* types of "outputs."  $\lambda_j$  is the corresponding weight coefficient.  $X_j$  represents the weight of input of the *j* type, *S* represents the weight of the type output,  $C^2R$  is the fractional programming model,  $C^2GS^2$  is the dual programming,  $S^-$ , and  $S^+$  is the slack vector.

#### 3. Data Analysis

Since the purpose of this research is not to evaluate the performance of local government public utilities management in a province, but to establish a scientific and feasible performance evaluation index system and evaluation model of local government public utilities management, empirical analysis is an important means to achieve this goal, rather than the end itself. Due to various reasons, the evaluation conclusion does not specify the names of cities and states, instead, they are A, B, C, D, E, F, G, H, I, J, and K, respectively, in Figure 2.

Indicator layer C has 19 quantitative indicator sets, as shown in Figure 3. The green, red, and blue parts indicate the percentage of "poor," "medium," and "good" of the corresponding indicator, respectively. The percentage sum of the columns corresponding to each layer C indicator is 100%, that is, the sum of the green, red, and blue parts of each column is 100%.

After calculation, the comparison results of the weights of indicators at layer C relative to those at layer A are obtained (Figure 4). The indexes at layer C are sorted in order according to their weight values, and the relative importance of factors at layer C and the weight of other indexes are less than 0.02, indicating that the importance is relatively small, or when the above two indexes are improved, automatically drive the improvement of these indicators.

As shown in Figure 5, on the processing of sample statistics, by defining each key performance factor containing key practices, make it have the same weight coefficient, and then the key practices of the score and total score for the corresponding key performance factor value can be obtained, and then add it. After the statistics of the scale as the basis of data analysis, the maturity model is evaluated and the structural equation model is calculated and verified.

The method in Figure 6 is adopted to generate a cloud model to represent the language preference information of decision makers or experts, which can better characterize the relationship between fuzziness and randomness in fuzzy preference information.

As can be seen from Figure 7 of technical efficiency, except for Province A, the trend of fiscal expenditure technical efficiency in the other five provinces is similar, showing A trend of deterioration in fluctuations. Technical efficiency has maintained a relatively stable situation and declined significantly in 2017. The other five provinces showed the first trough in 2005 and 2006, and then picked up, and began to decline in 2010 for the second time, and the decline speed is obvious.

The overall efficiency comparison results of the first stage and the third stage are presented in Figure 8. It can be seen

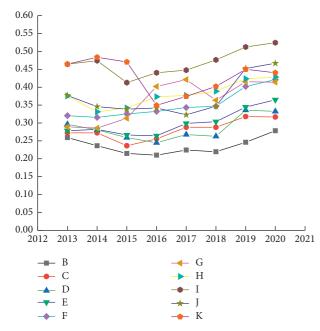


FIGURE 2: Comparison line chart of performance evaluation results of public management.

from Figure 8 that the efficiency value of the first stage is significantly different from that of the third stage, indicating that environmental variables and random factors have a great disturbance on the fiscal expenditure efficiency of the six central provinces, which also proves the significance and value of selecting the three-stage DEA model.

#### 4. Study on Countermeasures

As a management tool, an important purpose of performance evaluation of local government public utilities management is to analyze and grasp the problems existing in local government public utilities management and provide basis for the governance of local government public utilities. From the empirical analysis conclusion on the performance evaluation of local government public utilities management in Section 4, it can be seen that in recent years, the three key indicators affecting the performance of local government public utilities management are the proportion of education expenses in GDP, the proportion of total annual wages of on-the-job employees of state organs in financial expenditure, and the proportion of administrative expenses in local financial expenditure. The effective solution of these three problems involves many factors. The fundamental lies in the comprehensive treatment from three aspects: establishing a scientific concept of local government public utilities management performance, innovating local government public utilities management system, and establishing and perfecting local government public utilities investment management mechanism in Figure 9.

Comprehensive development, coordinated development, and sustainable development are inter-related. Allround development means that all aspects should be developed. Economic development, social development, and people's all-round development cannot ignore one and lose the other; coordinated development means that all aspects of development should adapt to each other; sustainable development means that the development process should be durable, continuous, and renewable. First, correctly handle the relationship between economic growth rate and economic structure optimization. Economic development must maintain a rapid development speed, especially as a large developing country, it needs to maintain a rapid development speed for a long time. However, the growth of total GDP and the improvement of its growth rate do not mean the optimization and upgrading of economic structure. When evaluating and managing the performance of local governments, we should not only use GDP indicators but also use the indicators of economic structure adjustment, optimization, and upgrading, so as to combine the growth of total GDP and its growth rate with the adjustment, optimization, and upgrading of economic structure, and take the adjustment, optimization, and upgrading of economic structure as the premise and foundation. From the perspective of local government public utilities management, the current problem to be attached great importance to and effectively solved is the imbalance in the proportion of material production and investment in social security, compulsory education, and public health, and the proportion of investment in social security, compulsory education, and public health in GDP is relatively small. Secondly, correctly handle the relationship between economic growth rate and quality and benefit. The growth of total GDP and the improvement of its growth rate do not mean the improvement of quality and efficiency. Moreover, sometimes the growth of total GDP and the improvement of its growth rate are at the expense of quality and efficiency. We should unify the growth of total GDP and its growth rate with quality and efficiency and increase GDP on the premise of ensuring quality and efficiency. To this end, we must prevent and overcome such undesirable phenomena as high input and low output, high cost and low efficiency, high energy consumption, and great damage to the ecological environment, pay attention to reducing resource costs, ecological and environmental costs, social costs, and administrative costs, and unify economic growth with quality and efficiency. Correctly handling the relationship between economic growth rate and structure, quality and efficiency objectively require that in the process of evaluating the performance of local governments, we should not only attach great importance to GDP indicators to adapt the development of public utilities to economic development but also pay too much attention to GDP. We should prevent and overcome one sidedness and absolutism and ignore and even sacrifice the development of public utilities; at the same time, we cannot ignore and deny the necessary and appropriate growth of GDP because we emphasize and pay attention to the development of public utilities, and we cannot talk about the development of public utilities without economic development.

Economic and social development should be based on the population carrying capacity, resource support capacity, ecological environment, and social bearing capacity. Beyond

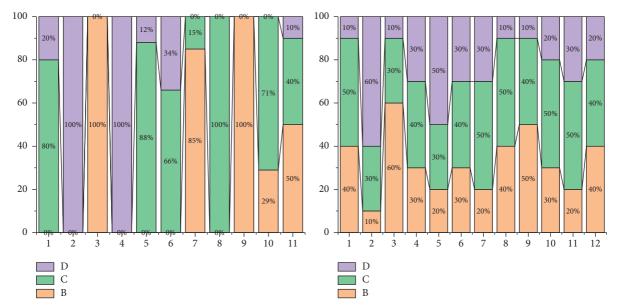


FIGURE 3: Hierarchical distribution of qualitative indicators.

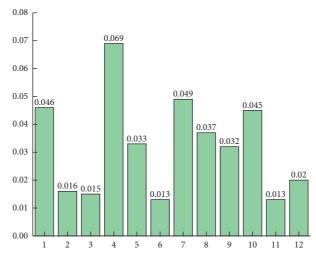


FIGURE 4: Weight comparison between the indicator layer and target layer.

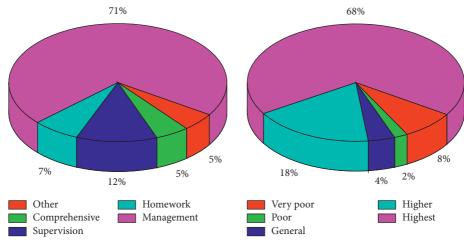


FIGURE 5: Distribution.

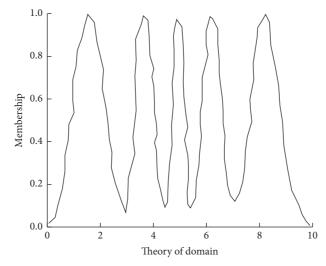


FIGURE 6: Relationship between domain and membership degree.

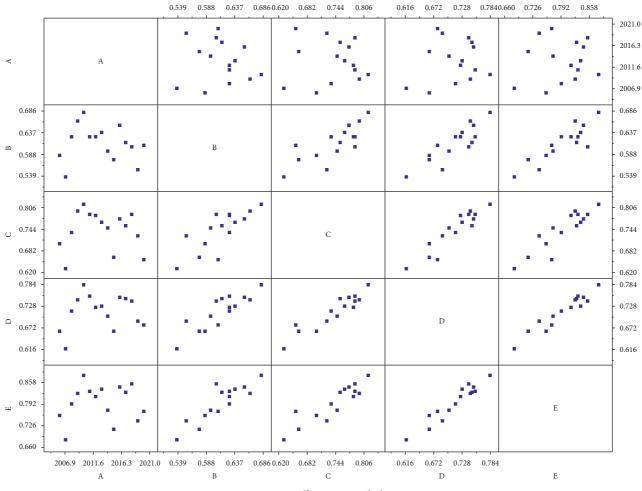


FIGURE 7: Efficiency trend chart.

the population carrying capacity, resource support capacity, ecological environment, and social bearing capacity, economic and social development cannot be sustainable. Local government public utilities management should guide and supervise local governments to control population, save resources, protect the environment, and strengthen ecological construction, so as to make rational use of resources. Economic development should not be at the cost of

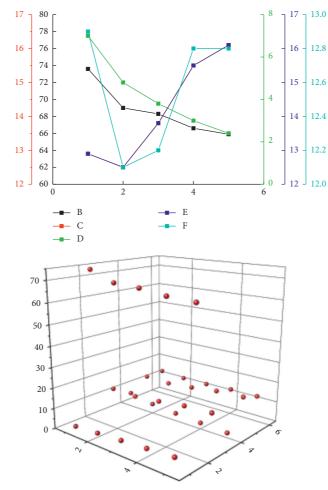


FIGURE 8: Overall efficiency comparison results.

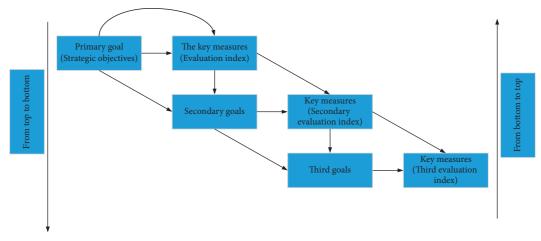


FIGURE 9: Index decomposition system.

destroying and wasting resources, polluting the environment and destroying ecological balance, so as to prevent and overcome blindly pursuing "big work and fast progress" only for immediate interests "there is water flowing fast," or divorced from reality, "lift a climax" and "create a miracle." Development is social development and all-round human development on the basis of economic development. Social development includes the development of social undertakings such as science and technology, education, culture and health, social employment, social security, social justice, social order, social self-care, and social harmony, as well as the development of democracy and legal system, spiritual civilization, social structure, social systems, and mechanisms. Economic development is the basis of social development, and social development is the guarantee of economic development. After the economy develops to a certain extent, we should strive to improve people's quality of life as a whole, enrich people's spiritual life, and provide a better humanistic atmosphere, medical and health conditions, and ecological environment for people's all-round development.

Administrative efficiency, administrative treatment, and administrative benefit are three inter-related and different concepts. Administrative efficiency refers to the ratio of the social effect produced by a certain administrative activity in unit time and space to the cost paid in the process of this activity, which is a quantitative concept; administrative treatment refers to the correctness of administrative objectives and the degree of their realization. It is the usefulness of social effects produced by administrative activities in unit time and space. It is a qualitative concept; administrative benefit refers to the ratio of the social effect produced by a certain administrative activity in line with social needs to the consumption in the process of this activity. Its essence is to provide more products or services in line with social needs with as little labor consumption and material consumption as possible. Administrative efficiency is the organic unity of administrative treatment and administrative benefit. Among them, administrative efficiency is the qualitative stipulation of administrative efficiency; administrative efficiency is the stipulation of the quantity of administrative benefits. Efficiency commands, limiting efficiency, efficiency obedience, and service efficiency are important. The two are closely linked, promote each other, and cannot be neglected.

4.1. Limiting Efficiency. The public utilities management system of local government is an institutional system about the division of responsibilities and rights among various subjects, levels, and departments of public utilities management. The core is the power, structure, and operation mode of various subjects, levels, and departments. In view of the disadvantages of the current local government public utilities management system, innovating the local government public utilities management system is the fundamental of local government public utilities governance.

The local government's investment in public utilities is based on the public's entrustment, which forms a principalagent relationship with the public in the process of investment. The existence of agency relationship means the existence of agency risk, that is, the local government may damage the interests of the initial principal by virtue of its own information advantage in the investment process. Therefore, we should establish and improve the investment benefit management mechanism and reduce the agency risk. The establishment and improvement of investment benefit management mechanism not only reflects the benefit orientation of local government public utility investment but also reflects the tool orientation of public utility management performance governance. Therefore, it is reasonable and inevitable.

## 5. Conclusion

- (1) Construct a relatively scientific and complete theoretical system of performance evaluation of local government public utilities management and promote the transformation of performance evaluation research of local government public utilities management from scattered research to systematic research. Based on the theoretical basis  $\longrightarrow$  technology, method  $\longrightarrow$  system arrangement  $\rightarrow$  governance countermeasures, and the theoretical basis  $\longrightarrow$  index system, evaluation model and empirical analysis  $\longrightarrow$  system arrangement  $\longrightarrow$  governance countermeasures are constructed.
- (2) Construct the public utility management performance evaluation index system and evaluation model. The construction of index system and evaluation model is the difficulty, focus, and key point of performance evaluation of public undertakings management. Based on the internal structure of balanced scorecard and public service management, this paper constructs the selection model of public service management performance evaluation index for the first time. On this basis, according to the scientific development concept and the correct view of achievements, it constructs the performance evaluation index system of local government public service management. This paper studies the scientificity, innovation, and feasibility of fuzzy comprehensive evaluation model and DEA model in the performance evaluation of local government public utilities management.
- (3) The research of performance evaluation should be promoted from technology and method to system arrangement and idea innovation. In view of the current performance evaluation research is mainly limited to the technology, method level, it is difficult to achieve the scientific, standardized, and institutionalized performance evaluation; this paper tries to break through this limitation, based on the technology, method and empirical research, research system arrangement, and idea innovation, to realize the combination of the research on the performance evaluation technology and method of public institution management with the research on system arrangement and idea innovation.

## **Data Availability**

The data used to support the findings of this study are available from the corresponding author upon request.

## **Conflicts of Interest**

The authors declare that they have no conflicts of interest or personal relationships that could have appeared to influence the work reported in this paper.

## References

- B. Müller, L. Johnson, and D. Kreuer, "Maladaptive outcomes of climate insurance in agriculture," *Global Environmental Change*, vol. 46, no. 12, pp. 23–30, 2017.
- [2] Z. Zhou, H. Xiao, Q. Jin, and W. Liu, "DEA Frontier improvement and portfolio rebalancing: an application of China mutual funds on considering sustainability information disclosure," *European Journal of Operational Research*, vol. 269, no. 1, pp. 111–131, 2018.
- [3] M. Shaverdi, I. Ramezani, R. Tahmasebi, and A. A. A. Rostamy, "Combining fuzzy AHP and fuzzy TOPSIS with financial ratios to design a novel performance evaluation model," *International Journal of Fuzzy Systems*, vol. 18, no. 2, pp. 248–262, 2016.
- [4] L. W. Fan, S. J. Pan, G. Q. Liu, and P. Zhou, "Does energy efficiency affect financial performance? Evidence from Chinese energy-intensive firms," *Journal of Cleaner Production*, vol. 151, no. 10, pp. 53–59, 2017.
- [5] M. Wijesiri, A. Martínez-Campillo, and P. Wanke, "Is there a trade-off between social and financial performance of public commercial banks in India? A multi-activity DEA model with shared inputs and undesirable outputs," *Review of Managerial Science*, vol. 13, no. 2, pp. 417–442, 2019.
- [6] Y. Deng, S. Zou, and D. You, "Financial performance evaluation of nuclear power-related enterprises from the perspective of sustainability," *Environmental Science and Pollution Research*, vol. 27, no. 10, pp. 11349–11363, 2020.
- [7] J.-Y. Dong, Y. Chen, and S.-P. Wan, "A cosine similarity based QUALIFLEX approach with hesitant fuzzy linguistic term sets for financial performance evaluation," *Applied Soft Computing*, vol. 69, no. 4, pp. 316–329, 2018.
- [8] J. Heidary Dahooie, E. K. Zavadskas, A. S. Vanaki, H. R. Firoozfar, M. Lari, and Z. Turskis, "A new evaluation model for corporate financial performance using integrated CCSD and FCM-ARAS approach," *Economic Research*, vol. 32, no. 1, pp. 1088–1113, 2019.
- [9] H. Moon and D. Min, "A DEA approach for evaluating the relationship between energy efficiency and financial performance for energy-intensive firms in Korea," *Journal of Cleaner Production*, vol. 255, Article ID 120, 2020.
- [10] J. Gui, "A study on financing efficiency measurement of information technology enterprises listed in NEEQ board based on three-stage DEA model and malmquist index," *Proceedings* of the 5th International Forum on Decision Sciences, vol. 10, no. 10, pp. 215–223, 2018.
- [11] S. Grigorieva and T. Petrunina, "The performance of mergers and acquisitions in emerging capital markets: new angle," *Journal of Management Control*, vol. 26, no. 4, pp. 377–403, 2015.
- [12] V. Acharya and Z. Xu, "Financial dependence and innovation: the case of public versus private firms," *Journal of Financial Economics*, vol. 124, no. 2, pp. 223–243, 2017.
- [13] J. Garst, V. Blok, L. Jansen, and O. Omta, "Responsibility versus profit: the motives of food firms for healthy product innovation," *Sustainability*, vol. 9, no. 12, pp. 2286–2297, 2017.
- [14] E. G. Carayannis, E. Grigoroudis, and Y. Goletsis, "A multilevel and multistage efficiency evaluation of innovation systems: a multiobjective DEA approach," *Expert Systems with Applications*, vol. 62, no. 13, pp. 63–80, 2016.
- [15] C. Kim and W. S. Shin, "Does information from the higher education and R&D institutes improve the innovation

efficiency of logistic firms?" *The Asian Journal of Shipping and Logistics*, vol. 35, no. 1, pp. 70–76, 2019.

- [16] M. Yazdi, "Risk assessment based on novel intuitionistic fuzzy-hybrid-modified TOPSIS approach," *Safety Science*, vol. 110, no. 3, pp. 438–448, 2018.
- [17] L. Fang, B. Xiao, H. Yu, and Q. You, "A stable systemic risk ranking in China's banking sector: based on principal component analysis," *Physica A: Statistical Mechanics and Its Applications*, vol. 492, no. 16, pp. 1997–2009, 2018.
- [18] N. K. Avkiran, "Measuring the systemic risk of regional banks in Japan with PLS-SEM," *Theoretical Economics Letters*, vol. 08, no. 11, pp. 2024–2037, 2018.
- [19] S. Mohsni and I. Otchere, "Does regulatory regime matter for bank risk taking? A comparative analysis of US and Canada," *Journal of International Financial Markets, Institutions and Money*, vol. 53, no. 6, pp. 1–16, 2018.
- [20] Y. Tan, "The impacts of risk and competition on bank profitability in China," *Journal of International Financial Markets, Institutions and Money*, vol. 40, no. 16, pp. 85–110, 2016.
- [21] A. Wajahat, A. Mohsin, A. Shaista, and R. R. Syed Aun, "Intricacies of competition, stability, and diversification: evidence from dual banking economies," *Economic Modelling*, vol. 83, no. 3, pp. 111–126, 2019.
- [22] P. Malgorzata, "Does the size and market structure of the banking sector have an effect on the financial stability of the European Union," *The Journal of Economic Asymmetries*, vol. 14, no. 12, pp. 112–127, 2016.
- [23] W. Lesyuk, C. Kriza, and P. Kolominsky-Rabas, "Cost-of illness studies in heart failure: a systematic review 2004–2016," *BMC Cardiovascular Disorders*, vol. 18, no. 1, pp. 1–11, 2018.
- [24] T. Kamio, T. Van, and K. Masamune, "Use of machine learning approaches to predict clinical deterioration in critically ill patients: a systematic review," *International Journal of Medical Research & Health Sciences*, vol. 6, no. 6, pp. 1–7, 2017.
- [25] N. Brasier, C. J. Raichle, M. Dörr et al., "Detection of atrial fibrillation with a smartphone camera: first prospective, international, two-centre, clinical validation study (DETECT AF PRO)," *Europace*, vol. 21, no. 1, pp. 41–47, 2019.
- [26] A. L. Buczak and E. Guven, "A survey of data mining and machine learning methods for cyber security intrusion detection," *IEEE Communications Surveys & Tutorials*, vol. 18, no. 2, pp. 1153–1176, 2015.
- [27] M. B. Ferraro and P. Giordani, "A toolbox for fuzzy clustering using the R programming language," *Fuzzy Sets and Systems*, vol. 279, no. 15, pp. 1–16, 2015.
- [28] P. Pallmann and L. A. Hothorn, "Analysis of means: a generalized approach using R," *Journal of Applied Statistics*, vol. 43, no. 5-8, pp. 1541–1560, 2016.
- [29] J. Wu, M. Xu, and P. Zhang, "The impacts of governmental performance assessment policy and citizen participation on improving environmental performance across Chinese provinces," *Journal of Cleaner Production*, vol. 184, pp. 227– 238, 2018.
- [30] J. Zheng, W. Wang, D. Chen et al., "Exploring the waterenergy-food nexus from a perspective of agricultural production efficiency using a three-stage data envelopment analysis modelling evaluation method: a case study of the middle and lower reaches of the Yangtze River, China," *Water Policy*, vol. 21, no. 9, pp. 49–72, 2019.
- [31] R. K. Lyons, "Economics of the ed tech revolution," *California Management Review*, vol. 59, no. 4, pp. 49–55, 2017.
- [32] M. Fahmy-Abdullah and L. W. Sieng, "Technical efficiency in Malaysian textile manufacturing industry: a stochastic

frontier analysis (sfa) approach," International Journal of Economics and Management, vol. 12, no. 2, pp. 407-419, 2018.

- [33] S. Jradi, T. B. Chameeva, B. Delhomme, and A Jaegler, "Tracking carbon footprint in French vineyards: a DEA performance assessment," *Journal of Cleaner Production*, vol. 192, no. 10, pp. 43–54, 2018.
- [34] A. Çalik, N. Y. Pehlivan, and C. Kahraman, "An integrated fuzzy ahp/dea approach for performance evaluation of territorial units in Turkey," *Technological and Economic Devel*opment of Economy, vol. 24, no. 4, pp. 1280–1302, 2018.
- [35] C. Nondo and J. R. Jaramillo, "Analyzing africa's total factor productivity trends," *International Journal of Sustainable Economies Management*, vol. 7, no. 4, pp. 45–61, 2018.