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Evaluating Livelihood Expenditure Performance under the Synergy of Big Data Empowerment and Basic Public Service Equalization

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Abstract: *The performance of livelihood expenditure undoubtedly plays a critical role in promoting equitable access to basic public services and improving social welfare. Evaluating livelihood expenditure under the synergy of big data empowerment and basic public service equalization enables governments to assess the effectiveness, efficiency, and fairness of public spending in real time. Therefore, it is of great significance to study strategies for designing evaluation methods that integrate advanced data technologies with equalization-oriented governance. In this paper, we examine strategies for evaluating livelihood expenditure performance through the lens of big data and public service equalization. We analyze and explain in detail the importance of synergy-based evaluation and the challenges encountered in accurately assessing expenditure performance. Based on this analysis, we propose several strategies for designing a comprehensive, data-driven, and equity-oriented evaluation method. The findings presented in this paper can provide practical guidance for improving expenditure performance evaluation in other public service domains.*

Keywords: *Livelihood expenditure; Big data empowerment; Public service equalization; Evaluation methods; Equity-oriented governance*

1. Introduction

The equalization of basic public services has become a strategic approach for mitigating multidimensional vulnerability and enhancing social welfare. Empirical evidence shows that disparities in access to education, healthcare, and other foundational services significantly shape regional inequalities (Guo et al.[1], 2023). Promoting service equalization reduces these gaps, improves accessibility, and helps alleviate socioeconomic risks. In parallel, digitization is accelerating improvements in public service delivery. Research reveals that digital technologies enhance the mechanisms and effectiveness of service equalization, though their impacts differ across regions and population groups due to heterogeneity in digital capacity (Huang & Zhang[2], 2025). Broader studies on digital development show that the expansion of the digital economy reshapes service provision models and strengthens the ability of governments to deliver efficient and high-quality public services (Tang et al.[3], 2023).

Digitally enabled service innovations also offer new pathways for overcoming traditional service divides. Evidence from the healthcare sector demonstrates that digital tools significantly enhance the timeliness, transparency, and user-centeredness of service delivery, thereby improving both efficiency and equity (Srivastava & Shainesh[4], 2015). Research on the interaction between public services and human development indicates that digitalization contributes to higher levels of public service performance and improved social outcomes (Cai[5], 2023). Together, these studies show that integrating big data technologies into public service governance holds considerable potential for enhancing the quality, responsiveness, and fairness of livelihood-related public expenditure.

At the methodological level, the evaluation of expenditure performance and service efficiency increasingly relies on Data Envelopment Analysis (DEA). Advances in DEA, including improved modeling of multi-stage systems, handling undesirable outputs, and network structures, have strengthened its ability to assess complex public service and expenditure systems. Novel DEA models have been applied to industrial production and environmental management (Zhou et al.[6], 2018), as

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well as to two-stage systems incorporating undesirable outputs (Wu et al.[7], 2016) and network structures with intermediate outputs (Wu et al.[8], 2015). DEA has also been widely used to evaluate environmental and energy efficiency across regions (Zhang & Wei[9], 2015; Wang et al.[10], 2013; Song et al.[11], 2018). A comprehensive literature review further confirms that DEA is a robust tool for evaluating systems involving energy, environment, and public resource allocation (Sueyoshi et al.[12], 2017). These methodological developments provide a solid foundation for adapting DEA to the evaluation of livelihood expenditure performance.

Taken together, existing research demonstrates growing recognition that the synergy between big data empowerment and basic public service equalization creates new momentum for improving the effectiveness of livelihood expenditure. Empirical work on urban-rural integration further indicates that balanced and well-targeted livelihood expenditure is essential for strengthening regional equity and sustaining long-term development (Liu et al.[13], 2025). However, there remains a lack of systematic evaluation frameworks that integrate digital capability, equalization objectives, and performance assessment tools. This gap highlights the need for a multidimensional evaluation model that captures the data-intensive, equity-oriented, and efficiency-driven characteristics of contemporary public spending, thus providing the central motivation for the present study.

2. Limitations of existing evaluations of livelihood expenditure performance

2.1. Insufficient focus on equity and equalization in evaluation objectives

Existing evaluations of livelihood expenditure performance often prioritize quantitative measures such as total expenditure, budget utilization, or program coverage, without examining whether spending effectively reduces disparities in access, quality, and outcomes of basic public services. They rarely consider fairness, inclusiveness, or balanced development as central evaluation criteria. As a result, policymakers lack insight into which regions, communities, or demographic groups remain underserved. This limitation restricts the evaluation's ability to guide equitable resource allocation and to ensure that public spending genuinely contributes to narrowing social and regional gaps, leaving the goal of public service equalization inadequately addressed.

2.2. Limited use of advanced data and real-time monitoring

Traditional evaluation approaches typically rely on historical, aggregate, or sample-based data, which cannot capture the dynamic nature of service delivery or quickly emerging disparities. This limitation prevents evaluators from continuously monitoring performance, tracking trends, or identifying sudden gaps in service provision. Moreover, without advanced data acquisition, analytical tools, and integration with real-time monitoring systems, evaluations cannot measure the effectiveness of expenditure interventions with sufficient precision or provide timely feedback. Consequently, governments struggle to make evidence-based adjustments or to prioritize interventions where they are most urgently needed.

2.3. Weak connection between evaluation outcomes and policy actions

Even when evaluations identify service gaps or measure expenditure effectiveness, results are often reported too late or in a format that is not actionable, limiting their influence on policy decisions. Existing evaluations typically lack structured mechanisms for feeding findings directly into budget allocation, program planning, or service delivery adjustments. As a result, evaluations fail to act as proactive management tools, leaving decision-making reactive rather than evidence-driven. This gap diminishes the potential of evaluation to support adaptive governance, timely interventions, and strategic allocation of resources aimed at achieving equalized access to basic public services.

3. Strategies for designing an evaluation method of livelihood expenditure performance under the synergy of big data empowerment and basic public service equalization

3.1. Orienting the evaluation of livelihood expenditure performance toward promoting basic public service equalization

Orienting the evaluation of livelihood expenditure performance toward promoting basic public

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service equalization is highly compatible with the overall goal of constructing an evaluation method that integrates big data empowerment with equalization-oriented governance. The synergy-based evaluation framework emphasizes a dual synergy: leveraging big data while advancing basic public service equalization. This strategy fits well because it positions equalization not as an auxiliary consideration but as the central criterion for judging whether livelihood expenditures are effective. Under big data empowerment, governments can obtain fine-grained, real-time information on disparities in education, healthcare, social assistance, and other essential services, allowing evaluators to directly link expenditure performance to the reduction of service gaps. By redefining the purpose of evaluation to focus on fairness and balanced development, this strategy ensures that the evaluation method fully reflects the policy logic behind basic public service equalization. It aligns naturally with the synergy-based evaluation framework's emphasis on designing a method that is both technologically enhanced and normatively guided toward inclusive development.

This strategy reinforces the synergy emphasized in the synergy-based evaluation framework by demonstrating how big data tools can operationalize the equalization agenda through more accurate assessment and targeted decision-making. Big data analytics enhance the capacity to measure supply-demand mismatches, identify underserved groups, and quantify how livelihood expenditures impact service accessibility and quality. This allows evaluation results to serve as evidence-based guidance for improving equalized resource allocation, thereby strengthening the "empowerment" aspect highlighted in the framework. At the same time, embedding equalization as a guiding principle ensures that data-driven evaluations do not become purely technical exercises, but instead remain anchored in the broader governance goal of strengthening equity. In this sense, the strategy exemplifies how an evaluation method can embody the synergy between technological capacity and equalization objectives, making it an essential and well-aligned component of the overall design framework.

3.2. Incorporating Big Data technology into the methodological design for evaluating livelihood expenditure performance

Big Data technology provides a robust methodological foundation for livelihood expenditure performance evaluation and aligns naturally with the synergy-based evaluation framework. This framework emphasizes the integration of big data empowerment and equalization of basic public services as core driving forces, which requires evaluation methods to be dynamic, data-driven, and technically advanced rather than dependent on traditional static or sample-limited approaches. By embedding big data tools for data collection, cleaning, integration, and multidimensional analysis into the evaluation design, the assessment mechanism can achieve real-time tracking, high-precision measurement, and comprehensive identification. Such technical advantages effectively improve the scientificity, objectivity, and responsiveness of performance evaluation, which constitutes the primary rationale for adopting big data in the synergistic evaluation system.

The integration of big data further enhances the operational logic and practical applicability of the synergy-based evaluation framework by supporting accurate identification of imbalances in public service provision. A fundamental goal of basic public service equalization is to eliminate regional, urban-rural, and group-level disparities, which demands reliable and fine-grained evidence to locate gaps in resource allocation. Big data enables dynamic monitoring, spatial-temporal comparison, and predictive analysis of livelihood expenditure flows and service coverage, allowing evaluators to capture subtle differences that traditional methods cannot detect. In this sense, big data does not merely improve technical efficiency but transforms the evaluation from a post-hoc assessment into an intelligent, forward-looking governance tool that supports targeted and equitable policy formulation.

Incorporating big data technology reinforces the synergy-based evaluation framework's dual-value logic of digital empowerment and equitable development, operationalizing it into tangible, evidence-driven governance practices closely aligned with the framework's core theoretical essence. The framework relies on two interdependent and mutually reinforcing objectives: methodological innovation to enhance the rigor and objectivity of performance assessment, and governance effectiveness focused on advancing basic public service equalization as a fundamental pillar of social equity. Big data acts as a critical intermediary, bridging the traditional divide between technical advancement and equity-oriented governance through high-volume, diagnostic data. It enables evaluators to rigorously judge if livelihood expenditure truly drives balanced, inclusive development, such as narrowing urban-rural service gaps and supporting underserved communities. Big data also strengthens the synergy between digital transformation and equalization goals, modernizing the evaluation system with dynamic analytics to ensure both methodological rigor and social responsiveness. Thus, it is not just a technical choice but a strategic approach that fully embodies the

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framework's theoretical orientation and practical demands.

Let us recall the DEA efficiency (CCR) model developed by A. Charnes, W.W. Cooper, and E. Rhodes. Suppose there are n Decision Making Units (DMUs) to be evaluated, each of which uses the same type of inputs to generate the same type of outputs. Let $X_j = (x_{1j}, \ldots, x_{mj})^{\mathrm{T}}$ and $Y_j = (y_{1j}, \ldots, y_{sj})^{\mathrm{T}}$ denote the input vector and output vector of DMU_j, respectively. The performance of each DMU is defined as the ratio of the weighted output value to the weighted input value, and the DMU being evaluated is denoted as DMU_k. The CCR model states as

$$\min \theta$$

$$\text{s.t.} \begin{cases} \sum_{j=1}^{n} \lambda_j x_{ij} \leqslant \theta x_k, \quad i = 1, \ldots, m \\ \sum_{j=1}^{n} \lambda_j y_{rj} \geqslant y_k, \quad r = 1, \ldots, s, \\ \sum_{j=1}^{n} \lambda_j = 1, \ \ \lambda_j \geqslant 0, \quad j = 1, \ldots, n. \end{cases}$$

Incorporating Big Data into the CCR model (a core DEA framework) for livelihood expenditure evaluation enriches it by enabling more Decision-Making Units (DMUs, e.g., households/regions) to improve discrimination between efficient/inefficient entities. It also provides granular, multi-dimensional inputs (e.g., detailed expenditure categories) and outputs (e.g., precise livelihood outcomes like health/education metrics), making the efficiency score (θ) more accurate. Real-time Big Data allows dynamic updates to the CCR model, enabling timely detection of efficiency shifts for prompt policy adjustments, while data cleaning tools ensure the inputs/outputs are reliable, thus validating the θ scores for informed decision-making.

3.3. Integrating Big Data Technology and basic public service equalization into the evaluation for livelihood expenditure performance

Integrating Big Data technology and basic public service equalization into the evaluation of livelihood expenditure performance is highly aligned with the objectives of the synergy-based evaluation framework, which emphasizes combining technological empowerment with equity-oriented governance. This strategy fits well because it does not treat Big Data and equalization as separate components; instead, it merges them into a unified analytical logic. By embedding both elements simultaneously, evaluators can use advanced data tools to identify disparities, trace the effectiveness of public spending, and observe how service gaps evolve over time. This integration ensures that technology is not used in isolation but is directly linked to improving fairness in public service provision. As a result, the evaluation method becomes both technically sophisticated and normatively grounded, which is precisely what the synergy-based evaluation framework seeks to achieve.

Furthermore, this strategy enhances the synergy-based evaluation framework by demonstrating how Big Data and equalization can mutually reinforce each other in shaping more scientific, precise, and equity-focused assessments. Big Data provides the analytical capacity to measure regional imbalances, detect underserved populations, and evaluate whether livelihood expenditure interventions meaningfully narrow service disparities. The principle of basic public service equalization guides how data should be interpreted and applied, ensuring that data-driven evaluations remain aligned with social justice goals rather than purely technical efficiency. By integrating these two dimensions at every stage: indicator design, model construction, monitoring, and feedback; this strategy creates a comprehensive and cohesive evaluation mechanism. It exemplifies the core logic of the synergy-based evaluation framework, making it an essential approach for designing a modern evaluation method for livelihood expenditure performance.

3.4. Updating real-time data in evaluating the livelihood expenditure performance

Updating real-time data in evaluating livelihood expenditure performance aligns closely with the synergy-based evaluation framework, which integrates big data empowerment with basic public service equalization. This strategy ensures that evaluation processes remain dynamic, responsive, and reflective

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of the current conditions of public service delivery. Unlike traditional methods that rely on historical or static data and often lag behind actual service needs, real-time data allows governments to continuously track expenditure outcomes, service accessibility, and quality indicators. This enables evaluators to identify emerging disparities promptly and provide timely, accurate assessments. By keeping datasets continuously updated, the evaluation process shifts from a retrospective review to a proactive, evidence-driven approach, enhancing the framework's technological empowerment while supporting more precise and equitable management of public resources to improve service equalization.

Updating real-time data strengthens the equity and equalization objectives at the core of the synergy-based evaluation framework. Access to current data allows evaluators to more accurately identify underserved populations and regions, detect sudden service imbalances, and assess the immediate effects of expenditure interventions on reducing disparities. This supports more precise, adaptive decision-making, ensuring that resources are allocated efficiently to promote equitable access to essential public services. Incorporating real-time data also enhances feedback mechanisms, enabling governments to adjust policies and spending strategies quickly to respond to changing conditions and achieve desired social outcomes. By combining continuous data monitoring with a focus on fairness, this strategy reflects the dual logic of the framework: it leverages advanced technology to improve analytical precision while guiding resource allocation toward basic public service equalization, making it a vital component of a modern, evidence-driven evaluation system.

3.5. Timely integration of evaluation results into government decision-making processes

Timely integration of evaluation results into government decision-making processes is highly consistent with the objectives of the synergy-based evaluation framework, which emphasizes the combination of big data empowerment and basic public service equalization. This strategy fits well because the ultimate purpose of evaluating livelihood expenditure performance is not merely to measure outcomes but to inform and improve policy and resource allocation. By ensuring that evaluation results are fed promptly into decision-making channels, governments can respond quickly to identified gaps, inefficiencies, or inequities in public service provision. This aligns with the framework's emphasis on leveraging big data, as real-time evaluation outputs can be directly translated into actionable insights, enhancing the responsiveness and effectiveness of governance.

In addition, this strategy strengthens the equalization dimension of the synergy-based evaluation framework. When evaluation findings are integrated promptly, policymakers can adjust fiscal allocations and service delivery strategies to prioritize underserved regions or vulnerable populations, effectively narrowing disparities in access and quality of basic public services. The timely feedback loop transforms evaluation from a passive reporting mechanism into a proactive management tool, ensuring that data-driven insights actively guide equitable policy implementation. By combining technological empowerment with practical governance application, this strategy exemplifies the dual logic of the framework: it enhances both analytical precision through big data and normative guidance toward balanced and inclusive public service outcomes. In this sense, timely integration of evaluation results becomes a crucial component for designing a modern, evidence-based system for assessing livelihood expenditure performance.

4. An empirical study

In this section, we apply Analytic Hierarchy Process(AHP) to explain how to design methods for evaluating livelihood expenditure performance. Based on the preceding discussion, we list the following measurable items as third-level indicators in the evaluation framework: Fairness and balanced development; Identification of service disparities; Assessment of expenditure effectiveness; Advanced data acquisition and analysis; Monitoring underserved populations and regions; Tracking improvements and progress over time; Integration of data and equity objectives; Timely and adaptive decision-making; Feedback and proactive management. Based on input from experts in related fields, an AHP model for effective livelihood-expenditure evaluation is constructed (Figure 1). These items are well suited as third-level indicators in an AHP structure because they capture the essential operational dimensions of evaluating livelihood expenditure performance under a framework that integrates big data empowerment with public service equalization. Indicators such as fairness and balanced development, identification of service disparities, and assessment of expenditure effectiveness reflect the core value-oriented objectives of the evaluation system. They ensure that the assessment goes beyond expenditure amounts to determine whether public spending genuinely promotes equity

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and reduces regional or demographic gaps. By translating high-level strategic goals into concrete, measurable components, these indicators allow the AHP model to represent the fundamental principles guiding public service equalization.

Indicators such as advanced data acquisition and analysis, monitoring underserved populations and regions, tracking improvements over time, integration of data and equity objectives, timely and adaptive decision-making, and feedback reflect the technical and procedural capabilities provided by big data. They demonstrate how real-time information, analytical tools, and dynamic monitoring enhance the accuracy, responsiveness, and overall quality of governance in evaluating livelihood expenditure performance. Including these items at the third level allows the AHP to clearly distinguish between normative equity-focused goals and the technological mechanisms that support them. This ensures the evaluation framework is comprehensive, systematic, and logically structured, integrating both data-driven processes and fairness objectives.

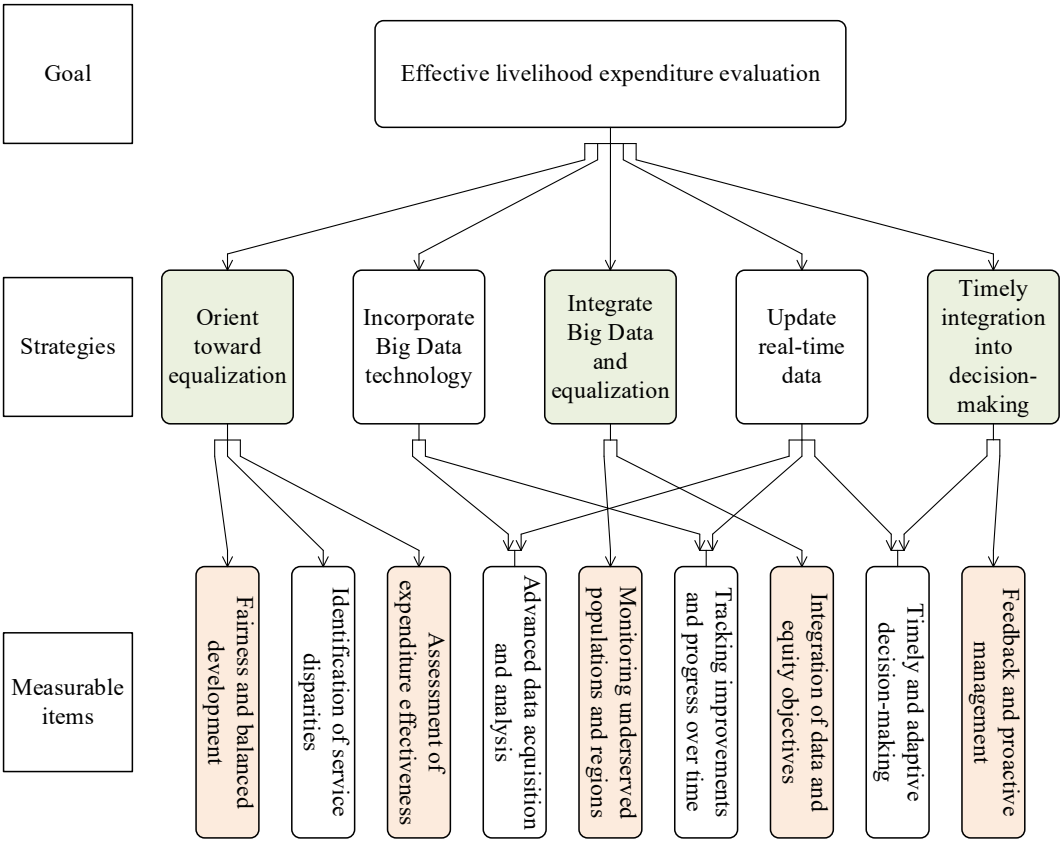

Figure 1. AHP diagram for effective livelihood expenditure evaluation

Table1. Saaty's 1—9 fundamental scale

Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
2	Slight importance	A value between 1 and 3, when the preference is very slight
3	Moderate importance	Judgment slightly favor one element over another
4	Moderate plus	Between moderate and strong
5	Strong importance	Judgment strongly favors one element
6	Strong plus	Between strong and very strong
7	Very strong importance	One element is very strongly favored
8	Very, very strong	Between very strong and extreme
9	Extreme importance	Evidence favors one element absolutely over another

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Table 2. Saaty random index

n	RI	n	RI	n	RI	n	RI
1	0.00	5	1.12	9	1.45	13	1.56
2	0.00	6	1.24	10	1.49	14	1.57
3	0.58	7	1.32	11	1.51	15	1.59
4	0.90	8	1.41	12	1.48		

The pairwise comparison matrix for the five strategies from Section 3 was developed by consulting a panel of experts and applying Saaty's 1–9 fundamental scale (Table 1). To support consistency ratio calculation, the classical Saaty random index parameters are presented in Table 2. The resulting weights for each strategy were subsequently calculated using MATLAB (Table 3).

Table 3. Pairwise comparison matrix and computed strategy weights

Items	Comparison matrix					Weights
Orient toward equalization	1	1	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{1}{3}$	0.1044
Incorporate Big Data technology	1	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	0.1220
Integrate Big Data and equalization	3	2	1	1	1	0.2648
Update real-time data	2	2	1	1	1	0.2440
Timely integration into decision-making	3	2	1	1	1	0.2648

Furthermore, we can get $CI = 0.0066$, and by consulting Table 2, we have $CR = 0.0059$. Similarly, the pairwise comparison matrix for the three items of Strategy 1 was developed by consulting a panel of experts using Saaty's 1–9 scale (Table 1). The resulting weights, calculated using MATLAB, are presented in Table 4. The consistency of the judgment was confirmed, with a CI of 0.0091 and a CR of 0.0176 (see Table 4 for the details).

Table 4. Pairwise comparison matrix and computed item weights for Strategy 1

Items	Comparison matrix			Weights
Fairness and balanced development	1	3	1	0.4434
Identification of service disparities	$\frac{1}{3}$	1	$\frac{1}{2}$	0.1692
Assessment of expenditure effectiveness	1	2	1	0.3874

The pairwise comparison matrix for the two items of Strategy 2 was developed by consulting a panel of experts using Saaty's 1–9 scale (Table 1). The resulting weights are presented in Table 5. The consistency of the judgment was confirmed, with a CI of 0.0000 and a CR of 0.0000.

Table 5. Pairwise comparison matrix and computed item weights for Strategy 2

Items	Comparison matrix		Weights
Advanced data acquisition and analysis	1	$\frac{1}{2}$	$\frac{1}{3}$
Tracking improvements and progress over time	2	1	$\frac{2}{3}$

The pairwise comparison matrix for the two items of Strategy 3 was developed by consulting a panel of experts using Saaty's 1–9 scale (Table 1). The resulting weights are presented in Table 6. The consistency of the judgment was confirmed, with a CI of 0.0000 and a CR of 0.0000.

Table 6. Pairwise comparison matrix and computed item weights for Strategy 3

Items	Comparison matrix		Weights
Monitoring underserved populations and regions	1	$\frac{1}{2}$	$\frac{1}{3}$
Integration of data and equity objectives	2	1	$\frac{2}{3}$

The pairwise comparison matrix for the three items of Strategy 4 was developed by consulting

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experts using Saaty's 1–9 scale (Table 1). The resulting weights are presented in Table 7. The consistency of the judgment was confirmed, with a $CI = -4.4409 \times 10^{-16}$, $CR = -8.5402 \times 10^{-16}$.

Table 7. Pairwise comparison matrix and computed item weights for Strategy 4

Items	Comparison matrix			Weights
Advanced data acquisition and analysis	1	2	1	0.4
Tracking improvements and progress over time	$\frac{1}{2}$	1	$\frac{1}{2}$	0.2
Timely and adaptive decision-making	1	2	1	0.4

The pairwise comparison matrix for the two items of Strategy 5 was developed by consulting a panel of experts using Saaty's 1–9 scale (Table 1). The resulting weights are presented in Table 8. The consistency of the judgment was confirmed, with a CI of 0.0000 and a CR of 0.0000.

Table 8. Pairwise comparison matrix and computed item weights for Strategy 5

Items	Comparison matrix		Weights
Timely and adaptive decision-making	1	2	$\frac{2}{3}$
Feedback and proactive management	$\frac{1}{2}$	1	$\frac{1}{3}$

Based on Tables 3-8, the overall weights of the measurable items are obtained by multiplying the weight of each strategy (from Table 3) by the corresponding weights of its individual items (from Tables 4-8). This approach generates overall weights that account for the relative significance of each strategy and the contribution of each measurable item within that strategy, providing a holistic assessment of the importance of all items in evaluating livelihood expenditure performance.

Table 9. Overall weights of the measurable items

	Orient toward equalization	Incorporate Big Data technology	Integrate Big Data and equalization	Update real-time data	Timely integration into decision-making	
	0.1044	0.1220	0.2648	0.2440	0.2648	
Fairness and balanced development	0.4434	0	0	0	0	0.0463
Identification of service disparities	0.1692	0	0	0	0	0.0177
Assessment of expenditure effectiveness	0.3874	0	0	0	0	0.0404
Advanced data acquisition and analysis	0	$\frac{1}{3}$	0	0.4	0	0.1383
Monitoring underserved populations and regions	0	0	$\frac{1}{3}$	0	0	0.0883
Tracking improvements and progress over time	0	$\frac{2}{3}$	0	0.2	0	0.1301
Integration of data and equity objectives	0	0	$\frac{2}{3}$	0	0	0.1765
Timely and adaptive decision-making	0	0	0	0.4	$\frac{2}{3}$	0.2741
Feedback and proactive management	0	0	0	0	$\frac{1}{3}$	0.0883

Based on the weighted strategic priorities (Table 9), an effective evaluation method for livelihood expenditure performance must center on creating a dynamic, data-driven feedback loop that continuously aligns resource allocation with equity goals. The highest priority should be given to

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establishing systems for timely and adaptive decision-making (0.2741). This involves implementing real-time performance dashboards and automated alerts that trigger when expenditures deviate from projected outcomes or when service gaps are detected. By leveraging advanced data acquisition and analysis (0.1383), the method would integrate diverse data streams, from government financial systems and service delivery records to satellite imagery and mobile data. The core of the evaluation is to constantly track whether spending is effectively closing equity gaps.

The evaluation framework must be fundamentally guided by the integration of data and equity objectives (0.1765). This means every performance metric should have a dual character, measuring not just efficiency but also distributional fairness. Instead of merely reporting the percentage of households with access to clean water, the evaluation would analyze access rates disaggregated by income quintile, geographic region, and ethnicity. This ensures that the goal of basic public service equalization is embedded directly into the performance indicators. A critical component is tracking improvements and progress over time (0.1301). Comparing current data against established baselines, the evaluation can distinguish between short-term fluctuations and genuine, sustainable trends, thereby assessing the long-term transformative impact of expenditures.

Operationally, the method would function as a continuous cycle rather than a one-off audit. It begins with the identification of service disparities (0.0463) and monitoring of underserved populations (0.0883) through spatial analysis and survey data. The assessment of expenditure effectiveness (0.0404) is then conducted by linking financial outlays to the changes in these disparity indicators. The entire process is fueled by feedback and proactive management (0.0883), where evaluation results are not just reported but are automatically fed back into budgetary and planning processes. This creates a self-correcting system where spending is constantly refined and redirected to where it can most effectively promote fairness and balanced development, ensuring that big data empowerment directly serves the mission of public service equalization.

5. Conclusions and policy implications

In this paper, we develop a framework and methodology for assessing livelihood expenditure performance by synergizing big data empowerment with basic public service equalization. The results indicate that integrating advanced data technologies with equity-centered objectives produces an evaluation approach that is scientifically rigorous, dynamic, and socially relevant. It enhances measurement precision, enables continuous monitoring, and ensures that public spending effectively promotes fairness, balanced development, and inclusive access to essential services.

First, orienting the evaluation toward basic public service equalization ensures that expenditure performance is assessed not solely on efficiency metrics but also on its contribution to reducing regional and social disparities. This focus aligns the evaluation process with governance goals of fairness, balanced development, and inclusive access to essential services.

Second, the incorporation of Big Data technology enhances the precision, responsiveness, and multidimensionality of the evaluation. Real-time, high-resolution data improve the discrimination of Decision-Making Units (DMUs) in DEA-based models, enable continuous monitoring, and allow timely adjustments to policy and resource allocation. These capabilities transform the evaluation process from a retrospective assessment into a proactive, evidence-driven governance tool.

Third, integrating Big Data and equalization objectives into a unified analytical system strengthens the intrinsic synergy. Advanced data analytics allow for the identification of service gaps, measurement of equity outcomes, and continuous tracking of expenditure effectiveness, while the equalization principle ensures that technical assessments remain socially grounded.

Fourth, updating evaluation data in real time and integrating results promptly into government decision-making closes the feedback loop between assessment and action. This ensures that resource allocation and policy interventions are adaptive, responsive, and equity-oriented, thereby enhancing the overall effectiveness of livelihood expenditures.

In summary, the synergy-based evaluation framework demonstrates that combining digital empowerment with equalization-focused governance creates a robust, dynamic, and socially responsible approach to assessing livelihood expenditure performance. It establishes a clear link between technological tools, efficiency measures, and social equity outcomes.

Policy Implications

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(1) Embed equalization as a core objective in public expenditure planning

Policymakers should place basic public service equalization at the core of fiscal planning and evaluation. Allocation of budgets, design of performance indicators, and assessment criteria should focus on minimizing disparities in access to essential services, including healthcare, education, and social support, ensuring that resources are directed toward promoting balanced development.

(2) Strengthen Big Data infrastructure for governance and evaluation

Building integrated, high-quality data platforms across sectors is critical. Governments should enhance data collection, interoperability, real-time monitoring, and cleaning processes to ensure accurate and timely evaluation of expenditure performance.

(3) Utilize advanced analytics to enhance fairness and precision

Techniques such as spatial-temporal analysis, predictive modeling, and intelligent monitoring should be embedded in the evaluation framework. These tools help detect underserved populations, quantify service gaps, and provide actionable insights for improving resource allocation.

(4) Apply DEA and other quantitative models for evidence-based assessment

Decision-making should be guided by robust models, such as the CCR DEA framework and its extensions. These models provide rigorous measures of efficiency and effectiveness, helping to identify best practices and optimize expenditure allocations.

(5) Establish a closed-loop feedback system linking evaluation and decision-making

Evaluation outcomes should directly inform policy design, budget planning, and resource reallocation. This ensures that assessments translate into timely, equity-focused interventions and reinforce evidence-driven governance.

(6) Build capacity for data-driven, equity-oriented governance

Public officials and evaluators should receive training in data analytics, DEA modeling, and evidence-based policy assessment. Strengthening capacity ensures that both technological and equity dimensions of the evaluation framework are effectively implemented.

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