

Data-Driven Operation Mechanism of Public Welfare Platforms for Left-Behind Children

Yihao Ning^{1*}, Feng Zhang²

¹*School of Converged Media Center, Hainan Vocational University of Science and Technology, Haikou, 571126, China*

²*School of Accounting, Hainan Vocational University of Science and Technology, Haikou, 571137, China*

**Corresponding author: 124027287@student.newinti.edu.my*

Abstract: *Left-behind children in rural China face persistent challenges related to psychological well-being, academic pressure, and insufficient social support. With the rapid development of digital technologies, public welfare platforms have become important tools to address these issues. However, most platforms still rely on experience-based management rather than systematic data utilization. This study is based on the practical implementation and field data of the “Yuguang Tongxing” program. This study proposes a data-driven operation mechanism for public welfare platforms serving left-behind children. By integrating insights from data-driven modeling, psychological measurement, stress heterogeneity, and public welfare governance, this paper constructs a mechanism that combines data integration, analysis, intelligent decision-making, and feedback optimization. Furthermore, testable hypotheses are proposed to enhance empirical applicability. The findings indicate that data-driven mechanisms can significantly improve service precision, resource allocation efficiency, and platform sustainability.*

Keywords: *left-behind children; public welfare platform; data-driven mechanism; digital governance*

Introduction

The issue of left-behind children has become a prominent social concern in rural China due to large-scale labor migration. These children often experience emotional distress, lack of parental support, and increased academic pressure, which adversely affect their overall development.

In response, digital public welfare platforms have emerged to provide educational, psychological, and social support. However, many platforms still rely on experience-based management rather than systematic data utilization, resulting in limited effectiveness.

Existing studies highlight the role of data-driven approaches in improving system performance and decision-making^[1]. In the field of child development, validated psychological measurement tools enable reliable assessment of well-being, while research reveals significant heterogeneity in stress and mental health conditions among left-behind children. In addition, studies on public welfare finance and platform risk management emphasize the importance of efficient resource allocation and governance mechanisms.

Against this background, constructing a data-driven operation mechanism is essential for improving platform effectiveness. This study is further grounded in the implementation of the “Yuguang Tongxing” program, where challenges related to imprecise service targeting, fragmented data integration, and inefficient resource allocation were observed, motivating the development of the proposed mechanism.

1. Limitations of Existing Public Welfare Platforms

Although digital platforms have expanded access to public welfare services for left-behind children, their effectiveness remains constrained by structural limitations rooted in traditional governance models.

First, service provision lacks precision due to insufficient data utilization. Standardized service models fail to capture individual heterogeneity in psychological and developmental needs, leading to

mismatches between service supply and actual demand.

Second, resource allocation is often inefficient and weakly responsive, as decisions rely on administrative judgment or static indicators rather than data-driven evaluation, thereby limiting the overall effectiveness of public service expenditure.

Third, risk governance remains underdeveloped. With the increasing integration of online fundraising and resource coordination, platforms face challenges related to transparency, information asymmetry, and accountability, which undermine operational sustainability.

More fundamentally, fragmented data and limited institutional coordination across stakeholders hinder effective service integration and reduce overall intervention efficiency.

These limitations highlight the inadequacy of experience-based operational models and underscore the necessity of transitioning toward a data-driven mechanism that integrates data, technology, and governance processes.

2. Theoretical Foundations of a Data-Driven Operation Mechanism

The proposed data-driven operation mechanism is grounded in an interdisciplinary theoretical framework that integrates technical, psychological, and operational perspectives. Rather than functioning as independent domains, these perspectives jointly explain how data-driven capabilities can be translated into effective public welfare governance.

From a technical perspective, mechanism-guided data-driven models provide the methodological foundation for integrating domain knowledge with data analytics. Unlike purely data-driven approaches, which often lack interpretability, mechanism-guided models incorporate structured rules and contextual understanding into the analytical process, thereby improving both decision accuracy and transparency. This is particularly important in public welfare contexts, where decision-making processes must be explainable and accountable. As a result, such models offer a viable pathway for transforming raw data into actionable and reliable intervention strategies.

From a psychological perspective, the effectiveness of any public welfare intervention ultimately depends on its ability to improve individual well-being. Validated measurement frameworks enable the quantitative assessment of psychological states, making it possible to incorporate well-being indicators into data systems^[2]. Furthermore, empirical research demonstrates that left-behind children exhibit significant heterogeneity in stress levels and mental health conditions, which implies that uniform intervention strategies are inherently limited in effectiveness. This theoretical insight directly supports the need for personalized intervention mechanisms within a data-driven framework, where services are tailored based on individual profiles and dynamic conditions.

From an operational perspective, the sustainability and effectiveness of public welfare platforms depend on efficient resource allocation and robust governance structures. Studies on public service expenditure highlight the importance of aligning resource distribution with actual demand in order to maximize social impact. At the same time, research on online public welfare platforms underscores the necessity of integrating risk management and transparency into operational processes to ensure accountability and long-term stability. These insights emphasize that data-driven mechanisms should not only improve service precision but also enhance governance efficiency and institutional trust.

Importantly, the integration of these three perspectives forms a coherent theoretical foundation for the proposed mechanism. The technical perspective explains how data can be processed and utilized, the psychological perspective defines what outcomes should be achieved, and the operational perspective clarifies how resources and risks should be managed. Together, they establish a logical chain linking data capability, intervention design, and governance outcomes.

3. A Data-Driven Mechanism for Public Welfare Platform Optimization

3.1 Data Integration for Comprehensive Profiling

The effectiveness of a data-driven public welfare platform fundamentally depends on the quality and completeness of its data infrastructure. Therefore, the first step is to establish a multi-dimensional data integration system that consolidates heterogeneous data sources into a unified analytical framework.

Specifically, the platform should integrate three categories of data: (1) demographic data, including age, gender, and family background; (2) educational data, such as academic performance, attendance records, and learning engagement; and (3) psychological data derived from validated measurement tools, such as well-being indicators and stress assessments.

To ensure usability, these data should be standardized, cleaned, and structured to form dynamic individual profiles. Unlike static records, such profiles should be continuously updated to reflect changes in children's developmental status. This dynamic profiling mechanism enables the platform to move beyond fragmented information and establish a comprehensive and longitudinal understanding of each child.

Moreover, data integration should also consider interoperability across institutions, including schools, local governments, and social organizations. This not only improves data completeness but also lays the foundation for cross-sector collaborative governance.

3.2 Data Analytics for Identifying Individual Needs

Building upon integrated data, the platform must employ analytical techniques to transform raw data into actionable insights. The core objective at this stage is to accurately identify individual needs and detect potential risks.

Through descriptive and predictive analytics, the platform can classify children into different risk categories based on psychological well-being, academic stress, and behavioral patterns. For instance, clustering or profiling methods can be used to distinguish high-risk groups, such as children experiencing severe academic stress or emotional distress. This approach is consistent with existing findings on the heterogeneity of stress and mental health conditions among left-behind children^[3].

In addition, network-based or pattern recognition methods can be applied to uncover relationships between variables, such as the interaction between stress and emotional well-being. Such analyses enable early warning mechanisms, allowing the platform to identify at-risk individuals before problems escalate.

Importantly, the analytical process should not be limited to retrospective analysis. Instead, it should incorporate predictive capabilities to anticipate future needs, thereby enabling proactive intervention rather than reactive response.

3.3 Intelligent Decision-Making for Resource Allocation

The transformation from data insights to practical intervention relies on an effective decision-making mechanism. In this context, data-driven decision-making plays a central role in optimizing resource allocation and service matching.

Based on analytical outputs, the platform can automatically generate intervention strategies tailored to individual needs. For example, children identified as high-risk may be prioritized for psychological counseling, educational support, or targeted welfare programs. This significantly enhances service precision compared to traditional one-size-fits-all approaches.

Mechanism-guided data-driven models provide a robust methodological foundation for this process by integrating domain knowledge with algorithmic decision rules, thereby improving both accuracy and interpretability. This is particularly important in public welfare contexts, where transparency and accountability are essential.

Furthermore, resource allocation decisions should consider both efficiency and equity. Data-driven optimization can ensure that limited resources are distributed to areas of greatest need while avoiding duplication or waste. This contributes to a more sustainable and effective public welfare system.

3.4 Feedback Mechanism for Continuous Optimization

A key feature that distinguishes data-driven systems from traditional models is the presence of a continuous feedback loop. This mechanism enables the platform to evaluate intervention outcomes and iteratively refine its operational strategies.

After implementing interventions, the platform should collect follow-up data on key indicators, such as changes in psychological well-being, academic performance, and participation levels. These

outcome data serve as inputs for evaluating the effectiveness of previous decisions.

Through iterative learning processes, the platform can update its analytical models and decision rules, thereby improving accuracy over time. This creates a self-optimizing system in which performance continuously improves as more data become available.

In addition, the feedback mechanism enhances accountability by providing evidence-based evaluation of program effectiveness. This is particularly relevant for public welfare platforms, where transparency and trust are critical for long-term sustainability.

Ultimately, the integration of data collection, analysis, decision-making, and feedback forms a closed-loop system that enables adaptive and intelligent governance of public welfare services.

3.5 Application in the “Yuguang Tongxing” Program

The proposed data-driven operation mechanism can be directly applied to optimize the implementation of the “Yuguang Tongxing” program. In practice, the program has accumulated multi-source data through field investigations, participant feedback, and activity records, providing a preliminary foundation for data integration.

By incorporating data integration and profiling methods, the program can establish dynamic individual profiles for left-behind children, enabling a more comprehensive understanding of their psychological and educational needs. Based on data analytics, participants can be categorized into different risk levels, allowing for targeted interventions such as psychological counseling, academic support, and social engagement activities.

Furthermore, the integration of intelligent decision-making mechanisms can improve the allocation of limited resources by prioritizing high-need groups. The feedback mechanism also enables continuous evaluation of intervention outcomes, allowing the program to refine its strategies over time.

Overall, the application of the proposed mechanism enhances the precision, efficiency, and sustainability of the “Yuguang Tongxing” program, demonstrating the practical value of data-driven public welfare governance.

4. Hypothesis Development and Empirical Implications

To enhance the empirical rigor of the proposed framework, this study develops a set of testable hypotheses grounded in the data-driven operation mechanism. These hypotheses are derived from the logical relationships among data capability, intervention processes, and outcome variables.

4.1 Data-Driven Capability and Service Precision

Data-driven capability refers to the platform’s ability to collect, process, and utilize data effectively. In traditional public welfare systems, service provision is often based on generalized assumptions, which leads to mismatches between supply and demand. In contrast, data-driven systems enable precise identification of individual needs through structured data analysis.

By integrating multi-source data and applying analytical techniques, platforms can significantly improve the accuracy of service matching. This reduces information asymmetry and enhances the effectiveness of interventions.

Therefore, the following hypothesis is proposed:

H1: Data-driven capability has a positive effect on service precision.

4.2 Data-Driven Capability and Psychological Well-Being

Improving psychological well-being is a core objective of public welfare platforms serving left-behind children. Existing research demonstrates that well-being can be reliably measured using validated instruments, enabling quantitative evaluation of intervention outcomes.

Data-driven capability enhances well-being through more targeted and timely interventions. By identifying emotional distress and risk factors at an early stage, platforms can provide appropriate support, thereby improving overall psychological outcomes.

Accordingly, the following hypothesis is proposed:

H2: Data-driven capability positively influences psychological well-being among left-behind children.

4.3 The Mediating Role of Personalized Intervention

While data-driven capability provides the foundation for improved outcomes, its impact is not direct but operates through intervention mechanisms. Personalized intervention represents the extent to which services are tailored to individual needs.

Data analytics enables the classification of children into different profiles, which in turn guides the design of targeted interventions. These personalized strategies are more effective than uniform approaches because they address specific risk factors and developmental needs.

Thus, personalized intervention serves as a key mediating mechanism linking data-driven capability to psychological well-being.

H3: Personalized intervention mediates the relationship between data-driven capability and psychological well-being.

4.4 Data-Driven Capability and Resource Allocation Efficiency

Efficient resource allocation is critical for the sustainability of public welfare platforms. Traditional allocation methods often rely on administrative judgment, which may lead to inefficiencies and resource misallocation.

Data-driven capability improves allocation efficiency by enabling evidence-based decision-making. By analyzing demand patterns and intervention outcomes, platforms can allocate resources to areas where they generate the greatest impact. This aligns with existing findings on the importance of optimizing public service expenditure.

Therefore, the following hypothesis is proposed:

H4: Data-driven capability improves resource allocation efficiency.

4.5 The Moderating Role of Stress Heterogeneity

Left-behind children are not a homogeneous group; instead, they exhibit significant variation in stress levels and psychological conditions. Research shows that stress profiles differ substantially, influencing how individuals respond to interventions.

This heterogeneity implies that the effectiveness of personalized intervention may vary across different subgroups. In particular, children experiencing higher levels of stress are likely to benefit more from targeted interventions, as their needs are more urgent and pronounced.

Thus, stress heterogeneity functions as a moderating variable that shapes the strength of the relationship between intervention and outcomes.

H5: Stress heterogeneity moderates the relationship between intervention and psychological well-being, such that the effect is stronger for high-stress groups.

4.6 Empirical Implications

The proposed hypotheses provide a structured framework for future empirical validation. These relationships can be tested using survey data, psychological assessment scales, and platform-generated behavioral data.

Specifically, data-driven capability can be operationalized through indicators such as data integration level, analytical capacity, and system responsiveness. Psychological well-being can be measured using standardized instruments, while service precision and resource allocation efficiency can be quantified through platform performance metrics.

Analytical methods such as regression analysis, mediation analysis, and moderation analysis can be employed to examine the proposed relationships. This ensures that the conceptual framework is not only theoretically grounded but also empirically testable.

5. Discussion: Implications for Public Welfare Governance

The proposed data-driven mechanism provides important insights for rethinking the governance logic of public welfare platforms, particularly in the context of serving left-behind children. Rather than functioning merely as service delivery tools, such platforms should be understood as data-enabled governance systems that integrate information, decision-making, and resource coordination.

5.1 From Generalized Support to Precision Governance

A key implication of the proposed mechanism is the transformation from generalized support to precision governance. Traditional public welfare models often rely on uniform service provision, which fails to address the diverse and dynamic needs of left-behind children.

By leveraging data-driven capabilities, platforms can achieve fine-grained identification of individual needs and deliver targeted interventions. This shift fundamentally changes the governance paradigm from reactive and experience-based management to proactive and evidence-based decision-making. As a result, intervention effectiveness can be significantly improved, particularly for high-risk groups whose needs are often overlooked in traditional systems.

5.2 Data-Driven Resource Allocation and Efficiency Enhancement

Another important implication lies in the optimization of resource allocation. Public welfare resources are inherently limited, making efficiency a central concern for governance systems.

The integration of financial, behavioral, and outcome data enables platforms to allocate resources based on actual demand and intervention effectiveness rather than administrative estimation. This data-driven allocation mechanism enhances both efficiency and accountability, ensuring that resources are directed to areas where they generate the greatest social impact. This finding is consistent with prior research emphasizing the importance of optimizing public service expenditure^[4].

Moreover, data transparency improves governance legitimacy by allowing stakeholders to monitor how resources are utilized, thereby strengthening trust in public welfare institutions.

5.3 Strengthening Risk Governance and Platform Sustainability

The incorporation of data-driven risk management mechanisms also contributes to more robust governance structures. As public welfare platforms increasingly rely on digital and financial technologies, risks related to fund management, information asymmetry, and operational transparency become more prominent.

By embedding risk monitoring and evaluation into the data system, platforms can detect anomalies, prevent misuse of funds, and ensure compliance with governance standards. This enhances both operational stability and long-term sustainability, aligning with findings on risk management in online public welfare platforms^[5].

In addition, the integration of risk governance into the operational mechanism promotes a shift from passive regulation to active risk prevention.

5.4 Challenges in Implementing Data-Driven Governance

Despite its advantages, the implementation of a data-driven governance model faces several practical challenges.

First, data privacy and ethical concerns may limit the scope of data collection and usage. Since the target population involves minors, strict data protection mechanisms must be established to ensure confidentiality and compliance with ethical standards.

Second, technological disparities between urban and rural areas may hinder the effective deployment of data-driven systems. In many rural regions, limited digital infrastructure and technical expertise constrain the ability to collect and process data, reducing the effectiveness of the proposed mechanism.

Third, the fragmentation of data across different institutions poses a significant barrier. Schools, local governments, and social organizations often operate in silos, resulting in incomplete data

integration and limited coordination. Without effective data-sharing mechanisms, the potential of data-driven governance cannot be fully realized.

5.5 Policy and Practical Implications

To address these challenges, several policy and practical measures should be considered.

From a policy perspective, governments should establish unified data governance standards to facilitate data sharing and interoperability across institutions. Clear regulations on data privacy and ethical use are also essential to balance innovation with protection.

From a practical perspective, public welfare platforms should invest in technological infrastructure and capacity building, particularly in rural areas. Training programs for platform operators and stakeholders can enhance data literacy and improve implementation effectiveness.

Furthermore, cross-sector collaboration should be strengthened to integrate resources and data from multiple stakeholders, thereby creating a more cohesive governance ecosystem.

6. Conclusion

This study proposes a data-driven operation mechanism for public welfare platforms serving left-behind children by integrating data collection, analysis, intelligent decision-making, and feedback optimization into a closed-loop system. The findings suggest that such a mechanism can significantly enhance service precision, improve the efficiency and transparency of resource allocation, and strengthen the sustainability of platform governance. The study contributes to the literature by linking data-driven capabilities with personalized intervention and welfare outcomes, offering both theoretical and practical insights for digital public welfare governance. However, as a conceptual study, it lacks empirical validation and assumes relatively strong data infrastructure conditions. Future research should focus on testing the proposed hypotheses with real-world data and exploring the application of advanced technologies to further improve platform effectiveness and scalability.

In particular, the proposed mechanism provides a practical framework for optimizing the operation of the “Yuguang Tongxing” program. By integrating data-driven capabilities into its service processes, the program can achieve more precise intervention, efficient resource allocation, and continuous performance improvement. This demonstrates the potential of transforming traditional public welfare initiatives into data-enabled governance systems.

References

- [1] Hu, S., Sheng, M., Chen, Y., Chen, W., Tian, S., Cao, W., & Li, G. (2026). Interpretable mechanism-guided and data-driven model for completion design. *Results in Engineering*, 30, 110420. <https://doi.org/10.1016/j.rineng.2026.110420>
- [2] Ren, Y., & Li, M. (2026). Reliability and validity of a Chinese version of PERMA-Profilier for left-behind children in rural China. *Psicologia: Reflexão e Crítica*. <https://doi.org/10.1186/s41155-026-00389-y>
- [3] Li, K., Ren, L., Lang, R., Li, X., Wu, L., Feng, T., & Ji, M. (2026). Heterogeneity of academic stress profiles and depression–anxiety symptom networks in left-behind children. *Stress and Health*, 42(2), e70172. <https://doi.org/10.1002/smi.70172>
- [4] Ren, S., Zhou, P., Wu, B., & Wang, P. (2025). Welfare public service expenditure, financing platform debt, and economic growth. *Economic Analysis and Policy*, 87, 649–664. <https://doi.org/10.1016/j.eap.2025.06.040>
- [5] Li, X., Gu, H., & Zhang, P. (2024). Research on fund risk management of internet public welfare crowdfunding platform. *Financial Engineering and Risk Management*, 7(2). <https://doi.org/10.23977/ferm.2024.070205>