World Journal of Management Science
Print ISSN: 2959-9628
Online ISSN: 2959-9636
DOI: https://doi.org/10.61784/wms3105

REDUCTION OF POLICY IMPLEMENTATION GAPS: A STUDY ON AIGC INTEGRATION PRACTICES IN LIAONING'S GOVERNMENT SERVICE SANDBOX

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Abstract: In the context of digital transformation, the development of digital government has become a pivotal driver for advancing modern national governance. However, the policy implementation gap between top-level design and grassroots practice remains the primary bottleneck hindering the improvement of local government service quality and efficiency. As a key hub of the Northeast Revitalization Strategy, Liaoning Province—a multi-ethnic province with distinctive regional cultural traits—struggles with a traditional governance model plagued by institutional inflexibility that fails to meet diverse public needs, resulting in particularly pronounced policy implementation deviations. From a public administration perspective, this study introduces the regulatory sandbox mechanism into government services, establishing a "three-tier temperature control" theoretical framework to systematically analyze the formation logic of policy implementation gaps. It ultimately proposes localized optimization recommendations for reducing implementation deviations via the government service sandbox. The research demonstrates that the government service sandbox effectively addresses core challenges such as governance structure ossification and insufficient cultural adaptation through flexible supervision, dynamic adjustment, and collaborative governance mechanisms. This study validates the core enabling value of AIGC dynamic adaptation technology in the government service sandbox system, and provides both theoretical references and practical paradigms for digital government construction in Liaoning and similar regions nationwide.
Keywords: Digital government; Government service sandbox; Policy implementation gap; AIGC; Emotion-aware knowledge graph

1 INTRODUCTION

The deep integration of digital technology with government services has become the core driving force behind the restructuring of government governance processes and innovation in operational models. The *Guiding Opinions on Strengthening Digital Government Construction* explicitly states that digital transformation should drive reforms in governance approaches, aiming to establish a new, intelligent, and user-friendly model for government operations[1]. Under this policy framework, digital government initiatives have been steadily advancing nationwide; however, a persistent gap persists between the inflexible top-down implementation of policies and the diverse, bottom-up demands of citizens.

Liaoning Province serves as the core zone for transforming the old industrial base in Northeast China and is also a province with a diverse ethnic population. Due to factors such as geographical features, ethnic customs and industrial transformation, the traditional regulatory model marked by organizational inertia struggles to meet diverse societal demands. Issues like misinterpretations in policy implementation and delayed responses have undermined governance effectiveness and government credibility. Addressing this, this paper introduces the sandbox mechanism—originally developed in financial regulation—to government service contexts. Through systematic literature review, it clarifies the research framework, analyzes the key challenges behind policy implementation gaps in Liaoning's local context, and ultimately proposes targeted optimization recommendations to provide academic insights for the digital governance transformation in ethnic regions and old industrial bases.

2 LITERATURE REVIEW

2.1 Advances in Relevant International Research

International research on regulatory sandboxes and policy implementation commenced earlier, having developed a relatively mature theoretical framework and practical paradigms. The core research trajectory can be categorized into three major dimensions.

Firstly, the foundational theories and cross-domain application research of regulatory sandboxes. The institutional design of regulatory sandboxes originated in financial regulation. In 2015, the UK Financial Conduct Authority (FCA) pioneered a regulatory sandbox framework, moving beyond the traditional "command-control" regulatory model to establish a dynamic governance cycle of "testing, feedback, and iteration." Scholars such as Bromberg defined its core essence as "a fault-tolerant regulatory tool providing a secure testing environment for innovators." Subsequently, the OECD summarized the operational logic of sandbox mechanisms into the "Innovation-Friendly Governance Quadrant

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Model", laying the theoretical foundation for their cross-domain applications. The EU's *Artificial Intelligence Act* (2024) dedicates a chapter to regulating AI sandboxes, introducing a groundbreaking "tiered authorization mechanism" that extends the sandbox framework from finance to data governance and AI regulation[2]. Meanwhile, Norway's Data Protection Agency implemented a "three-tier risk circuit breaker" mechanism through its ethical sandbox, achieving comprehensive risk management across data security, algorithmic bias, and societal impacts—providing practical reference for applying sandbox mechanisms in public governance.

Secondly, research on policy implementation gaps and digital empowerment in governance. International studies on policy implementation gaps trace back to the classic policy implementation theory proposed by Pressman and Wildavsky. Scholars generally attribute policy implementation deviations to core factors such as structural mismatches between policy provisions and grassroots needs, administrative barriers within organizations, and insufficient capabilities of implementing entities. With advancements in digital technologies, algorithm-driven policy implementation has become a research frontier. The AI regulatory framework developed by the U.S. Government Accountability Office (GAO, 2021) enables virtual simulation of policy implementation outcomes through a "policy knowledge graph–digital twin" integration mechanism. Germany's "Policy Digital Twin Initiative" employs multi-agent simulation technology to reduce the response time for dynamic adjustments to social security policies to just 72 hours, demonstrating the pivotal role of digital technologies in dynamic policy adaptation.

Third, research on the application of AIGC and affective computing in public governance. With the advancement of generative AI technology, international scholars have focused on the value of AIGC in generating government service content and responding to public demands, while conducting empirical studies on affective computing's application in identifying public emotions and accurately capturing governance needs. These studies demonstrate that multimodal affective analysis effectively addresses information asymmetry in government services, providing theoretical insights for this paper's integration of an emotion-aware knowledge graph to establish a government service sandbox framework.

2.2 Progress of Relevant Domestic Research

Domestic research, building on international experiences, has focused on three key areas: the localized adaptation of regulatory sandboxes, the optimization of digital government and policy implementation, and the application of AIGC in government services, yielding research outcomes tailored to China's governance context.

First, research on the localization adaptation and cross-domain extension of regulatory sandboxes. Early domestic studies primarily focused on localized design of sandbox mechanisms in financial regulation. Yu Xiaoyu[3], drawing on China's pilot experiences during its reform and opening-up period, identified the core conditions and implementation pathways for localized regulatory sandbox adoption, emphasizing its core value in addressing the time-lagging shortcomings of traditional regulation. In recent years, research has gradually expanded to data governance and public governance domains. Chen Zhenqi noted that the rigid controls and information barriers of traditional hierarchical regulation struggle to meet the inclusive and prudent requirements of data element governance[4], whereas the collaborative governance model of regulatory sandboxes effectively enhances institutional flexibility and mitigates inherent challenges of institutional blockages. Zhang Hong and Yue Yang systematically developed a localized institutional framework for AI regulatory sandboxes[2], proposing a "Data Authority + Industry Regulatory Departments" classified supervision model. Zhang Yuan et al. transcended conventional compliance evaluation frameworks by establishing a sandbox maturity assessment system encompassing policy flexibility, technical robustness[5], and social acceptance, providing instrumental support for quantitative management of sandbox mechanisms. However, existing research rarely integrates sandbox mechanisms deeply with the entire public policy implementation process, and theoretical frameworks and practical approaches for government service sandboxes remain in their nascent stages.

Second, research on policy implementation gaps and digital governance optimization. The academic community in China generally defines policy implementation gaps as the gap between top-level policy design and actual grassroots implementation outcomes, with core causes including governance structure ossification, information asymmetry in policy interpretation, and insufficient implementation resources at the grassroots level. In digital empowerment studies, Zhang Weichong et al. proposed a semantic computing method for identifying potential policy conflicts[6], enabling intelligent detection and early warning of contradictory policy provisions. Some scholars developed dialect-specific policy interpreters for ethnic regions, establishing bidirectional mapping matrices between dialect semantics and policy texts that significantly improved public understanding—providing valuable insights for policy adaptation in Liaoning's multi-ethnic context. However, existing research predominantly focuses on nationwide universal analyses, while scenario-specific studies for old industrial bases like Liaoning or multi-ethnic regions remain scarce, failing to establish systematic frameworks addressing policy implementation gaps tailored to regional characteristics.

Third, research on the application of AIGC and emotion-aware knowledge graphs in government services. With the advancement of generative AI technologies, domestic scholars have focused on exploring how AIGC can empower government services. Ma Kunkun et al. systematically analyzed the application logic of AIGC in intelligent reading services[7], providing a reference for its use in interpreting government policies; Zhou Zhi et al. revealed the underlying mechanisms of users' perception of AIGC value[8], offering theoretical support for personalized government service adaptation. In the field of emotional computing, Peng Zhikang et al. employed knowledge graphs and topic analysis methods to identify patterns in emotional discourse across social media[9], providing methodological support for recognizing public sentiment. However, existing research predominantly emphasizes optimizing procedural efficiency in government services, lacking deep integration with humanistic dimensions such as public emotions, regional cultures,

and ethnic customs, and has not yet established a comprehensive "perception–prevention–optimization" framework for dynamic policy adjustment.

2.3 Research Review

A review of relevant domestic and international research reveals that three key areas—regulatory sandboxes, optimized policy implementation, and digital technology empowerment—have yielded substantial findings, providing a solid theoretical foundation for this study. However, existing research still exhibits three critical gaps, which constitute the primary focus of this study.

First, the adaptability of the research scenarios is insufficient. Current research on sandbox mechanisms primarily focuses on finance and data governance, with few studies integrating them deeply throughout the entire public policy implementation process. The theoretical frameworks and localized application research for sandbox mechanisms in government service scenarios remain scarce, failing to address the unique governance needs of regions like Liaoning—a multi-ethnic area undergoing industrial transformation.

Secondly, there is insufficient integration among research perspectives. Existing studies on policy implementation gaps primarily focus on institutional-level attributions, while research on digital technology empowerment emphasizes process efficiency optimization. These two approaches lack deep integration, particularly failing to address humanistic dimensions such as public sentiment, regional culture, and ethnic customs, thereby remaining unable to resolve the core contradiction between "inflexible control" and "flexible adaptation" in policy implementation.

Third, the research framework lacks systematic coherence. Current studies have not established a comprehensive analytical framework for addressing policy implementation gaps through government service sandbox mechanisms. Critical questions—including how the sandbox mechanism can overcome **institutional blockages**, facilitate dynamic policy adjustments, and balance innovation with security—remain unanswered, with insufficient localized implementation strategies or optimization recommendations. This constitutes the primary focus of this study.

3 A THEORETICAL EXPLANATORY FRAMEWORK FOR GOVERNMENT SERVICE SANDBOX POLICY IMPLEMENTATION OPTIMIZATION

3.1 Definition of Core Concepts

The core concept of this paper, policy implementation gap, refers to the discrepancy between the top-level design of policies and their actual implementation outcomes at the grassroots level, as well as public perception. This gap manifests in four dimensions: inaccurate policy interpretation, inadequate process alignment, delayed response to public needs, and incomplete coverage of target groups. At its core, it represents a structural contradiction between standardized policy frameworks and diverse public demands, with its root cause lying in the rigid control mechanisms of traditional administrative regulation and barriers to information flow.

The government service sandbox is an environment that applies the core principles of regulatory sandboxes to public administration, creating a simulated, isolated, and controllable space for policy testing and optimization. Its primary value lies in enabling comprehensive scenario simulation, end-to-end risk management, and dynamic optimization across the entire policy lifecycle through a prudent testing framework, thereby minimizing the adverse impacts of trial-and-error approaches on real-world governance systems. Its defining characteristics include multi-stakeholder participation, transparency, rule exemptions, and dynamic iteration[4].

3.2 Theoretical Analysis Framework

This paper innovatively proposes the "Sandbox Three-Tier Temperature Control" governance model as the core analytical framework for the entire study. The model comprises three key layers—the temperature sensing layer, the risk buffering layer, and the intelligent evolution layer—establishing a closed-loop governance logic of "sensing–prevention and control–optimization", thereby providing a systematic analytical framework for addressing disparities in policy implementation.

The temperature perception layer serves as the foundational tier of the model, with its core function being the precise capture of public emotions and demands. Utilizing natural language processing and sentiment analysis technologies, this layer analyzes public inquiries, linguistic expressions, and behavioral data to monitor real-time emotional shifts and demand patterns. By integrating a Northeast Chinese dialect corpus and an ethnic cultural feature database, it enables accurate identification of differentiated public needs, addressing the information asymmetry inherent in traditional top-down government governance models and providing public opinion support for policy optimization.

The risk buffer layer serves as an intermediate tier of the model, with its core function being to implement comprehensive risk prevention and control throughout the entire policy implementation process. Utilizing the isolated testing environment of the sandbox, this layer establishes a dynamic risk monitoring and early warning mechanism for policy execution, enabling proactive identification, timely alerts, and flexible resolution of potential compliance risks, cultural conflicts, and group tensions that may arise during policy implementation. Additionally, through rule exemptions and error-tolerance/correction mechanisms, it provides a secure testing environment for policy innovation, overcoming the dilemma in traditional regulation where excessive regulation stifles innovation while excessive relaxation leads to disorder, thereby achieving a dynamic balance between innovation and security[1].

The intelligent evolution layer serves as the model's core decision-making tier, with its primary function being to drive the continuous iteration and optimization of government service strategies. Leveraging public opinion data from the temperature perception layer and operational data from the risk buffer layer, this layer integrates AIGC dynamic adaptation technology with an emotion-aware knowledge graph. This enables personalized interpretation of policy content, precise matching of service solutions, and dynamic adjustment of implementation strategies, ultimately transforming policy execution from "inflexible control" to "flexible adaptation" and endowing policies with a "breathing rhythm" that aligns with public needs.

4 THE REAL CHALLENGES OF POLICY IMPLEMENTATION GAPS IN LIAONING PROVINCE

Based on the "Sandbox Three-Tier Temperature Control" governance model and tailored to the local context of Liaoning Province's government services, the logic behind policy implementation gaps can be summarized into four interconnected core dimensions, addressing the gaps in the traditional government model's mechanisms across the entire chain of perception, buffering, and evolution.

4.1 The Rigid Constraints of Administrative Regulation Result in Insufficient Policy Scenario Adaptability

The traditional administrative regulatory model adheres to a rigid "rule-based" approach, characterized by impersonal and standardized practices that inherently conflict with the flexibility and context-specific adaptation required for policy implementation[4]. On one hand, standardized policy documents and uniform enforcement requirements fail to accommodate Liaoning Province's diverse ethnic composition and significant regional disparities. Different ethnic groups and regions exhibit markedly varying levels of policy comprehension and acceptance, making a "one-size-fits-all" implementation approach prone to misinterpretation. On the other hand, hierarchical barriers within administrative structures delay policy adjustments, as policies undergo multi-level approval processes from formulation to implementation. This hinders timely responses to evolving public demands, creating a structural contradiction between "policy inflexibility" and "dynamic needs" —the institutional root cause of implementation gaps.

4.2 Significant Information Flow Barriers, Coupled with Deficiencies in Public Opinion Perception and Response Capabilities

In the traditional government service model, policy information dissemination relies predominantly on a top-down, one-way transmission mechanism, lacking bottom-up channels for public feedback, which creates significant information asymmetry. Vertically, the pyramid structure of administrative organizations forces public opinions to undergo multiple layers of reporting before reaching decision-makers, leading to delays, distortions, or even filtering of information during circulation—making it difficult for policymakers to accurately grasp grassroots demands[4]. Horizontally, the compartmentalized organizational structure fragments government data across various departments, with data silos preventing comprehensive capture of public needs and leaving policy formulation and refinement without robust public opinion data support. Additionally, traditional government services lack sensitivity to implicit public needs such as emotional and cultural factors; policy explanations remain dominated by official terminology without adaptation to Northeastern dialects or ethnic cultural contexts, further exacerbating communication barriers in the "last mile" of policy dissemination.

4.3 Lack of Space for Innovative Trial-and-Error and Insufficient Motivation for Dynamic Policy Optimization

Policy implementation is a continuous iterative and dynamically optimized process, yet the traditional regulatory model lacks effective error-tolerance and correction mechanisms, making it ill-suited to the trial-and-error demands of policy innovation[3]. On one hand, the existing regulatory framework prioritizes compliance over innovation; frontline implementation agencies tend to strictly adhere to established procedures, lacking the incentive or flexibility to tailor execution strategies to local contexts—even when policy gaps with actual needs are identified, flexible adjustments prove challenging. On the other hand, policy innovation carries inherent compliance and social risks. The traditional approach lacks isolated, controllable testing environments, preventing comprehensive scenario simulations and risk assessments of policy optimization plans. Direct implementation may trigger unforeseen negative consequences, trapping policymakers and executors in a dilemma of "reluctance to innovate and unwillingness to optimize", making it difficult to bridge implementation gaps through dynamic adjustments.

4.4 Imbalance Between Risk Prevention and Governance Effectiveness, With a Disruption in the Closed-Loop Policy Implementation

In traditional government governance models, risk prevention and control versus efficiency enhancement in policy implementation often exist in opposition: either excessive emphasis on risk prevention leads to rigid control measures that result in inflexible policy execution, or excessive pursuit of governance efficiency causes relaxed risk management, leading to policy deviations. The root cause lies in the absence of a comprehensive risk buffering and dynamic adjustment mechanism throughout the entire process. On one hand, risk monitoring during policy implementation primarily focuses on post-event response, lacking proactive early warning and real-time intervention mechanisms. By the time policy

deviations occur, negative impacts have already materialized, missing the optimal window for refinement. On the other hand, effectiveness evaluations lack systematic feedback mechanisms, preventing data on implementation outcomes and public satisfaction from serving as valid foundations for policy optimization. Consequently, the closed-loop governance process of "formulation–implementation–evaluation–optimization" remains unestablished, perpetuating persistent implementation gaps that are difficult to resolve fundamentally.

5 OPTIMIZATION RECOMMENDATIONS FOR REDUCING POLICY IMPLEMENTATION GAPS VIA GOVERNMENT SERVICE SANDBOXES

To address the underlying causes of policy implementation gaps in Liaoning Province, this paper employs the "Three-Tier Temperature Control" governance model for government service sandboxes. By integrating the core mechanisms of regulatory sandboxes with the local needs of Liaoning's government services, it proposes localized optimization recommendations across four dimensions—institutional framework development, capacity building, mechanism refinement, and risk mitigation—to reduce policy implementation gaps, thereby providing practical guidance for Liaoning's digital governance initiatives.

5.1 Improve the Top-Level Institutional Design for Government Service Sandboxes and Establish an Inclusive, Prudent and Flexible Regulatory Framework

Focusing on local governance scenarios in Liaoning, we will accelerate the establishment of institutional frameworks for government service sandboxes to overcome the rigid constraints of traditional administrative supervision. First, formulate local management guidelines for government service sandboxes, clarifying implementation entities, applicable scopes, testing procedures, and authority boundaries. Establish a three-tiered implementation system featuring "provincial coordination, municipal pilots, and industry-specific implementation", led by the Provincial Data Bureau with respective industry authorities responsible for scenario execution—aligning with Liaoning's government service management structure and meeting the requirements of the *Liaoning Province's 14th Five-Year Digital Government Development Plan*[10]. Second, establish a policy testing mechanism with rule exemptions and error-tolerance mechanisms. For key scenarios such as policy adaptation in ethnic regions, transformation of livelihood services in old industrial bases, and enterprise lifecycle services, relax procedural constraints in the isolated sandbox environment. Exempt or mitigate accountability for non-subjective, non-malicious compliance deviations during testing, providing ample room for grassroots policy innovation. Third, implement differentiated policy evaluation systems, abandoning the rigid "one-size-fits-all" assessment model. Develop tailored evaluation criteria for diverse ethnic regions, industrial zones, and service scenarios, incorporating public satisfaction, demand alignment, and population coverage as core metrics to shift policy implementation from "standardized provision" to "precision-adapted execution."

5.2 Establish a Multi-Dimensional Public Opinion Sensing System to Enhance the Precision of Policy Demand Identification

Centered on the temperature sensing layer of the government service sandbox, this initiative establishes a comprehensive, intelligent public opinion sensing and response system to eliminate bottlenecks in two-way policy information flow. First, it integrates multi-channel government service demand data by breaking down inter-departmental data barriers, aggregating information from sources such as the 12345 government service hotline, service window evaluations, online inquiries, and field surveys in ethnic regions to create a province-wide government demand database that enables full-dimensional collection and sharing of public feedback. Second, it develops semantic parsing models tailored to Liaoning's local context, combining sentiment analysis technology with emotion-aware knowledge graphs. Specialized speech recognition and semantic parsing models are created for Northeastern dialects and minority languages (Manchu and Mongolian) to accurately capture both explicit demands and implicit emotions, identifying deviations in policy understanding and core needs across different groups, thereby providing precise public opinion support for policy interpretation and optimization[9]. Third, a rapid-response and closed-loop feedback mechanism is established, incorporating response status and resolution outcomes into full-process policy evaluations. This creates a virtuous cycle of "public opinion sensing – policy adjustment – result feedback – public evaluation", effectively addressing information asymmetry inherent in traditional government governance models.

5.3 Establish a Full-Lifecycle Dynamic Policy Adjustment Mechanism to Form a Closed-Loop Governance System

Centered on the intelligent evolution layer of the government service sandbox, this framework establishes a dynamic optimization mechanism covering the entire policy implementation lifecycle, facilitating the transition from "static policy formulation" to "dynamic iteration." First, leveraging AIGC technology, it builds an intelligent policy adaptation system that transforms standardized policy texts into culturally relevant and accessible interpretations tailored to Liaoning's diverse ethnic groups, regions, and populations. This includes developing localized versions such as "dialect-specific" and "ethnic language versions" of policy explanations, enabling personalized communication tailored to specific groups and addressing policy interpretation discrepancies[7]. Second, a sandbox simulation mechanism is implemented to conduct comprehensive testing of policy execution processes in a controlled environment. This allows early identification of potential bottlenecks, risks, and compatibility issues, enabling refinement of implementation procedures and supporting

measures to prevent deviations during actual implementation. Third, the dynamic iteration and optimization mechanism is enhanced by continuously adjusting policy strategies based on sandbox test results, real-time public feedback, and grassroots implementation experiences. This creates a closed-loop cycle of "testing–feedback–optimization–implementation", ensuring policies consistently align with genuine public needs.

5.4 Improve the End-to-End Risk Prevention and Control System, Balancing Policy Innovation With Safety Safeguards

Centered on the risk buffer layer of the government service sandbox, we establish a comprehensive, multi-dimensional risk prevention and control system to achieve a dynamic balance between policy innovation and risk management. First, a full-process risk monitoring mechanism for policy testing is implemented. During sandbox testing, real-time monitoring is conducted on policy compliance, social impact, public acceptance, and cultural adaptability. Hierarchical risk warning thresholds are set to promptly issue alerts and implement corrective measures for potential risks, ensuring all risks remain confined within the sandbox environment without adversely affecting actual government operations or public interests[4]. Second, a collaborative risk governance framework integrates multiple stakeholders—including government agencies, industry associations, research institutions, ethnic representatives, and public representatives—to jointly participate in risk assessment, policy optimization, and outcome evaluation. This approach leverages governmental regulatory oversight while incorporating technical expertise from professional institutions and public feedback, enabling coordinated risk mitigation. Third, a robust full-process documentation and traceability mechanism utilizing blockchain technology is established to record all stages—from policy design and implementation to risk resolution and outcome evaluation—ensuring transparency and traceability throughout the policy refinement process. This approach maximizes the potential for policy innovation while maintaining strict safety standards.

6 CONCLUSION

This study is grounded in the local context of government services in Liaoning Province and addresses the core challenges in policy implementation by introducing a regulatory sandbox mechanism into the public service sector. It innovatively develops a "three-tier temperature control" governance model, systematically analyzes the underlying logic behind policy implementation gaps, and proposes localized optimization recommendations for reducing such gaps through the government service sandbox approach.

The research identifies four primary causes of policy implementation gaps in Liaoning: the rigid constraints of traditional administrative supervision, the absence of public opinion sensing mechanisms, limited room for innovative experimentation, and gaps in the risk prevention and control framework. The government service sandbox effectively mitigates these inherent limitations through four key mechanisms—flexible supervision, public opinion sensing, dynamic adaptation, and risk buffering—enabling dynamic alignment between policy implementation and public needs. Notably, AIGC dynamic adaptation technology serves as the core technical support for the government service sandbox to achieve flexible policy adjustment and eliminate implementation gaps.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This work was supported by the 2025 College Students' Innovation and Entrepreneurship Training Program of Dalian Minzu University: Construction of "Guandong Warm Government" Sandbox Cultivation System—Research on AIGC Dynamic Adjustment and Emotional Knowledge Graph Integration Based on Liaoning Province Policy Implementation (Project No. 202512026079); Dalian Minzu University Sunbird Research Project (Project No. tyn2025021); 2026 Liaoning Provincial Economic and Social Development Research Program (General Category): Research on the Path of Optimizing Governance Structure and Enhancing Liaoning's Social Resilience through Digital and Intelligent Technologies (Project No. 2026lslybkt-046).

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