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Article

Multi-Agent Collaboration for Government Process Optimization and Service Efficiency Enhancement in Smart Governance

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Abstract: With the rapid development of digital government and artificial intelligence, smart governance increasingly requires more intelligent mechanisms for process coordination and public service delivery. Traditional government services often suffer from fragmented departmental responsibilities, repeated material submission, inefficient task allocation, and delayed cross-departmental collaboration, which collectively hinder administrative responsiveness. To address these persistent problems, this paper explores the application of multi-agent collaboration in government process optimization and service efficiency enhancement. Based on the core concepts of smart governance, government process reengineering, and multi-agent systems, the study constructs a comprehensive three-layer analytical framework consisting of the service interaction layer, process collaboration layer, and decision optimization layer. It further analyzes prominent real-world cases, including Estonia's Bürokratt, Finland's AuroraAI, Singapore's LifeSG, Shanghai's "Government Online-Offline Shanghai" and "One Network Unified Management," and the Hangzhou City Brain initiative. The empirical findings demonstrate that multi-agent collaboration can significantly improve government services through intelligent task allocation, seamless cross-departmental coordination, data-driven decision optimization, and robust human-in-the-loop supervision. However, its widespread application also raises critical challenges related to data privacy, accountability, algorithmic bias, explainability, and the risks of excessive automation in high-stakes matters. Ultimately, the paper argues that Agent technology should be understood not merely as an automated consultation tool, but as a transformative governance mechanism essential for reorganizing administrative workflows and enhancing adaptive public decision-making in the modern digital era.

Keywords: multi-agent collaboration; smart governance; process optimization; public service; digital government

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1. Introduction

With the rapid development of digital government and artificial intelligence, smart governance has become an important direction for improving public administration capacity and service efficiency. Governments worldwide are increasingly using digital platforms, data sharing systems, intelligent assistants, and automated decision-support tools to simplify administrative procedures and respond more effectively to citizens' needs. However, many government processes still face persistent problems, including fragmented departmental responsibilities, repeated material submission, inefficient task allocation, delayed cross-departmental coordination, and limited capacity for dynamic

decision-making in complex service scenarios. These problems show that government service transformation should not rely only on online platforms, but also requires a more intelligent and collaborative operational mechanism [1].

Multi-agent collaboration provides a promising approach to these challenges. In a multi-agent system, different agents can represent citizens, government departments, data resources, decision-making units, and supervision mechanisms [1]. Each agent performs specific functions, such as identifying service demands, decomposing complex tasks, matching responsible departments, coordinating inter-agency actions, retrieving data, and optimizing decisions through real-time feedback. Through communication, negotiation, and cooperation among agents, government processes can shift from a linear, department-centered model to a distributed, citizen-centered, and dynamically optimized service model. This is especially valuable in smart governance, where public problems often involve multiple actors, heterogeneous data sources, and rapidly changing conditions.

In practice, the value of multi-agent collaboration can be observed in several real-world smart governance cases. Estonia's Bürokratt project aims to build a network of public-sector virtual assistants that guide citizens across government services. Finland's AuroraAI focuses on life-event-based service matching, connecting citizens with suitable public and social services according to personal situations. Singapore's LifeSG integrates multiple government services into one digital platform and provides personalized recommendations [1]. In China, Shanghai's "Government Online-Offline Shanghai" and "One Network Unified Management" initiatives show how data sharing and cross-departmental coordination can support more efficient administrative services and urban governance. Hangzhou's City Brain further illustrates the potential of intelligent systems in traffic management, risk warning, and real-time urban decision-making. Although these cases are not all fully developed multi-agent systems, they provide realistic foundations for analyzing agent-based government process optimization.

This paper explores how multi-agent collaboration can enhance government process optimization and public service efficiency in smart governance. It focuses on three dimensions: intelligent task allocation, cross-departmental collaboration, and dynamic decision optimization. By combining theoretical analysis with real-world cases, the study argues that agent technology is not merely a tool for automated consultation, but a governance mechanism capable of reorganizing administrative workflows, improving service responsiveness, and supporting adaptive public decision-making. At the same time, multi-agent systems in government raise issues related to data security, accountability, transparency, fairness, and human oversight [2]. Therefore, this paper provides both a technical and governance-oriented understanding of multi-agent collaboration in the future development of smart governance.

2. Literature Review and Theoretical Framework

2.1. Smart Governance and Government Process Reengineering

Smart governance is closely connected with the development of digital government, whole-of-government reform, collaborative governance, and government process reengineering. Early digital government studies mainly focused on moving public services from offline procedures to online platforms. With the development of data infrastructure and cloud-based systems, research gradually shifted toward integrated governance, emphasizing the connection of departments, databases, and administrative procedures through unified platforms [2].

Whole-of-government theory highlights the need to overcome departmental fragmentation. Many public services, such as business registration, welfare application, healthcare reimbursement, and emergency response, involve several government agencies [1]. Therefore, governance efficiency depends not only on individual departments but also on interdepartmental coordination. Government process reengineering further argues that administrative procedures should be redesigned

around user needs rather than bureaucratic structures. In smart governance, this means reducing repeated material submission, simplifying approval chains, and promoting one-stop services.

However, existing studies mainly emphasize platform integration, data sharing, and institutional coordination. Less attention has been paid to how intelligent agents can actively participate in workflow organization, task allocation, interdepartmental negotiation, and dynamic decision optimization. This research gap provides the basis for introducing multi-agent collaboration into smart governance [2].

2.2. Applicability of Multi-Agent Systems in Public Governance

A multi-agent system consists of multiple autonomous or semi-autonomous agents that can perceive information, reason, act, and collaborate. Compared with traditional information systems, multi-agent systems are more suitable for complex, distributed, and dynamic environments. Public governance has similar features: tasks are distributed across departments, citizen demands are diverse, policy rules are complex, and decision conditions may change rapidly.

In smart governance, different agents can be designed according to administrative functions. A Citizen Request Agent identifies citizens' demands, policy needs, and service intentions. A Task Allocation Agent decomposes complex matters, matches them with responsible departments, and generates service routes. A Department Agent represents a government department and performs approval, verification, and feedback tasks. A Data Governance Agent manages data retrieval, access control, privacy compliance, and digital certificate sharing. A Decision Optimization Agent supports priority ranking, resource allocation, and solution adjustment based on real-time data. A Human Oversight Agent, or human-in-the-loop mechanism, transfers high-risk or legally sensitive cases to public officials for manual review [3].

Through these roles, multi-agent systems can turn government processes from passive information transmission into active collaborative problem solving [4]. Agents do not simply replace human officials; they support workflow organization, coordination efficiency, and adaptive decision-making.

2.3. Theoretical Analytical Framework

This paper proposes a "three-layer and six-agent" framework for analyzing multi-agent collaboration in smart governance. The first layer is the service interaction layer, which addresses citizens and enterprises. It is responsible for identifying demands, providing intelligent consultation, recommending services, and collecting feedback [4]. The Citizen Request Agent plays a central role in converting user needs into administrative tasks.

The second layer is the process collaboration layer, which operates within the government system. It focuses on allocating tasks, coordinating departments, tracking progress, and integrating procedures. The Task Allocation Agent, Department Agent, and Data Governance Agent are the primary components of this layer. They facilitate the breakdown of complex matters, connect responsible agencies, and reduce cross-departmental communication costs [1].

The third layer is the decision optimization layer, which supports urban governance and policy implementation. It emphasizes risk warning, resource scheduling, emergency response, and dynamic policy adjustment. The Decision Optimization Agent and Human Oversight Agent are particularly significant, as public decisions involve uncertainty, public interest, and legal responsibility [5].

This framework provides the theoretical foundation for subsequent case analysis and mechanism design. It demonstrates that multi-agent collaboration can enhance smart governance not only in front-end service interaction but also in internal administrative workflows and strategic decision-making.

3. Real-World Cases: Agent Collaboration Logic in Smart Governance

3.1. Estonia's Bürokratt: From Government Chatbots to a Cooperative Agent Network

Estonia's Bürokratt is one of the most relevant cases for this study because it explicitly moves from public-sector virtual assistants toward a cooperative AI agent network. Its roadmap shows that the system will develop LLM/RAG-based capabilities, a general knowledge module, and a "global classifier" to enable secure communication among different Bürokratt instances. From 2026, each institution or domain is expected to have its own personalized AI agent within a unified network [1].

From a multi-agent perspective, Bürokratt reflects a clear collaboration process. A front-end request agent identifies citizens' questions or service intentions [6]. A classification agent determines which public institution should handle the request. Department agents then retrieve information from their own knowledge bases or service systems. For complex or legally sensitive cases, the task can be transferred to human officials. Therefore, Bürokratt demonstrates that agent technology can support not only automated consultation but also task routing, institutional coordination, and service process optimization.

3.2. Finland's AuroraAI: Life-Event-Based Service Matching Agents

Finland's AuroraAI represents a shift from department-centered service delivery to life-event-based governance. Instead of requiring citizens to understand administrative structures, AuroraAI aims to identify people's life situations, such as employment, education, family changes, or ageing, and connect them with suitable services [2]. This model is described as a way to reduce "failure demand," which refers to unnecessary or poorly timed service use caused by fragmented systems.

AuroraAI can be modeled as a service-matching agent system. A Life-event Agent identifies the citizen's current situation. A Service Matching Agent connects the person with relevant public, private, or social services. A Well-being Assessment Agent builds a cross-sector understanding of user needs [7]. A Coordination Agent links different service providers. Its main value lies in reorganizing public services around citizens' real problems rather than administrative categories.

3.3. Singapore's LifeSG: One-Stop Service Integration and Personalization

LifeSG is not a fully developed multi-agent system, but it provides a practical prototype for agent-based public service delivery [8]. It integrates over 100 government services, supports personalized recommendations and eligibility checks, and offers services such as birth registration, preschool search, and neighborhood issue reporting.

Its agent-based potential is significant. The eligibility checker can be upgraded into an Eligibility Agent. Life-stage guides could evolve into Life-stage Planning Agents [8]. Applications, appointments, benefits, and notifications may be integrated into a Personal Government Assistant. Meanwhile, services from different agencies could be transformed into callable Department Service Agents. Thus, LifeSG provides an institutional foundation for future multi-agent service ecosystems.

3.4. Shanghai's "Government Online-Offline Shanghai" and "One Network Unified Management"

Shanghai's digital governance practice demonstrates how cross-departmental data sharing supports "one-stop" and "one-thing-at-a-time" services [9]. The State Council has emphasized the importance of unified access, data sharing, and collaboration among departments in approval, investigation, and review procedures. Shanghai's platform exemplifies how public service applications, digital certificates, and departmental systems can be integrated to minimize repeated submissions and enhance administrative efficiency.

From an agent perspective, Shanghai's case highlights task orchestration and data-governance logic. Service agents can identify user needs, task allocation agents can break down "one thing" into departmental subtasks, data governance agents can verify certificates and permissions, and decision agents can support urban operation management under the "One Network Unified Management" model.

3.5. Hangzhou City Brain 3.0: Dynamic Decision Optimization in Urban Governance

Hangzhou City Brain 3.0 demonstrates how smart governance can evolve from service integration to real-time urban decision optimization. It utilizes AI assistants, medical insurance consultation systems, digital twins, and risk-warning tools to enhance public services and city operations. For instance, the "Survey Smart Guardian" system has managed numerous projects and issued risk alerts for urban safety management [10].

This example can be understood as a dynamic decision-agent system. Traffic Agents oversee road conditions and signals. Emergency Response Agents allocate resources during incidents. Risk Warning Agents identify construction, geological, and safety risks. Public Service Agents offer consultation in areas such as policing, medical insurance, and mental health. Decision Agents integrate real-time data and adjust resource allocation. As summarized in Table 1, these examples illustrate various stages and forms of Agent collaboration in smart governance.

Table 1. Real-world Cases and Their Agent Collaboration Logic

Case	Main Governance Scenario	Agent Collaboration Logic
Bürokratt	Public-sector virtual assistance	Request recognition, classification and inter-agency routing
AuroraAI	Life-event services	Need identification and cross-sector service matching
LifeSG	One-stop digital services	Personalization and service integration
Shanghai	One-stop services and urban management	Data sharing, task orchestration and departmental coordination
Hangzhou City Brain 3.0	Urban operation and risk warning	Real-time sensing, prediction and dynamic resource allocation

4. Mechanism Design: Multi-Agent Collaboration for Government Process Optimization

4.1. Government Task Allocation Mechanism

Intelligent task allocation is a core mechanism for optimizing government processes. In traditional services, citizens often need to identify responsible departments, navigate complex procedures, and repeatedly submit similar materials. A multi-agent mechanism can address these inefficiencies by transforming citizen requests into structured administrative tasks and assigning them to appropriate agencies [11].

In this mechanism, the Citizen Request Agent identifies the applicant's intention, identity information, policy category, and urgency through natural language interaction or digital forms [9]. The Task Decomposition Agent divides complex matters into interrelated subtasks. The Department Matching Agent assigns these subtasks to responsible departments based on statutory duties, policy rules, and data availability. Department Agents handle verification, approval, notification, or certificate generation, while the Feedback Agent monitors progress and collects user feedback.

This mechanism is suitable for one-stop government services. For example, newborn birth services may involve birth registration, household registration, medical insurance enrollment, and social security card application [12]. Business registration may require

coordination among market regulation, taxation, social insurance, and licensing departments. Medical insurance reimbursement involves verifying medical records, insurance status, and payment standards. Public rental housing applications require validation of household registration, income, property ownership, and eligibility.

4.2. Cross-Departmental Collaboration Mechanism

Cross-departmental collaboration is essential because many public services cannot be completed by one agency alone. Multi-agent collaboration can be designed as a negotiation-based network in which each Department Agent operates within its responsibility boundary, data permissions, and service capacity. Department Agents execute tasks, provide feedback, and update processing status within a shared workflow.

The Coordination Agent manages task sequences, resolves workflow dependencies, and reduces conflicts among departments. For example, enterprise relocation registration may involve market regulation, taxation, social insurance, and housing fund departments, which must update information in a coordinated order. When necessary data are missing, the Coordination Agent can request supplementary verification or adjust the workflow.

The Data Governance Agent supports collaboration by accessing population databases, legal-entity databases, digital certificate systems, spatial information, and historical service records. It also enforces access control, privacy protection, and data minimization. The Approval Agent generates preliminary suggestions based on laws, policies, and submitted evidence. However, high-risk, ambiguous, or socially sensitive cases should be transferred to a Human Oversight Agent for manual review, ensuring accountability and fairness [3]. As shown in Table 2, effective collaboration depends on technical connection, institutional responsibility, controlled data sharing, and human supervision.

Table 2. Functional Roles of Agents in Cross-Departmental Collaboration

Agent Type	Core Function	Governance Value
Department Agent	Executes verification, approval and feedback	Clarifies responsibility
Coordination Agent	Manages sequences and dependencies	Improves collaboration efficiency
Data Governance Agent	Controls data access and compliance	Protects privacy and security
Approval Agent	Generates rule-based suggestions	Reduces repetitive workload
Human Oversight Agent	Reviews complex or high-risk cases	Safeguards fairness and accountability

4.3. Dynamic Decision Optimization Mechanism

Dynamic decision optimization extends multi-agent collaboration from routine services to real-time urban governance. In scenarios such as traffic congestion, disaster warning, public health emergencies, and urban safety incidents, governments must respond quickly to changing conditions. Traditional systems based on hierarchical reporting and manual coordination often lack timeliness and adaptability.

A multi-agent decision mechanism improves this process through sensing, classification, prediction, resource scheduling, and feedback adjustment [13]. Sensing Agents collect data from government platforms, IoT devices, traffic cameras, emergency hotlines, and public service systems. Classification Agents identify event type and urgency. Prediction Agents estimate affected areas, population exposure, and resource demand. Decision Optimization Agents generate response options, while Task Allocation

Agents assign responsibilities to transport, police, emergency, healthcare, and municipal departments. Feedback Agents then monitor implementation and update strategies.

For example, in a serious traffic accident, Traffic Agents detect congestion, Emergency Response Agents coordinate police and ambulance resources, and Decision Optimization Agents recommend signal adjustment or route diversion. In disaster warning, Risk Warning Agents integrate meteorological, geological, and infrastructure data to identify potential hazards [5].

4.4. Technical Architecture Design

The above mechanisms require a systematic technical architecture [14]. As illustrated in Figure 1, this paper constructs a four-layer architecture consisting of the Data Layer, Knowledge Layer, Agent Layer, and Governance Layer.

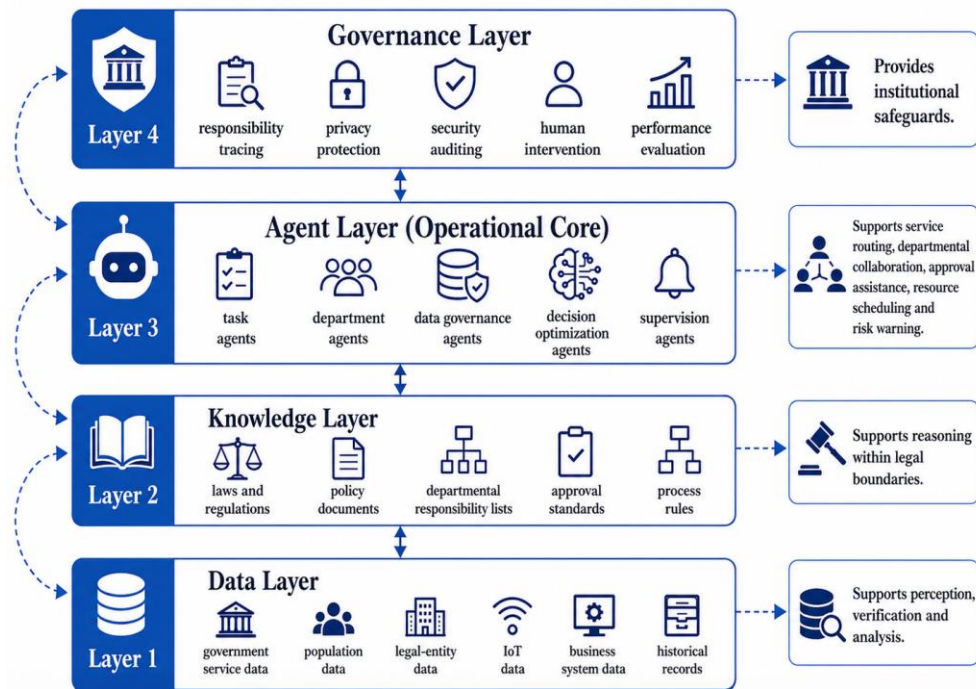


Figure 1. Four-layer Architecture of Multi-Agent Collaboration in Smart Governance

The Data Layer provides resources for perception, verification, and analysis, including government service data, population data, legal-entity data, IoT data, business system data, and historical records. The Knowledge Layer contains laws, regulations, policy documents, departmental responsibility lists, approval standards, and process rules, enabling agents to reason within legal boundaries [15].

The Agent Layer is the operational core, including task agents, department agents, data governance agents, decision optimization agents, and supervision agents. These agents support service routing, departmental collaboration, approval assistance, resource scheduling, and risk warning [16]. The Governance Layer provides safeguards such as responsibility tracing, privacy protection, security auditing, human intervention, and performance evaluation.

Overall, this chapter shows that multi-agent collaboration can transform smart governance from platform-based service integration into intelligent workflow coordination, improving administrative efficiency and urban governance capacity while maintaining institutional control.

5. Evaluation and Comparative Analysis: Case Comparison and Efficiency Assessment

5.1. Comparative Dimensions

The five cases discussed in this study reflect different paths through which Agent-based collaboration can support smart governance. Although their technical maturity and

institutional contexts vary, they all demonstrate the transition from fragmented service delivery to more integrated, adaptive, and citizen-centered governance. Table 3 compares these cases according to their core scenarios, Agent collaboration features, and optimization objectives.

Table 3. Comparative Analysis of Agent Collaboration in Smart Governance Cases

Case	Core Scenario	Agent Collaboration Feature	Optimization Objective
Estonia's Bürokratt	Government virtual assistant network	Collaboration among AI assistants across institutions	Reducing consultation and service-entry complexity
Finland's AuroraAI	Life-event-based service matching	Coordination among public, private and social service providers	Improving service precision
Singapore's LifeSG	One-stop life services	Multi-agency service integration and personalized recommendation	Enhancing user experience
Shanghai's "Government Online-Offline Shanghai" and "One Network Unified Management"	One-stop service delivery and urban governance	Data sharing and cross-departmental workflow circulation	Reducing materials, procedures and physical visits
Hangzhou City Brain	Urban operation and risk warning	Real-time sensing, analysis and resource scheduling	Improving response speed and governance efficiency

As shown in Table 3, the cases can be divided into two broad categories. The first category focuses on public service delivery, represented by Bürokratt, AuroraAI, and LifeSG. These cases aim to simplify access, identify user needs, and provide more personalized services. The second category focuses on administrative coordination and urban governance, represented by Shanghai and Hangzhou. These cases emphasize data sharing, workflow integration, real-time monitoring, and dynamic resource allocation.

5.2. Service Efficiency Assessment Indicators

The value of Agent technology in smart governance should be evaluated not only by technological sophistication but also by its contribution to public service efficiency and administrative quality. This paper proposes several indicators for assessing the performance of multi-agent collaboration.

Average processing time can measure whether Agent-based task allocation reduces delays in administrative procedures. If citizen requests can be automatically classified, decomposed, and routed to responsible departments, the total processing time should decrease. The number of repeated material submissions reflects the effectiveness of data

sharing and certificate reuse. A well-designed Data Governance Agent should reduce the need for citizens to submit the same information repeatedly.

The number of interdepartmental transfers can indicate whether the workflow is properly organized. Excessive transfers may suggest unclear responsibility allocation, while optimized Agent coordination should reduce unnecessary circulation. Automatic allocation accuracy measures whether the system can correctly match tasks with responsible agencies. This indicator is particularly important for complex one-stop services involving multiple departments.

The first-time completion rate evaluates whether citizens can complete services without repeated corrections, supplementary submissions, or offline visits. User satisfaction reflects the perceived quality of the service experience, including convenience, transparency, and responsiveness. The manual customer-service transfer rate can show whether intelligent assistants effectively solve routine problems while still identifying cases that require human intervention [17].

For urban governance scenarios, additional indicators are needed. The early-warning lead time measures how much earlier risks can be detected before they escalate. The resource scheduling response time evaluates how quickly relevant departments can be mobilized after an incident is identified. Together, these indicators provide a more comprehensive evaluation framework covering both administrative service efficiency and real-time governance capacity.

5.3. Cross-Case Findings

Several findings can be drawn from the comparative analysis [18]. Bürokratt represents the clearest direction toward a multi-agent government service network. Its significance lies in the idea that different public-sector virtual assistants can communicate, classify requests, and route services across institutional boundaries. This model directly reflects the logic of Agent collaboration.

AuroraAI highlights the importance of shifting from departmental logic to life-event logic. Instead of asking citizens to search for services according to administrative categories, the system attempts to identify life situations and match services accordingly. This approach is highly compatible with the Citizen Request Agent and Service Matching Agent proposed in this study.

LifeSG demonstrates that one-stop platforms are an important foundation for future Agent collaboration [4, 5]. Although it is not a complete multi-agent system, its integration of services, eligibility checks, and personalized recommendations creates the conditions for developing personal government assistants and department service agents.

Shanghai and Hangzhou illustrate that data sharing, city sensing, and scheduling platforms are essential infrastructures for multi-agent governance. Shanghai emphasizes cross-departmental workflow integration, while Hangzhou highlights real-time urban perception and decision optimization. These cases show that Agent collaboration depends on both digital service platforms and data-driven operational systems [2].

Overall, the core value of multi-agent systems in smart governance is not limited to automated consultation. More importantly, Agent technology can support process orchestration, task coordination, cross-departmental collaboration, and dynamic decision-making [13]. This broader function makes multi-agent collaboration a promising mechanism for improving both public service efficiency and governance responsiveness.

6. Discussion and Conclusion: Risks, Governance Mechanisms and Future Directions

This paper argues that multi-agent collaboration can play three major roles in smart governance. First, it improves task allocation by decomposing complex administrative matters into executable subtasks and assigning them to appropriate departments. This is particularly useful for one-stop services such as business registration, medical insurance reimbursement, and public rental housing applications. Second, it strengthens cross-departmental collaboration. Through Department Agents, Coordination Agents, and Data Governance Agents, government agencies can share information, clarify responsibilities,

and reduce procedural fragmentation. Third, it supports dynamic decision optimization. In urban governance scenarios, agents can collect real-time data, identify risks, predict impacts, and adjust resource allocation according to feedback, enabling faster responses to traffic congestion, disaster warnings, public health emergencies, and urban safety incidents.

However, the application of multi-agent systems in government also involves significant risks. The first challenge is data privacy and government data security, because smart governance depends on large-scale data sharing across departments and platforms. If data access is excessive or poorly controlled, public trust may be weakened. The second challenge concerns decision errors and accountability. When an Agent assigns a task incorrectly, rejects an application unfairly, or recommends an inappropriate response plan, responsibility may be difficult to determine. In addition, unclear departmental authority may create conflicts between automated workflow coordination and legal administrative responsibility. Algorithmic bias may also affect equal access to public services, especially when training data contain historical inequalities. Black-box decision-making and insufficient explainability further reduce transparency. Therefore, high-risk matters should not be fully automated without human judgment.

To manage these risks, smart governance should adopt a human-centered and accountable Agent governance framework. A human-in-the-loop approval mechanism should be established, requiring manual review for high-risk, legally ambiguous, or socially sensitive cases. Governments should also create a public-sector Agent capability registry to define each Agent's functions, accessible data, system interfaces, decision authority, and limitations. Cross-departmental task logs and responsibility-tracing mechanisms are necessary to record how tasks are assigned, processed, and modified. Explainable AI and regular algorithmic auditing should be adopted to improve fairness and transparency. In practice, governments may begin with relatively clear scenarios, such as one-stop services, life-event-based services, and urban incident response, before expanding to more complex fields. Future research can further examine how large-language-model-driven government agents integrate with traditional administrative systems, how multi-agent negotiation can meet legal requirements in administrative approval, and how different countries adapt Agent-based smart governance to their own institutional contexts.

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